Appeal No. 05-1062

In the

United States Court of Appeals

for the

Federal Circuit

LIZARDTECH, INC.,

Plaintiff-Appellant,

v.

EARTH RESOURCES MAPPING, INC.
and EARTH RESOURCE MAPPING PTY LTD.,

Defendants-Appellees.

Appeal from the United States District Court for the Western District of Washington in Case No. 2:99-CV-01602, Judge John C. Coughenour.

BRIEF OF THE PLAINTIFF-APPELLANT LIZARDTECH, INC.

PHILIP P. MANN
MANN LAW GROUP
1420 Fifth Avenue, Suite 2200
Seattle, WA 98101
(206) 224-3553

ROBERT J. CARLSON
KEVAN L. MORGAN
CHRISTENSEN O'CONNOR JOHNSON & KINDNESS PLLC
1420 Fifth Avenue, Suite 2800
Seattle, WA 98101
(206) 682-8100

Attorneys for Plaintiff-Appellant

DECEMBER 21, 2004

Counsel Press, LLC (202) 783-7288 * (888) 277-3259

CERTIFICATE OF INTEREST

Counsel for Appellant LizardTech, Inc., certifies the following:

1. The full name of every party or amicus represented by me is:

LizardTech, Inc.

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is:

LizardTech, Inc.

3. The parent companies, subsidiaries (except wholly-owned subsidiaries), and affiliates that have issued shares to the public, of the party or amicus represented by me are:

Celartem Technology USA, Inc.; Celartem Technology, Inc.

4. The name of all law firms and the partners or associates that appeared for the party or amicus now represented by me in the trial court or agency or are expected to appear in this court are:

Philip P. Mann
MANN LAW GROUP
1420 Fifth Avenue, Suite 2200
Seattle WA, 98101
Telephone: 206.224.3553

Bruce E. O'Connor
Robert C. Carlson
Kevan L. Morgan
Gregory F. Wesner
Steven V. Gibbons
Christensen O'Connor Johnson Kindness PLLC
1420 Fifth Avenue, Suite 2800
Seattle, WA 98101-2347
Telephone 206.682.8100
Fax. 206.224.0779

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STATEMENT OF RELATED CASES

An appeal in this case was previously before this court as Appeal No. 01-1343, captioned "*LizardTech, Inc. v. Earth Resources Mapping, Inc., and Earth Resource Mapping Pty Ltd.*" On May 22, 2002 a panel composed of Judges Lourie, Schall and Gajarsa agreed with LizardTech that the District Court improperly granted summary judgment of non-infringement after misconstruing the claims of the subject U.S. Patent No. 5,710,835. In its unreported May 22, 2002 decision, the panel reversed the District Court and remanded the case for further proceedings consistent with its holding. (A0100-0113) The case now returns to this court following that remand.

At the time of the earlier appeal, an appeal in a separate but related case was also before this Court. That related appeal, Appeal No. 01-1344, captioned "*LizardTech, Inc. v. Earth Resource Mapping, Inc., Earth Resource Mapping Pty Ltd, and Earth Resource Mapping Ltd.*" was also decided in LizardTech's favor on May 22, 2002 by the same panel composed of Judges Lourie, Schall and Gajarsa and remanded for further proceedings consistent with its holding. The action underlying that related appeal has since been concluded and no longer remains pending.

There are no other cases known to counsel to be pending in this or any other court that will directly affect or be directly affected by this court's decision in the pending appeal.

STATEMENT OF JURISDICTION

(a) Jurisdiction in the District Court was based upon 28 U.S.C. § 1338(a).

(b) This Court's jurisdiction is based on 28 U.S.C. § 1295(a), this being an appeal from a final decision of a District Court having jurisdiction under 28 U.S.C. § 1338(a).

(c) This appeal is timely under Fed. R. App. P. 4. A final judgment was entered by the District Court on October 6, 2004. A timely Notice of Appeal to this Court was filed on October 29, 2004.

STATEMENT OF THE ISSUES

1. Did the District Court commit reversible error in holding on summary judgment that Claims 21-25 and 27-28 of U.S. Patent No. 5,710,835 are invalid under 35 U.S.C. §112 as being inadequately described?

2. Did the District Court commit reversible error in holding on summary judgment that Claim 21 of U.S. Patent No. 5,710,835 is invalid under 35 U.S.C. §103 as being obvious in view of U.S Patents No 5,204,916 (Hamilton) and No. 5,563,960 (Shapiro)?

3. Did the District Court commit reversible error in holding on summary judgment that Claims 1 and 13 of U.S. Patent No. 5,710,835 are not infringed?

STATEMENT OF THE CASE

LizardTech Inc. ("LizardTech") is the exclusive licensee of U.S. Patent No. 5,710,835 ("the '835 patent") issued to Jonathon N. Bradley on January 20, 1998 and assigned to the Regents of the University of California, Office of Technology Transfer ("the University"). (A0114-0127) LizardTech's image compression software products are protected under one or more claims of the '835 patent, and LizardTech is authorized by the University to enforce the '835 patent against infringement by others. Earth Resource Mapping ("ERM") produces, distributes and sells software products in competition with LizardTech. This case arises from Earth Resource Mapping's unauthorized manufacture, use and sale of image compression technology in violation of rights under that license and patent.

On October 6, 1999, LizardTech sued ERM in the United States District Court for the Western District of Washington at Seattle, alleging infringement of the '835 patent. This appeal arises directly form the District Court's March 18, 2004 summary judgment order dismissing LizardTech's patent infringement claims and its subsequent grant of Final Judgment in ERM's favor on October 6, 2004. (A0001-0022)

This case was previously before this Court as Appeal No. 01-1343. On May 22, 2002 a panel consisting of Judges Lourie, Schall and Gajarsa agreed with LizardTech that the District Court improperly granted summary judgment of non-

infringement against LizardTech based on its improper construction of the '835 patent claims. *LizardTech, Inc. v. Earth Resources Mapping, Inc.*, 35 Fed. Appx. 918, No. 01-1343. (A0100-0133) The panel reversed the District Court and remanded the case for further proceedings consistent with its holding.

Following remand, the District Court appointed a Special Master to consider various issues raised by ERM and provide recommendations to the court regarding disposition of those issues. In particular, the Special Master considered claim construction issues once again raised by ERM and made recommendations to the District Court regarding those issues. The District Court adopted those claim construction recommendations without change. (A0023-0026)

Thereafter, at the direction of the District Court, the Special Master considered and made recommendations as to motions for summary judgment made by ERM concerning the validity and infringement of LizardTech's patent claims. Although the Special Master made recommendations in LizardTech's favor as to some of the summary judgment issues and against LizardTech as to others, the District Court rejected those recommendations favorable to LizardTech while adopting those unfavorable to LizardTech. The District Court then dismissed all of LizardTech's patent infringement causes of action on October 6, 2004. (A0001)

This case returns to this Court following the District Court's summary judgment dismissal of LizardTech's patent infringement claims on remand.

STATEMENT OF FACTS

A. Following Remand, The District Court Appointed A Special Master To Consider And Provide Recommendations As To Remaining Claim Construction Issues.

This case returns to the Federal Circuit following this Court's remand to the District Court on May 22, 2002. (A0135) During the prior appeal, this Court found that the District Court misconstrued the claims of U.S. Patent No. 5,710,835 ("the '835 patent") and improperly granted summary judgment of non-infringement based on that misconstruction. In its May 22, 2002 decision, this Court set out the proper construction for all claim terms in dispute and remanded the case for further consideration consistent with its holdings. (A0100-0113)

Upon remand, the District Court appointed a Special Master to resolve any remaining claim construction issues and make recommendations as to their disposition. During the proceedings before the Special Master, ERM again raised claim construction issues that had previously been considered and decided by this Court. The Special Master, over LizardTech's objections, concluded he had jurisdiction to resolve those issues and conducted a hearing. On December 21, 2002, the Special Master issued his "Special Master's Report and Recommendation on Claim Construction" (hereinafter, "Report on Claim Construction"). (A0734-0774) Although LizardTech did not agree that the Special Master had jurisdiction to revisit issues previously raised before this Court,

the Special Master substantially adopted LizardTech's proposed claim construction, thereby rendering that issue moot. The District Court adopted the Special Master's Report on Claim Construction without change on March 27, 2003 (A0023-0026).

B. ERM Then Filed Motions For Summary Judgment That Certain Claims Of The '835 Patent Are Invalid While Others Are Not Infringed. The District Court Directed The Special Master To Consider And Provide Recommendations As To These Motions.

The '835 patent contains three independent claims. ERM infringes each of these independent claims, as well as many of the dependent claims based thereon, through manufacture, distribution and sale of image compression software products, including its "ER Mapper" software.

Following the District Court's adoption of the Special Master's Report on Claim Construction, ERM filed two motions for summary judgment. In the first of its motions, ERM argued that the broadest of the independent claims (Claim 21) is invalid on two grounds, namely lack of adequate description, and obviousness in view of prior art. In the second of its motions, ERM argued that the narrower independent claims, namely Claims 1 and 13, are not infringed. ERM did not challenge the validity of Claims 1 and 13 on any ground. The District Court directed the Special Master to make recommendations with respect to each of these motions. (A0093)

C. ERM's Motion For Summary Judgment That Independent Claim 21 Is Invalid For Failure To Meet The "Written Description" Requirement Of 35 U.S.C. § 112.

1. ERM Argued That Claim 21 Is Inadequately Described Even Though Each Step Specified By The Claim Is Described In The Patent Specification, And Even Though Claim 21 Itself Was Part Of The Patent Application As Filed And Was Allowed And Issued Without Amendment.

In the first of its motions for summary judgment, ERM argued that Independent Claim 21 fails to satisfy the "written description" requirement of 35 U.S.C. §112. In opposition to that motion, LizardTech established beyond question that each and every step specified by Claim 21 is, in fact, described in the '835 patent specification – a finding noted in the Special Master's subsequent report. (A0033) In particular, LizardTech demonstrated that the '835 patent specification adequately supports Claim 21 and pointed out where in the '835 patent specification each step specified in Claim 21 is found and described. LizardTech further pointed out that narrower Independent Claim 1 of the '835 patent – whose validity has not been challenged by ERM – itself includes verbatim each and every step specified by Claim 21. (A0032) LizardTech also showed that Claim 21 was part of the original patent application as filed and was itself allowed and issued without amendment. (A0031) Finally, LizardTech showed that nothing in the '835 patent constitutes the type of "clear, unambiguous statement in the specification" that this Court relied on, in part, to reach the result it did in *Gentry Gallery, Inc. v. Berkline Corp.*, 134 F.3d 1473 (Fed. Cir. 1998). (A0036)

2. The Special Master Properly Rejected ERM's "Lack Of Written Description" Challenge To Claim 21 And Properly Recommended That ERM's Motion Not Be Granted.

Following consideration of, and a hearing on, ERM's motion that Claim 21 is invalid for failing to meet the "written description" requirement of 35 U.S.C. § 112, the Special Master issued his "Report and Recommendations on Defendants' Motion for Partial Summary Judgment that Certain Claims of U.S. Patent No. 5,710,835 are Invalid" (hereinafter, "Report on Invalidity"). (A0027-0039) In his Report on Invalidity, the Special Master correctly and properly recommended that ERM's summary judgment not be granted. In particular, the Special Master correctly noted that each and every step specified by Claim 21 is, in fact, described in the '835 patent specification. (A0033) The Special Master further noted, correctly, that Claim 21 appeared in the original patent application *as filed* and was ultimately allowed *without amendment*. (A0031) Thus, Claim 21 itself constitutes part of the original disclosure. Finally, the Special Master correctly noted that the '835 patent "does not so clearly and unambiguously *exclude* the method of claim 21 as to lack written description to support it." (Emphasis in original.) (A0036) Accordingly, the Special Master correctly concluded that summary judgment should not be granted that Claim 21 is invalid.

3. Following The Rejection Of ERM's Motion By The Special Master, ERM Filed Objections With The District Court.

Having failed to persuade the Special Master, ERM then filed objections to the Report on Invalidity with the District Court. In its objections, ERM argued that the Special Master applied the incorrect law. In particular, ERM argued that this Court's holding in *Turbocare v. General Electric Co.*, 264 F.3d 1111 (Fed. Cir. 2001) is controlling and supersedes that in *Gentry Gallery*. Surprisingly, at the hearing on ERM's objection, the District Court, after hearing ERM's full argument on the written description issue, and without ever hearing from LizardTech, declined even to let LizardTech's counsel address the issue. Following ERM's counsel's extensive argument on the entire 35 U.S.C. § 112 issue, the following exchange occurred:

> MR. SHELTON: ...If there is nothing, then that does require the type of undue experimentation that shows that the enablement requirement has not been satisfied. Thank you, Your Honor.
>
> THE COURT: Thank you, gentlemen. You will be hearing from me shortly.
>
> MR. MANN: Your Honor, may I respond to –
>
> THE COURT: I don't think I need any more.
>
> THE CLERK: All rise. Court is adjourned.

(A1864)

4. The District Court Improperly Overruled The Special Master And Improperly Rejected His Recommendation That ERM's Motion Not Be Granted.

In its March 18, 2004 Order, the District Court rejected the Special Master's Report on Invalidity and granted summary judgment in ERM's favor. In particular, the District Court held that the Special Master's reliance on *Gentry Gallery* was misplaced and that this Court's holding in *Turbocare* somehow applied. (A0015-0016) The District Court held that *Gentry Gallery* did not impose a requirement for express disavowal of what would otherwise be encompassed by an original claim and concluded that:

> [I]n *Turbocare,* decided subsequently to Gentry Gallery, the Federal Circuit found just the opposite. The *Turbocare* court addressed a written description issue in the context of the original claim describing a specific location of a spring, and the patentee's subsequent attempt to add dependent claims in which the spring would be located elsewhere.

(A0015)

In reaching this conclusion, the District Court cited *Turbocare* for the proposition that, "summary judgment is appropriate where the specification is lacking in any description of an embodiment." (A0016) The District Court nowhere addressed the indisputable fact that Claim 21, as part of the original disclosure, *itself* provides description. Nor did the District Court address the

indisputable fact that the steps specified by Claim 21 are, in fact, described in the '835 patent specification.

The District Court reached its erroneous conclusion by failing to appreciate that, unlike the case at hand, *Turbocare* involved a claim that was not part of the original application and that was added during prosecution well after the application was filed. Furthermore, in *Turbocare,* the patent specification itself had been amended after filing, and the issue in that case was whether the specification as originally filed "inherently" disclosed what was later claimed and added. In the present case, Claim 21, as allowed and issued, *was* part of the original disclosure. Thus, unlike in *Turbocare,* the present case *does not* involve the question of whether later added claims were supported by the patent specification as filed. Nor does the present case raise the question of whether matter subsequently added to a specification was nevertheless "inherently" disclosed by the specification. Again, there is no question that the steps specified by Claim 21 are described in the '835 patent specification, that Claim 21 was part of the '835 patent application as filed, and that Claim 21 was allowed and issued without amendment. The facts here are completely different from those in *Turbocare.*

D. ERM's Motion For Summary Judgment That Independent Claim 21 Is Invalid Under 35 U.S.C. § 103 As Being "Obvious" In Light Of The Prior Art.

ERM further moved for summary judgment that Claim 21 is "obvious" under 35 U.S.C. § 103 in view of U.S. Patents No. 5,563,960 (Shapiro) and No. 5,204,916 (Hamilton). (A1084-1105; A1107-1163) In its motion, ERM alleged that Shapiro "inherently or explicitly discloses the first, third, fourth, fifth and sixth elements of Claim 21." The second element, which ERM itself acknowledged Shapiro fails to teach, specifies "defining a plurality of discrete tile image data $T_{ij}(x,y)$ subsets, where said complete set of image data I(x.y) is formed by superposition of said discrete tile image data $T_{ij}(x,y)$." ERM further alleged that this missing second element is taught by Hamilton and that the "motivation or suggestion" to combine Hamilton with Shapiro comes from within the Hamilton patent. (A0980-0981)

1. LizardTech Submitted Substantial Evidence In Opposition To ERM's Motion For Summary Judgment. LizardTech's Expert, Dr. Stanley Osher, Testified It Would *Not* Be Obvious To One Skilled In The Art To Combine The Teachings Of Shapiro And Hamilton And Provided His Reasons Why.

In opposition to ERM's summary judgment motion, LizardTech provided the declarations of its technical expert, Dr. Stanley Osher, who testified ERM's argument is flawed for two reasons. (A1240-44) *First,* Dr. Osher testified that one skilled in the art would not see any teaching or suggestion in either Shapiro or

Hamilton that their respective teachings be combined. *Second,* Dr. Osher testified that, even if Shapiro and Hamilton are combined, the method specified by Claim 21 does not result.

In opposition to ERM's bare-bones assertions, Dr. Osher testified that "the process described by Shapiro does not teach or even suggest a method for selectively viewing areas of an image at multiple resolutions as described and claimed in Claim 21 of the '835 patent." (A1243) This followed from Dr. Osher's additional testimony and observations that, "Shapiro discloses a system for emphasizing a selected region of an image by allocating more bits to the selected region when compressing the image...," that "Shapiro provides a modified image prior to transformation and compression," and that "Shapiro is not concerned with viewing areas of an image that are selected for viewing after the image has been transformed and compressed." (A1242-1243; ¶¶9 & 10) Dr. Osher further testified that he "did not see any teaching in Shapiro suggesting that the bit-emphasizing technique [Shapiro] discloses would work with an image divided into tiles," and that he "did not see any teaching in Shapiro that suggests tiling is even desirable." (A1243; ¶11) On the contrary, Dr. Osher noted that, "Shapiro is not concerned with reducing memory requirements during the process of image compression." (A1243; ¶11)

As to ERM's claim that it would be obvious to combine the teachings of Shapiro and Hamilton, Dr. Osher testified that, unlike Shapiro, Hamilton "deals with image processing in real space, not wavelet space," and that, even if Shapiro and Hamilton were combined, "the combination does not disclose all the elements recited in Claim 21 and does not render obvious the invention claimed in Claim 21." (A1243-1244, ¶12) Accordingly, and for these reasons, Dr. Osher concluded that, "at the time the '835 patent was filed...the invention claimed in Claim 21 of the '835 patent would not have been obvious to one of ordinary skill in the art in view of any combination of Hamilton and Shapiro." (A1243-1244, ¶12)

2. Effectively Usurping The Role Of A Jury, The Special Master Impermissibly Decided The Weight And Credibility Of Dr. Osher's Testimony.

In his subsequent Report on Obviousness, the Special Master impermissibly considered the weight of Dr. Osher's testimony and his credibility as a witness rather than confine himself to the proper role of determining whether there are any genuine issues of material fact. In particular, the Special Master accused Dr. Osher of "evasive and conclusory statements" and in essence argued with Dr. Osher over his statements. (A0047) Despite the fact that Dr. Osher and ERM's expert, Dr. Gray, drew vastly different conclusions regarding the combinability of Shapiro and Hamilton, the Special Master states that, "Dr. Osher...does not contradict Professor Gray's summary in any material way." (A0046) With respect

to each of the operative statements made by Dr. Osher to support his conclusion, the Special Master took it upon himself to refute those statements.

For example, after acknowledging the truth of Dr. Osher's statement that, "Shapiro does not teach or even suggest a method for selectively viewing areas of an image at multiple resolutions as described in Claim 21 of the '835 patent," the Report on Obviousness then challenges Dr. Osher with the Special Master's own claim that Shapiro nevertheless "indicates such methods are known." (A0046)

After acknowledging that "Dr. Osher correctly points out that Shapiro is 'primarily concerned' with emphasizing regions of an image *before compression,"* the Special Master himself then cites to other parts of Shapiro to challenge Dr Osher's conclusions. (A0046)

As to Dr. Osher's clear and dispositive testimony that he "did not see any teachings in Shapiro suggesting that the bit-emphasizing technique he discloses would work with an image divided into tiles" the Special Master accuses Dr. Osher of missing the point. (A0046) That, however, is precisely the point. If the supposedly invalidating combination of references would not work, their combination *cannot* render obvious the method of Claim 21 which indisputably *does* work. *See, McGinley v. Franklin Sports, Inc.,* 262 F.3d 1339, 1354 (Fed. Cir. 2001).

After purportedly acknowledging as "true" Dr. Osher's testimony that "Shapiro is not concerned with reducing memory requirements during the process of image compression," the Special Master then goes on to *challenge* the accuracy of that very statement with the speculative assertion that, "If not 'concerned,' Shapiro is plainly aware of the desirability of reducing memory requirements." (A00547)

Finally, and with apparent disregard for all Dr. Osher had to say earlier about Shapiro and Hamilton and their respective teachings, the Special Master dismisses Dr. Osher's ultimate conclusion with the unfair and inaccurate accusation that Dr. Osher's testimony is "evasive and conclusory" and does not explain why the teachings of Shapiro are not combinable with those of Hamilton. (A0047)

3. LizardTech Properly Filed Timely Objections To The Special Master's Report On Obviousness. Dr. Osher Also Provided Supplemental Testimony Supporting His Conclusions.

Following the Report on Obviousness, LizardTech filed timely objections with the District Court. In its objections, LizardTech pointed out that the Special Master clearly went beyond the role of determining whether evidence (in this case expert testimony) exists to support opposite conclusions as to an issue of material fact (in this case the "obviousness" of combining Shapiro with Hamilton) and

instead decided the issue of whose expert is more credible. LizardTech also provided a supplemental declaration from Dr. Osher, challenging and addressing the supposed deficiencies in his testimony. (A1838-1842) In particular, Dr. Osher clarified that, "there is a distinction between *storage* memory required for storing a file (such as an image) and *processing* memory required for processing a file (such as compressing an image)." (A1839; ¶5) He also clarified that although "[d]ata compression is useful for reducing the size of a file so it will occupy less space when stored in memory," the "manage[ment of] processing memory required to perform the data compression is a distinct and different endeavor." (A1839: ¶5) (Emphasis in original.) Based in part on these distinctions, Dr. Osher further testified that "Shapiro provides no discussion of reducing the memory required to *perform* the image compression" and that this distinction between memory needed to perform image compression as opposed to memory needed to store a compressed image provided the basis for his statement that "Shapiro is not concerned with reducing memory requirements during the process of image compression." (A1839-1840; ¶6) (Emphasis in original.)

Clarifying still further, Dr. Osher testified that "Hamilton, on the other hand, discloses tiling an image in the context of image rotation and half-toning" and that "Hamilton...deals with image processing in real space, not wavelet space." As a result, "Hamilton is not processing an image for purposes of data compression."

(A1840: ¶7) "Based on these specific facts," Dr. Osher reiterated that he "do[es] not believe one having ordinary skill in the art of digital image processing could combine the teachings of Hamilton with those of Shapiro to obtain the invention in Claim 21." (A1840; ¶7)

Dr. Osher then addressed the Special Master's claim that Dr. Osher does not explain what specific elements of Claim 21 would not be disclosed by the combination of Hamilton and Shapiro. In response to this misstatement by the Special Master, Dr. Osher referred to paragraph 10 of his earlier declaration where he pointed out that Claim 21 of the '835 patent is expressly directed to "a method for selectively viewing areas of an image at multiple resolutions" whereas "Shapiro is not concerned with viewing areas of an image that are selected for viewing after the image has been transformed and compressed." (A1840; ¶9) Dr. Osher testified further that, unlike the Shapiro method which "emphasiz[es] a selected region in an image before compression so that, on decompression of the image, the selected region appears within the image with better quality," the method defined by Claim 21 functions far differently. (A1840-1841; ¶¶ 9 & 10) Instead of selecting a viewing portion of an image before compression as in Shapiro, elements 4, 5 and 6 of Claim 21 recite "selecting a viewing set" of the image for viewing, "determining a viewing set of said DWT wavelet coefficients that support said viewing set" and

"forming from said subset of said DWT coefficients a computer display" of the selected viewing set. All this takes place after compression.

After thus identifying the important distinctions between these steps actually recited by Claim 21 and the method disclosed by Shapiro, Dr. Osher's testified that "this enables the user to selectively view areas of the image (as stated in Claim 21), after it has been compressed, using only those DWT coefficients that are needed to support that selected view" and that, unlike in Shapiro, "the entire image need not be decompressed." (A1840-1841; ¶10) Dr. Osher then testified in clear, unambiguous terms that, "Those elements of Claim 21 (i.e., elements 4, 5, and 6) are absent from Shapiro, and are not supplied by Hamilton." (A1841; ¶ 11)

Finally Dr. Osher addressed the Special Master's claim that Shapiro's "background" teaches hierarchical subband decomposition of an image. In response to this claim, Dr. Osher testified that "Enabling a user to select the resolution at which to view an image, as provided by the prior art, should not be confused with enabling a user to selectively view areas of a compressed image (such as "the lower left corner" or "the middle part of the upper edge") and decompress only those DWT coefficients that are needed to view that area." (A1841; ¶12) Accordingly, Dr. Osher concluded and testified that the Special Master's reference to Shapiro's background teaching of prior art methods "does not impact the nonobviousness of Claim 21." (A1841; ¶12) Again, elements 4, 5

and 6 of Claim 21 describe a different process (i.e. enabling a user to view selected portions of a compressed image) than that of the prior art (i.e. permitting a user to view an entire image at different resolutions).

4. The District Court Improperly Rejected LizardTech's Challenge To The Report On Obviousness And Improperly Granted Summary Judgment That Claim 21 Is Obvious In View Of Shapiro And Hamilton.

Despite Dr. Osher's testimony, the District Court granted summary judgment that Claim 21 is rendered obvious by Shapiro and Hamilton. In so doing, the District Court simply reiterated the Special Master's conclusions and plainly failed to consider evidence indisputably submitted by LizardTech.

For example, the District Court's Order states, "Dr. Osher does not explain what specific elements of claim 21 would *not* be disclosed by the cited combination of references." (A0011) This however clearly ignores paragraphs 10 and 11 of Dr. Osher's supplemental declaration wherein he clearly states that "elements 4, 5, and 6" of Claim 21, "are absent from Shapiro, and are not supplied by Hamilton." (A1840-1841; ¶¶ 10 & 11)

Similarly, the District Court repeated the Special Master's inaccurate challenge to Dr. Osher's testimony that Shapiro is not concerned with reducing memory requirements *during* compression rather than following compression. (A0007) Despite Dr. Osher's express testimony that "it is critical to understand

there is a distinction between *storage* memory...and *processing* memory...," and his further testimony that Shapiro deals with the former while Claim 21 deals with the later (A1839; ¶5), the District Court simply repeated the Special Master's irrelevant and essentially meaningless claim that, "Shapiro is plainly aware of the desirability of reducing memory requirements." (A0009) Neither the Special Master nor the District Court *ever refuted* Dr. Osher's testimony that neither Shapiro nor Hamilton deals with reducing memory requirements during the *process* of DWT compression.

Ultimately, the District Court held it was "satisfied with the Special Master's consideration of the evidence submitted by the parties" and agreed "with his overall assessment and recommendation." (A0011) The District Court further stated that, "Plaintiff's expert offered conclusions, consisting primarily of opinions not based on specific evidence." (A0011) These statements by the District Court are in direct conflict with the express content of Dr. Osher's declarations and are thus factually incorrect.

E. ERM's Motion For Summary Judgment Of Non-Infringement As To Claims 1 and 13.

ERM has not challenged the validity of Independent Claims 1 and 13 of the '835 patent, which are narrower in scope than Claim 21. Instead, ERM alleges the method used in its ER Mapper and other products does not infringe either claim.

ERM's non-infringement argument is based its claim that the method it employs does not include the step of "maintaining updated sums of ... DWT coefficients" as called for by each claim.

1. This Court Previously Considered The Claimed Step Of "Maintaining Updated Sums Of Said Coefficients."

During the prior appeal of this action, ERM raised, and this Court considered, issues regarding the claimed step of "maintaining updated sums of said coefficients." (A0111) During the prior appeal, ERM argued there that its use of a "single row" tile and its processing of the resulting DWT coefficients fails to constitute "maintaining updated sums of said coefficients" and thus falls outside the scope of Claims 1 and 13 and their dependent claims.[1] In response to these arguments, this Court expressly held that, "the fact that ER Mapper utilizes coefficients adduced after performing only part of the DWT process in future calculations does not mandate a finding of non-infringement as a matter of law." (A0112) Continuing, this Court further held, "ERM has not propounded an

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[1] Because the parties agreed that Claim 1 was representative of all claims for purposes of claim construction, only Claim 1 was considered in detail in the prior appeal. (A101) It will be understood that the step of "maintaining updated sums" appears in both Claim 1 and 13 and has the same meaning in each claim.

argument, let alone an argument that would persuade us to grant summary judgment of non-infringement on a basis the district court did not address, articulating why the data maintained by ER Mapper, which is obtained by performing at least part of the DWT process, do not, as a matter of law, constitute "sums of DWT coefficients." (A0112)

2. Following Remand, The Special Master Provided Recommendations Regarding Remaining Claim Construction Issues. The District Court Accepted And Adopted The Special Master's Recommendation.

Upon remand, the District Court directed the Special Master to consider whatever additional claim construction issues remained. Over LizardTech's objections, the Special Master revisited the "maintaining updated sums" arguments previously advanced by ERM. ERM again urged that all types of limitations be read into the claims despite their not actually appearing in the claim language. For example, ERM completely revisited the step of "defining a plurality of ... [tiles]" that had been the subject of the original appeal by this time focusing on the meanings of "defining" and "superposition." (A0774-0759) Similarly, ERM proposed that the words, "wherein each tile contains a non-overlapping subset of I(x,y) and zero elsewhere" be read into the claims even though no such language appears anywhere in the claims. (A0744)

ERM also revisited the meaning of "performing one or more discrete wavelet transformation (DWT)-based compression processes on each said time image data $T_{ij}(x,y)$" and proposed that this should be construed as "performing one or more separate and independent two-dimensional DWTs on each tile." (A0759-0760) Again, ERM impermissibly tried to read limitations into the claims that simply are not there. The claim language does not specify "two-dimensional." Nor does it specify "separate and independent." Nor is any such requirement made by the '835 patent specification.

ERM further revisited the "maintaining updated sums" claim element as well. Before the Special Master, ERM argued that this step should be construed to mean "[s]umming (1) the DWT coefficients from tile $T_{ij}(x,y)$ [the subject tile]; and (2) the overlapping DWT coefficients from adjacent tile(s) previously processed to completion; and (3) maintaining a running sum of (1) and (2) to produce a seamless DWT of the image." Again, ERM's proposed limitations regarding "overlapping" and "previously processed to completion" do not appear in the actual claim language. Nor were they required by this Court's previous consideration of the subject claim term.

The Special Master's Report on Claim Construction considered and rejected ERM's proposed constructions finding these were either contrary to this Court's prior rulings or not mandated by the claim language itself, the specification, or

other evidence. In considering the nature of DWT processing, the Special Master noted that, "the total number of output coefficients typically is somewhat greater than the number of input samples." (A0740) In so doing, he correctly recognized that the '835 patent itself states, "Note that DWT 120 effects an expansive transform, that is, the number of nonzero coefficients emanating from the routine is generally greater than the number of pixels that are input to it." (A0740) Later in his Report on Claim Construction, the Special Master expressly noted that:

> There is no disagreement that 'maintaining updated sums of said DWT coefficients' in the context of the '835 patent includes summing overlapping DWT coefficients from two adjacent tiles. Note that the 'adjacent' tiles would be abutting, or side by side, but their respective DWT coefficients overlap because of the expansive nature of the transform explained earlier. This much is not disputed."

(A0771-0772) Thus, the Special Master's Report on Claim Construction itself correctly recognizes that "overlapping" coefficients result whenever a DWT process is performed on "adjacent" tiles and that this necessarily results as an inherent characteristic of the DWT process itself. Again, the Report on Claim Construction correctly notes that "This much is not disputed." (A0771-0772)

3. In Its Motion For Summary Judgment, ERM Set Out In Detail How Its "ER Mapper" Product Operates And What Steps It Performs. ERM Again Urged That Claims 1 And 13 Mean Something Other Than What They Say And Contain Limitations Not Actually Expressed In The Claim Language.

In its motion for summary judgment, ERM claimed that its method does not perform the step of "maintaining updated sums" required by Claims 1 and 13. In making this argument, ERM set out in detail how its accused ER Mapper product functions and what steps it performs in implementing a tile-based DWT process. ERM's own evidence demonstrates that its method infringes. In particular, the declarations submitted by ERM's CEO and founder, Stuart Nixon, and its expert, Dr. Robert Gray, establish that the ERM method in fact *does* perform the step of "maintaining updated sums" as originally construed by the Special Master and adopted by the Court. (A0948-0952; A0864-0873)

The relevant operation of the ERM method is described in Paragraphs 4-7 of the May 2, 2003 Declaration of Stuart Nixon (A0949-0952) and in Paragraphs 6-8 of the May 8, 2003 Declaration of Dr. Gray (A0867-0869) Both declarations show that in "Step 1" of the ERM method, "a line of image data as it appears in the image is read." At the same time, a previously generated line of DWT coefficients "drops off at the top of both the low-pass and high-pass sliding windows." This is described and shown pictorially in Paragraph 4 of the Nixon Declaration. (A0949-0950)

In "Step 2" of the ERM method, a DWT process is performed on the newly read in line of image data to create DWT coefficients. These DWT coefficients are "not added to anything, but rather, are simply placed at the bottom of the sliding window." This is described and shown pictorially in Paragraph 5 of the Nixon Declaration. (A0950)

In "Step 3" of the ERM method, "Steps 1 and 2 are repeated to generate a second line of DWT coefficients." These DWT coefficients too "are placed at the bottom of the sliding window." This is described and shown pictorially in Paragraph 6 of the Nixon Declaration. (A0951)

In "Step 4" of the ERM method, a "vertical one-dimensional DWT is performed on the DWT coefficients resulting from Steps 1 and 3...." This is described and shown pictorially in Paragraph 7 of the Nixon Declaration. (A0951-0952)

The declarations of Dr. Gray and Mr. Nixon further establish that corresponding DWT coefficients from vertically adjacent ones of the pixels in each "tile" used in the ERM method are, in fact, summed and that this summing process is maintained and constantly updated throughout the ERM compression process. In particular, "Graphic Exhibit 3" of the Nixon declaration shows a "2nd New Line of DWT coefficients" being placed below a "1st New Lind of DWT Coefficients" with a direct one-to-one correspondence of coefficients in each vertical column.

(A0951) The Nixon declaration then goes on to say that, "In Step 4 of the ERM method, the vertical one-dimensional DWT is performed on the DWT coefficients resulting from Steps 1 through 3, to generate a line of the four sub-bands." (A0951) Finally, at paragraph 8 of his declaration, Mr. Nixon states, "The process repeats recursively for all levels until all sub-bands for all levels of the entire image have been completed. (A0952) In paragraph 13 of his declaration, Dr. Gray testifies that DWT itself "is a process of multiplying image data (pixel values) by a fixed set of filter values and summing the resulting products to generate an output value." (A0871)[2]

In view of the foregoing, ERM's own evidence shows and describes a "vertical one dimensional DWT" being performed on two or more vertically adjacent lines or tiles of DWT coefficients.

At the District Court's direction, the Special Master conducted a hearing on ERM's motion for summary judgment of non-infringement. During the hearing,

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[2] Dr. Gray also tries to defuse the profound infringement implications of this fact by arguing that "maintaining updated sums" as used in the patent claim "should not be confused with the mathematics inherent in the prior art DWT process." (A0871) The Court's claim construction order and the actual language of the claims, however, say nothing of the sort. Nor does applicable law.

ERM made the accurate, but nevertheless irrelevant point that DWT coefficients developed at the right and left ends of each single-line tile during *horizontal* DWT processing are in essence discarded and not used in ERM's method. However, ERM did not and could not dispute the irrefutable fact that DWT coefficients developed during *vertical* DWT processing across vertically adjacent lines *are not* discarded and in fact are *added* to each other on a corresponding basis. Nor could ERM refute the fact that, as a result of adding these corresponding DWT coefficients from vertically adjacent tiles, ERM's method produces *exactly the same* output coefficients as the claimed method would when used with single row tiles extending horizontally across the full image width. (A0061) It was on this basis that LizardTech opposed ERM's motion and argued, accurately, that ERM's own evidence establishes that DWT coefficients from vertically adjacent tiles are, in fact, added to each other in a corresponding manner and that the ERM method in fact "maintains updated sums of said DWT coefficients."

4. The Special Master Then Retroactively Changed His Own Prior Claim Construction To Introduce A New "Overlapping" Requirement Narrower Than Anything Appearing In The Prior Report On Claim Construction And Subsequent Court Order.

In his Report on Noninfringement, the Special Master recommended that ERM's motion for summary judgment of non-infringement be granted. In particular, the Report on Noninfringement concluded that ERM's method does not

include "overlapping "DWT coefficients and hence did not perform the step of "maintaining updated sums." In the words of the Report on Noninfringement, "Plaintiff's argument fails in any event...because the DWT coefficients that are summed in the vertical DWT filtering step of the ERM method...are not *overlapping.*" (Emphasis in original) (A0065) This erroneous statement is the *only* basis stated in the Report on Infringement for concluding there is no infringement. No other basis for finding non-infringement is provided anywhere in the Report.

Elaborating on the new significance of "overlapping," (a word that does not actually appear in any of the '835 patent claims), the Report on Noninfringement further states, "The adjective *'overlapping'* in the '835 patent indicates that certain tile coefficients overlap those of a neighboring tile; in other words, image data from both tiles (or at least some data near the border) contribute to the DWT coefficients." (Emphasis in original.) (A0066) This interpretation of "overlapping" – i.e., that "image data from both tiles...contribute to the DWT coefficients" – appears for the very first time only in the Report on Noninfringement. It does not appear in the Report on Claim Construction. Nor does it appear in the '835 Patent itself or in its file history. *Most importantly, it does not appear in the Court's claim construction order.* This is an entirely new construction that appears for the first time only in the Report on Noninfringement and forms the *only* basis stated in the Report for finding no infringement.

5. LizardTech Filed Timely Objections To The Special Master's Report On Infringement.

LizardTech filed timely objections to the Report on Noninfringement. In particular, LizardTech argued that the new construction used by the Special Master, i.e., that "overlapping" requires that "image data from both tiles contribute to the DWT coefficients," was *not* part of the Court's previously entered claim construction order and appeared for the very first time in the Report on Noninfringement. LizardTech further argued that relying on this new construction makes a mockery of the earlier Report on Claim Construction wherein the Special Master himself noted that, in the case of adjacent tiles "respective DWT coefficients overlap because of the expansive nature of the transform" and that "this much is not disputed." Finally, LizardTech argued that, even under this new construction, ERM's product, by its own admission, nevertheless includes "overlapping" coefficients.

6. The District Court Improperly Accepted The Special Master's Report On Noninfringement.

Despite LizardTech's objections, the District Court nevertheless accepted the Report on Noninfringement and granted ERM's motion for summary judgment. In particular, the District Court reasoned that, "in the ERM method, the horizontal DWT coefficients are generated by a DWT filtering applied *only* to that row, but are not influenced by any other row." (Emphasis in original.) (A0018) *This,*

however, totally ignores the vertical DWT coefficients which are generated and summed across vertically adjacent rows and thereby "overlap" even under the overly narrow construction retroactively adopted by the Special Master.

Neither the Special Master nor the District Court ever explained how or why the periodic summation of DWT coefficients generated during *vertical* processing of vertically adjacent tiles in the ERM products does not comprise "maintaining updated sums of said coefficients" within the properly construed meaning of Claims 1 and 13.

SUMMARY OF THE ARGUMENT

A. The District Court Erred In Granting Summary Judgment That Claim 21 Fails To Satisfy The Description Requirement Of 35 U.S.C. § 112.

The District Court improperly held on summary judgment that the method of Claim 21 is not adequately described in the '835 patent specification. It is undisputed that each and very step recited by Claim 21 is explicitly and painstakingly described in the patent specification. Each and every step recited by Claim 21 is, in fact, *also* recited by Claim 1, a claim whose validity has not been challenged.

In holding Claim 21 invalid, the District Court mistakenly relied on this Court's inapposite holding in *Turbocare.* In *Turbocare,* the claims at issue were only added after the subject patent application was filed. They did not constitute

part of the original disclosure. Nor did the specification describe what was later claimed – it, too, was amended after filing to describe the later added claims. Thus, the issue in *Turbocare* was whether the specification as filed inherently disclosed what was later claimed. Here, by contrast, there is no question that Claim 21 *was* part of the '835 patent application as filed, *was* allowed without amendment, and clearly constitutes part of the original patent disclosure.

Nor is this Court's holding in *Gentry Gallery* applicable. Unlike here, the subject claims in *Gentry Gallery* were not added until well after the patent application was filed. Unlike in *Gentry Gallery*, there is absolutely no question that the inventor in the '835 patent *did* consider the method described by Claim 21 to be his invention, and *did* recognize that method as his invention at the time he filed his patent application. Not only did the Special Master correctly find that nothing in the '835 patent "clearly and unambiguously *exclude[s]* the method of Claim 21," it is unnecessary even to apply the analysis in *Gentry Gallery*. The facts are altogether dissimilar.

Because each and every step of Claim 21 is, in fact, described in the '835 patent specification, and because Claim 21 was part of the '835 patent application as filed, the method of Claim 21 is, as a matter of law, adequately and necessarily described within the requirements of 35 U.S.C. §112. The District Court's holding to the contrary ignores indisputable fact and misapplies controlling law. The

District Court's reliance on a perceived "exception" established by *Turbocare* is misplaced. The facts here are far different than those in both *Turbocare* and *Gentry Gallery.*

B. The District Court Erred In Granting Summary Judgment That Claim 21 Is Invalid Under 35 U.S.C. § 103 As Being Obvious In Light Of Shapiro And Hamilton.

The District Court improperly held on summary judgment that Claim 21 is obvious in light of Hamilton and Shapiro. LizardTech's expert, Dr. Stanley Osher, testified that Hamilton and Shapiro do not render Claim 21 obvious for two primary reasons.

First, Dr. Osher testified it would not be obvious to one skilled in the art to combine the teachings of Hamilton with those of Shapiro. Neither Shapiro nor Hamilton addresses reducing memory requirements during the process of DWT compression as opposed to reducing memory requirements after compression is completed. They address altogether different problems. Significantly, neither addresses the problem addressed by Claim 21. As Dr. Osher pointed out in his testimony, the Hamilton and Shapiro references themselves fail to include a teaching, suggestion or incentive that their respective teachings be combined.

Second, Dr. Osher testified that, even if Shapiro and Hamilton are combined, the claimed invention does not result. In particular, Dr. Osher testified that the fourth, fifth and sixth steps specified by Claim 21 are not taught by either Shapiro

or Hamilton. The District committed clear error in holding that Dr. Osher did not identify the elements not taught by Shapiro and Hamilton. The record clearly shows he did.

What Hamilton and Shapiro teach is ascertained from the references themselves and cannot be changed by expert testimony. An objective review of Shapiro and Hamilton shows that Shapiro teaches the use of compression to reduce memory needed to store the resulting compressed data. Shapiro nowhere addresses the problem of reducing memory requirements during DWT processing. Hamilton on the other hand teaches the use of tiling during image rotation. He, too, does not address the problem of reducing memory requirements during DWT processing. The Special Master's conclusion, adopted by the District Court, that "Shapiro is plainly aware of the desirability of reducing memory requirements" is glib and fails to consider what Shapiro actually teaches. It fails also to recognize what one skilled in the art would view Shapiro as actually teaching.

Ultimately, the District Court's principal error was its misplaced focus on the wording of Dr. Osher's declarations, the weight of his testimony and its assessment of his credibility. These are clearly matters for the jury, not the District Court or Special Master, to decide. They are not properly decided on summary judgment.

C. The District Court Erred In Granting Summary Judgment That Claims 1 And 13 Are Not Infringed

Finally, the District Court erred in granting summary judgment that ERM's accused process does not infringe Claim 1 of the '835 patent. There is no dispute as to how ERM's accused ER Mapper product operates or the steps it performs. The facts concerning such operation are clear. Accordingly, the only relevant issue is claim construction, a matter this Court reviews *de novo*.

Based on ERM's own description and evidence of how its products operate, infringement necessarily exists. In particular, there is no question ERM uses a "tile" comprising a single row of pixels extending across the entire image. (This was, in fact, one of the central matters decided during the earlier appeal.) There is no question that the ERM method performs a two-dimensional DWT process – both horizontally along the width of each pixel row *and vertically across vertically adjacent ones of the pixel rows.* There is no question that "because of the expansive nature of the [DWT] transform," the "respective DWT coefficients" of such vertically adjacent tiles necessarily "overlap" as found by the Special Master in his Report on Claim Construction, later adopted in its entirety by the District Court. And there is no question that ERM's process provides *exactly the same result* as the claimed method, which can only be the case if corresponding coefficients from adjacent tiles are added to each other in each process. It was

only by retroactively changing his earlier claim construction that the Special Master was able to avoid a compelled finding of infringement.

The District Court's summary judgment holding of non-infringement rests on an untenable construction of the claims. First, there is no "overlapping" requirement in Claim 1. The relevant claimed step of "maintaining updated sums of said DWT coefficients" says absolutely nothing about "overlapping" coefficients. Nor is such a requirement imposed by the '835 patent specification. As occurred in the earlier appeal of this case, the District Court again improperly found an imaginary and illusory limitation that does not actually appear in the claim language. Second, even if an "overlapping" requirement is improperly introduced, the coefficients in ERM's accused process do in fact "overlap," – a fact initially acknowledged, then later ignored, by the Special Master.

ARGUMENT

A. The Standard Of Review.

This Court reviews the grant of summary judgment *de novo*. *See, Caterpillar Inc. v. Sturman Industries, Inc.,* 387 F.3d 1358 (Fed. Cir. 2004). Summary judgment is only appropriate "if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and the moving party is entitled to judgment as a matter of law." Fed.R.Civ.P. 56(c). "The evidence of the

non-movant is to be believed, and all justifiable inferences are to be drawn in his favor." *Anderson v. Liberty Lobby, Inc.,* 477 U.S. 242, 255 (1986).

One attacking the validity of a patent must present clear and convincing evidence establishing facts that lead to the legal conclusion of invalidity. *Apple Computer, Inc. v. Articulate Systems, Inc.,* 234 F.3d 14 (Fed. Cir. 2000). This is true whether the purported ground of invalidity is inadequate description under 35 U.S.C. §112, or obviousness under 35 U.S.C. § 103. *Glaxo Group Ltd. v. Apotex, Inc.* 376 F.3d 1339 (Fed. Cir. 2004).

Whether a patent claim is invalid as being obvious is a question of law that this Court reviews *de novo. Catalina Lighting, Inc. v. Lamp Plus, Inc.* 295 F.3d 1277 (Fed. Cir. 2002).

Whether a specification complies with the written description requirement of 35 .U.S.C.§ 112, ¶1 is a question of fact. *Koito Mfg. Co., v. Turn Key Tech, LLC.,* 381 F.3d 1142 (Fed. Cir. 2004).

Claim construction is a matter of law subject to *de novo* review on appeal. *Cybor Corp. v. FAS Technologies, Inc.,* 138 F.3d 1448 (Fed. Cir. 1998)(*en banc).*

B. The District Court Improperly Ruled On Summary Judgment That Claim 21 Of The '835 Patent Is Not Adequately Described.

1. The Special Master Properly Rejected ERM's Argument That Claim 21 Is Inadequately Described.

In his Report on Invalidity, the Special Master properly recommended that ERM's motion for summary judgment of invalidity be denied. Although the Special Master exceeded his authority in "balancing" the relative weight of the evidence and opining on the credibility of the witnesses, he properly recognized that "each of the steps that does appear in claim 21 finds support (adequate description) in the specification," that "Claim 21 and those depending from it were all filed as part of the original application," that "Claim 21 is identical to claim 1, *except* that [Claim 1] includes (and claim 21 omits) two limitations that appear after the 'performing' step of claim 1," and that "ERM focuses on the first *omitted* element...and argues that there is no description in the specification adequate to support the invention described by claim 21...because that invention *lacks* the limitation of maintaining updated sums." (A0031-0032)

The Special Master properly recognized that "A patent claim does not fail as lacking written description in the specification merely because it omits any particular element." (A0034) Citing *Reiffin v. Microsoft Corp.*, 214 F.3d 1342 (Fed. Cir. 2000), the Special Master properly recognized that "there is no 'omitted element test' for meeting the written-description-requirement." (A0034) Relying

further on *Johnson Worldwide Assocs., v. Zebco Corp.*, 175 F.3d 985 (Fed. Cir. 1999), the Special Master correctly recognized that any "teaching away" argument "requires a very clear, unambiguous statement in the specification that would exclude the claim at issue in order to hold it lacks written description." (A0035) The Special Master found no such "clear, unambiguous statement" in the '835 patent specification and thereby found ERM's reliance on *Gentry Gallery, Inc. v. Berkline Corp.*, 134 F.3d 1473 (Fed. Cir.1998) misplaced. (A0035-0036)

2. The District Court Improperly Relied On This Court's Holding In *Turbocare*. The *Turbocare* Holding Is Inapposite Because It, Unlike Here, Involved Claims Added *After* The Patent Application Was Filed.

ERM objected to the Special Master's Report on Invalidity claiming that the Special Master "erred by overstating the legal standard" ERM was required to meet and that "The Federal Circuit has made clear the written description bar is not so high." (A1712) ERM further argued that the Special Master's reliance on this Court's holding in *Gentry Gallery* was misplaced (A1715) and that this Court's holding in *Turbocare v. General Electric Co.*, 264 F.3d 1111 (Fed. Cir. 2001) somehow overruled or modified its earlier holding in *Gentry Gallery* to impose a more easily met standard for invalidating a claim on lack-of-description grounds. (A1715-1716)

Presenting what can only be described as gross distortions if not outright misrepresentations, ERM argued that, "Here, the facts are even less favorable to the patentee than in *Turbocare.*" (A1716) The District Court mistakenly accepted ERM's arguments and declined to follow the Special Master's recommendation that summary judgment not be granted.

As noted by the Special Master, each element specified by Claim 21 is, in fact, described by the '835 patent specification. Furthermore, Claim 21 was part of the '835 patent application as filed and was allowed and issued without amendment. It thus formed part of the original disclosure, and its very existence makes absolutely clear that the inventor possessed, and regarded as his invention, the very method it specifies. Nor is there any question that the steps recited by Claim 21 and described in the '835 patent specification are clear and understandable to one skilled in the art. The law is clear that, under such circumstances, disclosure in an originally filed claim satisfies the written description requirement. *Union Oil Co. of California v. Atlantic Richfield Co.,* 208 F3d 989 (Fed. Cir. 2000).

In *Turbocare,* by contrast, the claims at issue were *not* part of the application as filed. More importantly, and unlike here, the critical elements they specified were *not* described by the specification. The patentee in *Turbocare* needed to and in fact did amend the specification to provide support. The patentee in *Turbocare*

thus needed to rely on an "inherency" argument to find support in the original specification. Here there is no need to do any of these things. The huge differences between the facts here and those in *Turbocare,* give lie to ERM's representation to the District Court that, "Here, the facts are even less favorable to the patentee than in *Turbocare.*" (A1716[PPM1])

Based on ERM's distorted statements of fact and its mischaracterization of the actual holding in *Turbocare,* the District Court declined to adopt the Special Master's recommendation and instead granted summary judgment that Claim 21 was invalid as being inadequately described. Prompted by ERM's disingenuous arguments, the District Court applied non-existent law to an imagined set of facts to reach a clearly erroneous result.

C. The District Court Improperly Granted Summary Judgment That Claim 21 Of The '835 Patent Is Invalid Under 35 U.S.C. § 103 As Being Obvious In Light Of Shapiro And Hamilton.

1. Dr. Osher's June 5, 2003 Declaration Adequately Supports His Conclusion That It Would Not Be Obvious to Combine the Teachings of Shapiro and Hamilton.

The central question in any motion for summary judgment is whether evidence exists to create a genuine issue of material fact. *See, Caterpillar Inc., supra.* Dr. Osher's declarations are more than sufficient to do so.

The Report on Obviousness erroneously and unfairly criticizes Dr. Osher for not explaining why the teachings of Hamilton could not be combined with

those of Shapiro. The reasons these teachings cannot be combined were, in fact, set out in paragraphs 11 and 12 of Dr. Osher's June 5, 2003 declaration submitted in opposition to ERM's motion for summary judgment of obviousness. (A1240-1244) In paragraph 11 of his June 5 declaration, Dr. Osher explained that "Shapiro is not concerned with reducing memory requirements during the process of image compression," while in paragraph 12, Dr. Osher explained that "Hamilton...deals with image processing in real space, not wavelet space." Dr. Osher's conclusion was based on this difference and, therefore, *was* stated in his declaration.

As explained in Dr. Osher's supplemental declaration submitted in connection with LizardTech's objections to the Special Master's Report on Obviousness, the Special Master misunderstood the important distinction that exists between *storage* memory for storing a file (such as an image) and *processing* memory required for processing a file (such as compressing an image). (A1839; ¶5) Data compression reduces the size of a file so that it occupies less space when stored in memory. (A1839; ¶5) Processing memory used in *performing* the data compression is an altogether distinct and different matter. (A1839; ¶5) Shapiro provides no discussion of reducing the memory required to perform image compression. (A1839-1840; ¶6) This provided the factual basis for Dr. Osher's statement in his June 5 declaration that "Shapiro is not concerned with reducing

memory requirements during the process of image compression." (A1839-1840; ¶6)

As further explained in Dr. Osher's supplemental declaration, Hamilton, in contrast to Shapiro, discloses tiling an image in the context of image rotation and half-toning. (A1840; ¶7) Furthermore, Hamilton processes an image in real space, not wavelet space. (A1840; ¶7) This provides the factual basis for Dr. Osher's statement in his June 5 declaration that "Hamilton...deals with image processing in real space, not wavelet space." (A1840; ¶8) Based on these facts, Dr. Osher concluded in his June 5 declaration that one skilled in the art would not combine the teachings of Hamilton with those of Shapiro because "the two references are directed to two completely different endeavors in the field of image processing." (A1840; ¶8) Image processing is a very large field, and there is no motivation to combine such disparate teachings. (A1840; ¶8)

Based on Dr. Osher's testimony, the factual basis for his conclusion – i.e., that Shapiro and Hamilton deal with different technologies and address wholly different concerns – is, in fact, stated in his June 5 declaration. Whether his conclusions will withstand cross-examination and prove more credible that Dr. Gray's contrary conclusions goes to the weight of the evidence, not whether such evidence exists in the first place. The Report on Obviousness impermissibly assesses the weight and credibility of the evidence rather than the existence of

genuine issues of material fact. This Court itself has warned that a trial with "the refining fire of cross-examination" is "a more effective means of arriving at the legal conclusion of obviousness vel non than perusal of ex parte affidavits and declarations of partisan experts lobbed at each other from opposing trenches." *Hodosh v. Block Drug Co.,* 786 F.2d 1136, 1143 (Fed. Cir. 1986).

2. Dr. Osher's June 5, 2003 Declaration Adequately Supports His Conclusion That, Even if the Teachings of Shapiro and Hamilton Are Combined, the Claimed Invention Does Not Result.

The Report on Obviousness also states that Dr. Osher provides no support for his declaration testimony that he did not identify the elements of Claim 21 that are not disclosed by Hamilton and Shapiro, even if combined. This statement too is in error.

As explained in paragraphs 9-11 of Dr. Osher's supplemental declaration, his earlier June 5 declaration explicitly states that "Shapiro does not teach or even suggest a method for selectively viewing areas of an image at multiple resolutions as described and claimed in Claim 21 of the '835 patent." (A1840-1841; ¶¶9-11) In particular, Claim 21 specifies "selecting a viewing set" of image data for viewing, "determining a viewing subset of... DWT...coefficients that support [the] viewing set" and "forming from [the] subset of ...DWT coefficients a computer display" of the selected viewing set. (A0127) These method steps *specified by*

Claim 21 appear nowhere in Shapiro. They do not appear in Hamilton either. It was on this factual basis that Dr. Osher testified in his June 5 declaration that, even when combined, Shapiro and Hamilton do not result in the claimed invention. Furthermore, these deficiencies flow directly from the fact that "Shapiro does not teach or even suggest a method for selectively viewing areas of an image at multiple resolutions" as noted in Dr. Osher's June 5 declaration. Again, the Report on Obviousness improperly assesses the scope and credibility of Dr. Osher's testimony, not whether that testimony gives rise to genuine issues of material fact.

3. The Report on Obviousness Improperly Attributes Teachings to Shapiro That Do Not, in Fact, Exist.

The Report on Obviousness discounts Dr. Osher's declaration testimony on the ground that "Shapiro observed that 'wavelet transforms otherwise known as hierarchical subband decomposition have recently been used for low bit rate image compression...." (A0046) As addressed in paragraph 12 of Dr. Osher's supplemental declaration, this observation is immaterial to the issue of obviousness. (A1841) In particular, and as pointed out by Dr, Osher, the quoted passage from Shapiro refers to the prior art technique of permitting a user to select the resolution at which to view an image. Claim 21, on the other hand, addresses enabling a user to selectively view areas of a compressed image (such as "the lower left corner" of "the middle part of the upper edge") and decompress only

those DWT coefficients that are needed to view that area. As further pointed out by Dr. Osher, these steps are addressed by elements 4, 5 and 6 of Claim 21. Dr. Osher's testimony establishes that the prior art technique taught by Shapiro and noted in the Report on Obviousness is *not,* therefore, the same as that addressed by Claim 21.

4. ERM Has Not Provided the "Clear and Convincing" Evidence Needed to Invalidate Claim 21.

The legal standard ERM must meet in its challenge to the validity of Claim 21 is clear. "When the issue is patent invalidity due to obviousness...the movant must overcome the statutory presumption of validity...by proving obviousness by clear and convincing evidence based on undisputed fact." *Quad Environmental Technologies Corp. v. Union Sanitary District,* 946 F.2d 870, 872 (Fed. Cir. 1991). "Although patent issues are as amenable to summary resolution as other matters, when material facts are disputed, and testimonial, documentary, and expert evidence is needed for their resolution, summary adjudication is not indicated." *Id.* Because of the high evidentiary standard, this Court has often overturned summary judgment findings of patent invalidity based on obviousness. *See, e.g., Apple Computer, Inc. v. Articulate Systems, Inc.,* 234 F.3d 14 (Fed. Cir. 200); *Karsten Manufacturing Corp. v. Cleveland Golf Co.,* 242 F.3d 1376 (Fed. Cir. 2001); *Biotec Biologische Naturverpackungen GmbH v. Biocorp, Inc.,* 249 F.3d 1341

(Fed. Cir. 2001); *Arkie Lures, Inc. v. Gene Larew Tackle, Inc.*, 119 F.3d 953 (Fed. Cir. 1997); *Monarch Knitting Machinery Corp. v. Fukuhara Industrial & Trading Co., Ltd.*, 139 F.3d 977 (Fed. Cir. 1998); *Rockwell International Corp. v. United States*, 147 F.3d 1358 (Fed. Cir. 1998).

Dr. Osher's declarations establish that genuine issues of material fact exist. These factual issues concern (a) the content of the prior art (i.e., whether Shapiro and Hamilton do, in fact, address the same problems and technologies) and (b) whether Shapiro and Hamilton do, in fact, provide the necessary "suggestion," "motivation" or "incentive" that they be combined. The Report on Obviousness dismissed the existence of these genuine issues with the sweeping statement that Dr. Osher's statements are "conclusory" and "evasive." That is not the proper standard. Whether Dr. Osher is believable is precisely the sort of issue to be resolved by a jury at trial, not by the Court on summary judgment. As established by Dr. Osher's supplemental declaration, his June 5 declaration *did* state the reasons and bases for his opinions and *did* comply with the requirements of Rule 56.

Because the Report on Obviousness improperly focused on the sufficiency and weight, rather than existence, of evidence supporting LizardTech's case, the District Court erred in adopting it and erred in holding on summary judgment that Claim 21 is invalid as being obvious.

D. The District Court Improperly Granted Summary Judgment That Claims 1 and 13 Of The '835 Patent Are Not Infringed.

1. The Material Facts Are Undisputed – The ERM Software Produces The Exact Same "Seamless" Coefficients As Does The Claimed Invention. The Minor Differences That Exist Between The ERM Software And The Preferred Embodiment Described In The '835 Patent Are Not Reflected In The Patent Claims.

There is no serious dispute over what the accused ERM software does and how it does it. (A0060-0062) The ERM software and claimed invention both operate to reduce processing memory requirements in performing a DWT compression function. The ERM software and claimed invention both compress large digital images by breaking the image into tiles and performing a two-dimensional DWT process on the tiles to produce an array of final coefficients that represent the compressed image. There is no dispute that the ERM software produces *the exact same coefficients as the claimed invention and adds (i.e.,"sums") those coefficients to produce the exact same "final" coefficients as the claimed invention.* The only difference between the accused ERM software and that described in the '835 patent concerns the size of the individual tiles and the timing in which the coefficients are produced and summed. Neither of these differences is reflected in the claim language, either expressly or as interpreted by the Court's claim construction order.

2. The Meaning Of "Overlapping" Was Previously Addressed. The Prior Claim Construction Order Specifically Notes That Coefficients Of Adjacent Tiles Necessarily "Overlap" Due To The "Expansive Nature" Of The DWT Process Itself. The Order Also Notes That "This Much Is Not Disputed."

The Special Master's original Report on Claim Construction (A0734) is incorporated in its entirety into the District Court's claim construction order. (A0023-0026) The Report on Claim Construction itself provides a meaning for "overlapping." In particular, that report recognizes that the DWT process is an inherently "expansive" process and that the process necessarily develops coefficients that are greater in number than the number of pixels that are input into the process. (A0740) Furthermore, in addressing the element 4 "maintaining updated sums" step that is at issue here, the Report on Claim Construction *specifically states*, "Note that the 'adjacent' tiles would be abutting, or side by side, but their respective DWT coefficients overlap because of the expansive nature of the transform explained earlier. *This much is not disputed."* (A0771-0772) (Emphasis supplied).

Based on the express language of the Report on Claims Construction, the DWT coefficients generated from "adjacent tiles" in the ERM method (i.e., vertically adjacent ones of the single pixel rows that make up the "tiles" in the ERM method) are necessarily "overlapping." Under this interpretation of "overlapping," *which is the only one stated in the Report on Claim Construction,*

there is no question that the vertically-generated DWT coefficients in the ERM method are "overlapping." Only by improperly and belatedly revisiting this pure claim construction issue in the guise of a motion for summary judgment of non-infringement was ERM able to rewrite the Court's claim construction order to include entirely new – and purely imaginary – limitations.

3. The Report On Noninfringement Now Ascribes A New And Special Meaning To The Term "Overlapping"

The erroneous conclusion reached in the Report on Noninfringement is based on the mistaken belief that the accused ERM software does not produce "overlapping" coefficients. In particular, page 13 of the Report states, "Plaintiff's argument fails in any event...because the DWT coefficients that are summed in the vertical DWT filtering step of the ERM method...are not *overlapping.*" (A0065) (Emphasis in original.) This erroneous finding is the *only* basis stated in the Report on Noninfringement for concluding there is no infringement.

The Report further states "The adjective *'overlapping'* in the '835 patent indicates that certain tile coefficients overlap those of a neighboring tile; in other words, image data from both tiles (or at least some data near the border) contribute to the DWT coefficients." (A0065) (Emphasis in original.) This interpretation of "overlapping" – i.e., that "image data from both tiles...contribute to the DWT coefficients" – appears for the very first time *only* in the Report. It does not appear

in the Report on Claim Construction. It does not appear in the '835 Patent itself. It does not appear in the '835 patent prosecution history. Most importantly, *it does not appear in the Court's claim construction order.* This is an entirely new construction that appears for the first time only in the Report on Infringement and exists principally to justify the erroneous conclusion that summary judgment of non-infringement should be granted.

4. The New Interpretation Of "Overlapping" Is Inconsistent With Both The Report On Claim Construction And The Court's Prior Claim Construction Order.

The Report on Claim Construction states, "The claim language, 'maintaining updated sums' of those DWT coefficients, read in light of the specification, refers to summing the DWT coefficients of one tile together with overlapping DWT coefficients from one or more adjacent tiles." (A0772) This statement is all that even purports to introduce an implied "overlapping" limitation into the claims. The Report on Claim Construction nowhere indicates that "overlapping" has the meaning the Report on Noninfringement now ascribes to that term.

The word "overlapping" appears nowhere in the '835 Patent, much less in the claims. The only support offered in the Report on Claim Construction for finding an "overlapping" limitation in the claims is a citation to two passages of the '835 Patent appearing at "col.2, [lines] 51-56" and at "col. 6, l. 49-col. 7, l. 18," respectively. (A0772) These passages of the '835 Patent however say nothing

about "image data from both tiles...contribut[ing] to the DWT coefficients." The passage at col. 2, lines 51-56 of the '835 patent simply says:

> A seamless wavelet-based compression process is effected on I(x,y) that is comprised of selectively inputting the tiles...in a selected sequence to a DWT routine, adding corrections that are passed from previous invocations of the DWT routine on other [tiles] and storing the resulting DWT coefficients in a first primary memory.

(A0121) This passage of the '835 patent, which says absolutely nothing about "overlapping," does not provide or suggest the construction the Report on Noninfringement now ascribes to "overlapping." The other passage cited in the Report on Claim Construction does not suggest that construction either.

The two words "overlap-add" are all that even purport to give rise to an "overlapping" requirement in the claims. These words appear only at Col. 2, line 63 and at Col. 6, line 12 of the '835 Patent. (A0121; A0123) In both instances, the patent first describes certain steps and then states these steps "can be viewed as an 'overlap-add' realization [or implementation] of the DWT." It is clear from this context that "overlap-add" refers to, and is intended to mean the previously described steps and not something else. Nothing in the patent specifies the meaning of "overlapping" that now appears in the Report on Noninfringement. The '835 Patent says nothing about "overlapping" coefficients or the necessity that

"image data from both tiles...contribute to the DWT coefficients" as now required by that Report.

In the prior appeal of this case, this Court warned against reading limitations of the preferred embodiment into the claims. Pointing to extraneous definitions of "overlap" cannot add limitations to the claim not otherwise contained in, and compelled by, the patent and its prosecution history. As before, doing so leads to reversible error.

5. Even If The Belated Claim Construction Is Adopted, Infringement Still Results. The Report On Noninfringement Fails Adequately To Consider The "Overlapping Coefficients" That Inherently Result From Vertical DWT Processing Of The Tiles In The ERM Method.

ERM's own evidence demonstrates that its method infringes, even under the new and erroneous claim construction belatedly adopted in the Report on Noninfringement. In particular, the declarations submitted by ERM's CEO and founder, Stuart Nixon, and its expert, Dr. Robert Gray, establish that the ERM method performs the step of "maintaining updated sums" as construed by the Court prior to being retroactively changed in the subsequent Report on Noninfringement.

Again the previously submitted Declarations of Stuart Nixon and Dr. Gray describe the relevant operation of the ERM process. They demonstrate that, in "Step 1" of the ERM method, "a line of image data as it appears in the image is

read," while at the same time, a previously generated line of DWT coefficients "drops off at the top of both the low-pass and high-pass sliding windows." (A0949-0950) They also show that, in "Step 2" of the ERM method, a DWT process is performed on the newly read in line of image data to create DWT coefficients and that these DWT coefficients are "not added to anything, but rather, are simply placed at the bottom of the sliding window." (A0950) Furthermore, the Declarations of Mr. Nixon and Dr. Gray establish that in "Step 3" of the ERM method, "Steps 1 and 2 are repeated to generate a second line of DWT coefficients," and that these DWT coefficients too "are placed at the bottom of the sliding window." (A0951) They also establish that in "Step 4" of the ERM method, a "vertical one-dimensional DWT is performed on the DWT coefficients resulting from Steps 1 and 3...." (A0951-0952) Finally, ERM's own exhibits and pictorial representations show that the DWT coefficients generated by individual ones of vertically adjacent pixels in its method are, in fact, ultimately added to each other to produce the exact same final output coefficients produced by the method of Claims 1 and 13. If these coefficients are not added, the same output would not be produced.

In his Declaration, Dr. Gray tried to explain away this inconvenient, and indeed dispositive fact with the entirely conclusory, unsupported statement that, "The adding required by the "maintaining updated sums" step claimed in the '835

patent should not be confused with the mathematics inherent in the prior art DWT process." (A0871) There is nothing in the Court's claim construction order to support this argument, and Dr. Gray, in his declaration, repeatedly relies on purported claim meanings that appear nowhere in the claim construction order.[3] Not only is Dr. Gray not qualified or asked to explain what the previously construed "'maintaining updated sums' step claimed in the '835 patent" should be deemed to cover or not cover, the basic legal analysis is wrong. It is elementary law that valid claims can be made up of new combinations of old steps. Whether "the mathematics inherent in the...DWT process" is "in the prior art" has nothing to do with infringement. Whether an individual step in an accused process can be found somewhere in the prior art has no legal relevance to the question of

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[3] Dr. Gray claims, for example, that "edge artifacts" are somehow a necessary element of the claims, and that "'maintaining updated sums' refers to an 'overlap-add' function' wherein DWT coefficients...from adjacent tiles that have been previously processed are retrieved and added to the DWT coefficients of the tile currently being processed." (A0866) In point of fact, this Court's earlier decision on appeal, and the claim construction initially adopted by the District Court, hold that timing or the "completion" of processing of one tile before another forms no part of the properly construed claimed process. (A0112; A0763-0765)

infringement. *See, RF Delaware, Inc. v. Pacific Keystone Technologies, Inc.* 326 F.3d 1255 (Fed. Cir. 2003).

During the hearing before the Special Master, it was demonstrated, and the Special Master agreed, that the DWT process is an inherently "expansive" process and, as a result, produces more coefficients than there are pixels. (A0740) "Overlapping" simply means that, during the process of adding up (i.e., "summing") coefficients generated during the vertical processing of tiles, the vertical coefficients generated in response to pixels in one column of a tile are added to the vertical coefficients generated in response to the pixels in the same column of the vertically adjacent column. Both ERM and the Special Master attribute a far different meaning to this process than what is actually described and claimed in the '835 patent and overlook that this concept of "overlapping" (which does not actually form part of the claim) is simply the matter of ensuring that coefficients resulting from pixels in one column are added to coefficients resulting from adjacent pixels in the same column rather than a different one. ERM is using smoke and mirrors to disguise the elementary and indisputable fact that adding "B" to "C" and then to "A" is no different than simply adding "A" "B" and "C" in the first place.

In view of the foregoing, ERM's own evidence shows and describes a "vertical one dimensional DWT" being performed on two or more vertically

adjacent lines or tiles of DWT coefficients. As noted at pages 35-36 of the Report on Claim Construction, DWT coefficients generated from "adjacent" (i.e., "abutting") tiles necessarily (and indisputably) "overlap because of the expansive nature of the transform explained earlier." (A0771-0772) Furthermore, these coefficients are necessarily added due to what Dr. Gray himself calls "the mathematics inherent in the prior art DWT process" (A0871) It is in this manner that DWT coefficients calculated from adjacent tiles *are* added and *do* "contribute" to the final two-dimensional DWT coefficients produced by the ERM method. It is in this manner that the ERM method "maintains updated sums" even under the new, and improperly narrow, claim construction provided in the ironically misnamed "Report on Noninfringement."

CONCLUSION

The District Court improperly granted summary judgment disposing of all of LizardTech's claims. Contrary to its findings, evidence exists and was presented that would support a jury finding in LizardTech's favor. The case, however, has yet to reach a jury. Both the District Court and Special Master have improperly assumed the fact-finder's role.

The District Court's shifting claim analysis and claim construction remains indeterminate more than five years after this case was filed and nearly three years after this Court made its rulings on claim construction. The District Court has once again found claim limitations that do not actually exist.

For the reasons stated herein, the District Court's grant of summary judgment in favor of ERM of should be reversed and this case should be remanded for a now long-overdue trial. Furthermore, because the undisputed operation of ERM's products is clear, and because the only relevant question – claim construction – is something this Court properly decides *de novo*, this Court can enter a finding of infringement and remand the case for trial of the remaining damages issues. Such action by this Court is requested.

Respectfully submitted,

Philip P. Mann
Mann Law Group
1420 Fifth Avenue, Suite 2200
Seattle, Washington 98101
(206) 224-3553

ADDENDUM

United States District Court

WESTERN DISTRICT OF WASHINGTON

LIZARDTECH, INC.

v.

EARTH RESOURCES MAPPING, INC., et at.,

JUDGMENT IN A CIVIL CASE

CASE NUMBER: C99-1602C

___ **Jury Verdict**. This action came before the Court for a trial by jury. The issues have been tried and the jury has rendered its verdict.

_X_ **Decision by Court**. This action came to trial or hearing before the Court. The issues have been tried or heard and a decision has been rendered.

IT IS ORDERED AND ADJUDGED: Defendants' Motion for Partial Summary Judgment on Count I (patent infringement) is GRANTED.

October 6, 2004

BRUCE RIFKIN
Clerk

s/L. Simle

By, Deputy Clerk

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

LIZARDTECH, INC.,

Plaintiff,

v.

EARTH RESOURCE MAPPING, INC., EARTH RESOURCE MAPPING PTY LTD.,

Defendants.

CASE NO. C99-1602C

ORDER

I. INTRODUCTION

This matter comes before the court on Defendants' Motions for Partial Summary Judgment (Dkt. No. 240, 245). By direction of the Court, the court-appointed Special Master submitted the following reports and recommendations pertaining to the summary judgment motions: (1) Report and Recommendations on Obviousness of Claim 21 ("Report on Obviousness") (Dkt. No. 262), (2) Report and Recommendation on Defendants' Motion for Partial Summary Judgment that certain claims of U.S. Patent No. 5,710,835 are Invalid ("Report on Invalidity") (Dkt. No. 261), and (3) Report and Recommendations on Defendants' Motion for Partial Summary Judgment of Noninfringement ("Report on Noninfringement") (Dkt. No. 260). The parties have timely filed their objections and responses to the Special Master's reports and recommendations. Having carefully considered the papers filed in support

of and in opposition to the parties' motions and having heard oral argument on the parties' objections to the Special Master's recommendations on these matters, the Court hereby finds and rules as follows.

II. BACKGROUND

A. Procedural History

Plaintiff LizardTech, Inc. ("LizardTech") brought this action alleging, among other claims, that Defendants Earth Resource Mapping, Inc. and Earth Resource Mapping Pty Ltd. (hereinafter collectively called "ERM") had infringed LizardTech's U.S. Patent No. 5,710,835 ("'835 patent"). On April 20, 2001, the Court entered an order granting Defendants' motion for summary judgment of noninfringement. (Dkt. No. 187.) The Federal Circuit reversed the Court's judgment in favor of Defendants and remanded the case to this Court with explicit instructions on the proper construction of certain claim terms. *See Lizardtech, Inc. v. Earth Res. Mapping, Inc.*, 35 Fed. Appx. 918 (Fed. Cir. 2002). On remand, the Special Master conducted a *Markman* hearing and issued a report and recommendation as to claim-construction issues in this matter. By an order dated March 23, 2003, this Court adopted the Special Master's report and recommendation. (Dkt. No. 237.)

Subsequently, Defendants timely filed two motions in question: Motion for Partial Summary Judgment That Certain Claims of U.S. Patent No. 5,710,835 are Not Infringed (Dkt. No. 240), and Motion for Partial Summary Judgment That Certain Claims of U.S. Patent No. 5,710,835 are Invalid. (Dkt. No. 245.)

B. Pertinent Facts[1]

The following technical facts are crucial to the resolution of Defendants' motions. Both Plaintiff's '835 patent and Defendants' U.S. Patent No. 6,201,897 ("'897 patent") relate to compression

[1] The Court notes that part II.B. of this Order is intended only as a basic background for reference purposes. *Greater detail is contained in the Special Master's Report on Noninfringement.*

of large digital images. "In particular, they process large images by using limited primary memory space – substantially less memory than would be necessary to load the entire image." (Report on Nonfringment at 1.)

Plaintiff's '835 patent "claims a method for performing DWT [discrete wavelet transform][2] based compression on large images in subparts using a technique that minimizes the formation and appearance of . . . edge artifacts." (Report on Noninfringement at 5) (citing *LizardTech*, 35 Fed. Appx. at 920 (slip op. at 3-4)). In basic terms, the '835 patent breaks a large image into "discrete tile image data subsets," which, when reassembled, would form the entire image. (*Id.*) These tiles are then "'successively input[] . . . in a selected sequence' into a DWT-based compression algorithm." (*Id.*) (brackets in original). The '835 patent differs from prior art which described DWT tiling solutions in that it incorporates a method for mitigating the prior art's "seam" and "edge artifact" problems. (*Id.*) Claim 1 of the '835 patent characterizes this method as "'maintaining updated sums' of said DWT coefficients from said discrete tile image . . . to form a seamless DWT of said image and storing said sums in a first primary memory [*i.e.*, RAM[3]] location of said computer." (*Id.* at 6-7) (citation omitted).

Defendants' '897 patent claims an "ECW" technology ("the ERM method"), which relates to compression and decompression of large digital images. (*Id.* at 8.) The '897 claims to create a "seamless or classical 2-D DWT of a large image." (*Id.* at 9) (citations omitted). Unlike Plaintiff's '835 patented method, Defendants' ERM method is "characterized . . . as using a 'recursive sliding window approach' . . . ." (*Id.*) (citations omitted).

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[2] For a discussion of the DWT-compression process, see Report on Noninfringement at 3.

[3] In the Report on Noninfringement, the Special Master notes the difference between primary memory, "typically RAM," and secondary memory. (*See* Report on Noninfringement at 1 n.1.)

III. INVALIDITY OF CERTAIN CLAIMS OF '835 PATENT

Defendant attacks the validity of claims 21 of Plaintiff's '835 patent and its dependent claims[4] on three grounds: (1) the obviousness of claim 21; (2) the claim's failure to meet the "written description" requirement of 35 U.S.C. § 112 (2004); and (3) the claim's failure to meet the "enablement" requirement of 35 U.S.C. § 112. (*See* Defs.' Mot. for Partial Summ. J. of Invalidity.) The Court addresses each contention below.

A patent carries a presumption of validity. *See* 35 U.S.C. § 282 (2004). At summary judgment, that presumption can be overcome only by clear and convincing evidence of invalidity demonstrating that a reasonable jury could not find the patent valid. *Eli Lilly and Co. v. Barr Labs., Inc.*, 251 F.3d 955, 962 (Fed. Cir. 2001). The moving party bears an initial burden on demonstrating the invalidity; if it carries that burden, in order to preclude summary judgment, the nonmoving party has to assert specific facts sufficient to establish a genuine issue of material fact that would merit trial. *See Celotex Corp. v. Catrett*, 477 U.S. 317, 324 (1986). Importantly, the nonmoving party may not merely rely on the pleadings in an attempt to demonstrate that triable issues of fact exist. *See Celotex*, 477 U.S. at 324. In determining whether a genuine issue of material fact exists, the court views the evidence in the light most favorable to the nonmoving party and resolves all doubts in its favor. *Eli Lilly*, 251 F.3d at 962; *see also Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 255 (1986). There is no genuine issue of material fact for trial unless "there is sufficient evidence favoring the nonmoving party for a jury to return a verdict for that party." *Anderson*, 477 U.S. at 249.

A. Invalidity of Claim 21 Based on Obviousness

It is axiomatic that in order for a patent to be valid, it must be nonobvious:

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[4] Claim 21 of the '835 patent is an independent claim, upon which Claims 22-25 and 27-28 depend. (Report on Invalidity at 1.)

> A patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. § 103(a). The obviousness of a patent is a question of law based upon certain factual inquiries, commonly referred to as "*Graham* inquiries", which include: (a) level of ordinary skill in the pertinent art,[5] (b) scope and content of prior art, (c) differences between claims at issue and prior art, and (d) secondary considerations of nonobviousness.[6] *Graham v. John Deere*, 383 U.S. 1, 17 (1966); *see also B.F. Goodrich Co. v. Aircraft Braking Sys. Corp.*, 72 F.3d 1577, 1582 (Fed. Cir. 1996).

Analysis of the obviousness of a claim requires a consideration of the differences between prior art and the claimed invention as a whole. *Ruiz v. A.B. Chance Co.*, 357 F.3d 1270, 1275 (Fed. Cir. 2004). In order to avoid hindsight invalidation of patents through reduction of their parts, the moving party must establish that a person of ordinary skill at the time of the invention, "confronted by the same problems as the inventor and with no knowledge of the claimed invention, would select the various elements from the prior art and combine them" in the manner claimed. *Id.* In addition, to combine cited references there must be some suggestion, teaching, motivation or reason in the prior art that makes the combination obvious to a person of ordinary skill in the area. "Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or

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[5] The parties have stipulated that one of "ordinary skill in the art" at the time of filing of the '835 patent application "would have been person with at least a master's degree in electrical engineering, computer science, or mathematics and one to two years of working in the field of digital signal and/or image processing." (Report on Nonobviousness at 4) (citation omitted).

[6] The Special Master indicated that secondary considerations, *e.g.*, commercial success or long-felt but unmet need, were not presented in the instant case. (*See* Report on Obviousness at 2.)

suggestion supporting the combination." *ACS Hosp. Systems, Inc. v. Montefiore Hosp.*, 732 F.2d 1572, 1577 (Fed. Cir. 1984).

1. *Special Master's Report and Recommendation on Obviousness*

Claim 21 of the '835 patent includes six elements, the third of which recites the DWT-based compression process "described in the Background section of the '835 patent as prior art." (Report on Obviousness at 3) (citations omitted.) The Special Master determined that the scope and content of prior art pertaining to DWT-based, hierarchical signal compression was further revealed and summarized in the background section of an earlier patent, Shapiro.[7] (*Id.*) The Special Master also noted that the use of tiles in image processing was "well known at the time the '835 patent application was filed," in light of an earlier patent, Hamilton.[8] (*Id.* at 4.) The Special Master noted that Plaintiff's expert, Dr. Osher, did "not contradict Professor Gray's summary in any material way." (*Id.* at 8.) The Special Master pointed out that Shapiro indicated that certain methods were known, even if it did "explicitly teach the 'method for selectively viewing areas of an image at multiple resolutions,'" as Plaintiff's expert had argued. (*Id.* at 6.) The Special Master is convinced that though Shapiro was not primarily "concerned with reducing memory requirements during the process of image compression," it is nonetheless, as evidenced in its background section, "plainly aware of the desirability of reducing memory requirements." (*Id.* at 7.)

Defendants' expert, Dr. Gray, indicated that "Hamilton provides the motivation or suggestion to combine the Hamilton and Shapiro references, as the need to reduce memory requirements in image processing was a concern in both." (Gray Decl. ¶ 22.) The Special Master agreed, especially in light of the fact that Plaintiff's expert did not explain, nor was his opinion supported by specific facts, why he

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[7] The Shapiro patent is also referred to as the '960 patent.

[8] Hamilton ('916 patent) describes the process of scaling and rotating an image using a tile-based approach in order to address memory limitations. (*See* Report on Obviousness at 4.)

did not agree that the teachings of Hamilton are combinable with those of Shapiro. (Report on Obviousness at 7.)

In addition, the Special Master noted that Plaintiff's expert, Dr. Osher, in his deposition, confirmed that claim 21 does not require "maintaining updated sums" as claim 1 does, a "step or something like it [that] would be necessary to avoid edge artifacts in the method of claim 21." (*Id.*) Although the Special Master indicated that this step was not required for patentability, Dr. Osher's deposition provided further evidence that the method would be needed in order to achieve the '835 patent's goal of seamlessness. (*Id.*) The Special Master further indicated that initially, the Patent Examiner had rejected claim 21 among other rejected claims. (*Id.* at 8-9.) Plaintiff applicant then submitted a response indicating that the goal of the process was to achieve seamlessness using the "updated sums" method. (*Id.* at 9.) Based on that response, the Examiner allowed all claims, and "stated that claims 1, 13, and 21 were allowed because they required '*maintaining updated sums of discrete wavelet transformation coefficients* from the discrete tile image to form a seamless discrete wavelet transformation of the image.'" (*Id.*) (citing Gray Decl. Ex. 4) (emphasis added). However, as the Special Master highlighted, "claim 21 does not include the step of 'maintaining updated sums,' as do claims 1 and 13." (*Id.*) (citing Gray Decl. ¶ 3.) Without this step, "claim 21 simply recites the well-known prior art method of performing a tiled DWT of an image." (*Id.* at 10) (citing Gray Decl. ¶ 6.)

In sum, the Special Master found that the "conclusory statements" asserted by Plaintiff's expert failed to meaningfully contradict the specific factual assertions submitted by Defendants, and concluded that the evidence was "clear and convincing that the putative invention of claim 21 would have been obvious, at the time the '835 patent application was filed, to one of ordinary skill in the art of image processing." (*Id.* at 8, 10.)

2. *Plaintiff's Objections*

Plaintiff argues that the Court should not adopt the Report on Obviousness for two reasons. First, Plaintiff argues that "the Report mistakenly focuses on the wording, sufficiency and credibility of LizardTech's expert declaration rather than on whether the declaration evidences genuine issues of material fact." (Pl.'s Objections to Report on Obviousness at 1.) Second, Plaintiff maintains that "ERM's argument is based on a patent (i.e., the Shapiro '960 Patent) it first disclosed to LizardTech long after discovery closed." (*Id.*)

Plaintiff specifically contends that the declaration of Dr. Osher did establish that "it would not be obvious to one skilled in the art to combine the teachings" of Shapiro and Hamilton, and that "even if references are combined, the claimed invention does not result." (*Id.*) In support of its argument, Plaintiff asks the Court to consider paragraphs 11 and 12 of Dr. Osher's declaration. (*Id.* at 2.) Paragraph 11 reads:

> In my review, I did not see any teaching in Shapiro suggesting that the bit-emphasizing technique he discloses would work with an image divided into tiles. Further, I did not see any teaching in Shapiro that suggests tiling is even desirable. Shapiro is not concerned with reducing memory requirements during the process of image compression.

(Osher Decl. at 4 ¶ 11.)

The Court finds that the Special Master adequately considered paragraph 11 of Dr. Osher's declaration. In fact, the Special Master cited, and refuted, the paragraph's last sentence, finding that "[i]f not 'concerned,' Shapiro is plainly aware of the desirability of reducing memory requirements" because Shapiro's background section discusses techniques for DWT-compression and "explains that 'a significant improvement in encoding the significance map translates into a *significant improvement in the compression of information* preparatory to storage or transmission." (Report on Obviousness at 7)

(citation to Shapiro patent omitted.) The Court agrees with the Special Master that the other sentences of paragraph 11 are conclusory, stating only Osher's opinion without any supporting evidence.

Paragraph 12 of Osher's declaration reads:

> I have reviewed the '916 to Hamilton Jr., et al., which deals with image processing in real space, not wavelet space. I do not agree that the teachings of Hamilton are combinable with Shapiro, but even if they were, the combination does not disclose all the elements recited in Claim 21 and does not render obvious the invention claimed in Claim 21. In other words, at the time the '835 patent was filed (i.e., November 14, 1995), the invention claimed in Claim 21 of the '835 patent would not have been obvious to one of ordinary skill in the art of any combination of Hamilton and Shapiro.

(Osher Decl. ¶ 12.) Plaintiff contends that the first sentence in which Dr. Osher highlights that Hamilton deals with image processing in real space, not wavelet space, is the basis for his conclusion. (Pl.'s Objections to Report on Obviousness at 2.) The Court notes that the '835 patent deals with wavelet space, as the process at issue is called "discrete wavelet transform" or "DWT." Plaintiff's objection, Dr. Osher's supplemental declaration in support of Plaintiff's objections, and Plaintiff's counsel's statements during oral argument appear to suggest that this difference makes Hamilton *non-analogous* prior art, and thus one with ordinary skill in the art would not combine "references . . . directed to two completely different endeavors in the field of image processing."[9] (*Id.* at 3; *see also* Tr. of Oral Argument at 11-13.) The Court notes that the Examiner cited Hamilton during prosecution of the '835

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[9] Defendants urge that the Court not consider Dr. Osher's Supplemental Declaration in support of Plaintiff's Objections to the Report on Obviousness. Fed. R. Civ. P. 56(e) indicates that the Court "may" permit supplemental affidavits. Plaintiff did not move the Court under Fed. R. Civ. P. 56(f) to consider a supplemental affidavit. Defendants cite *Ashton-Tate Corp. v. Ross*, in which the Ninth Circuit indicated that "the process of evaluating a summary judgment motion would be flouted if requests for more time, discovery, or the introduction of supplemental affidavits had to be considered even if requested well after the deadline set for the introduction of all information needed to make a ruling has passed." 916 F.2d 516, 520 (9th Cir. 1990). The supplemental declaration was submitted prior to the hearing on the matter, and Defendants had an adequate opportunity to and, in fact, did respond to contentions made therein. However, the Court finds that Dr. Osher's supplemental declaration, even if considered, still fails to reach the level of specific evidentiary detail as does Dr. Gray's declaration submitted on behalf of Defendants.

patent. (Report on Obviousness at 1.) Furthermore, as Defendants point out, in *Union Carbide Corp. v. American Can Co.*, the Federal Circuit affirmed summary judgment of invalidity for obviousness on similar facts. 724 F.2d 1567 (Fed. Cir. 1984). An expert opined that certain non-analogous prior art "would not [] have been considered" because it solved a different problem. *Id.* at 1571. The Federal Circuit noted that "the [expert's] affidavit expressed no more than an unsupported conclusory opinion which ignored, rather than conflicted with, the evidence of record. Thus no genuine issue of material fact was raised by appellant on the scope and content of the prior art. . . ." *Id.* at 1572.

Again, the Special Master indicated that Dr. Osher failed to explicitly state *why* the teachings of Hamilton are not combinable with those of Shapiro. (Report on Obviousness at 7.) In addition, Dr. Osher "does not explain what specific elements of claim 21 would *not* be disclosed by the cited combination of references." (*Id.*) In contrast, Defendants' expert, Dr. Gray's declaration "specifically discussed each element of the claim," and explicitly addressed *why* Hamilton provides motivation to combine the teachings of Shapiro and Hamilton. (*Id.* at 5) (citing Gray Decl. ¶ 15, 22.)

Consequently, as to Plaintiff's first objection noted above, the Court is satisfied with the Special Master's consideration of the evidence submitted by the parties, and agrees with his overall assessment and recommendation. Defendants offered expert evidence specifically detailing the elements of the claim and outlining the *reasons* for the expert's conclusion. In contrast, Plaintiff's expert offered conclusions, consisting primarily of opinions not based on specific evidence.

The Court similarly finds Plaintiff's second objection without merit. Plaintiff indicates that the Shapiro patent was not disclosed to it until April 21, 2003, nearly three years after the close of discovery on September 22, 2003. (Pl.'s Objections to Report on Obviousness at 6.) In light of this, Plaintiff argues that it has been prejudiced as a result of Defendants' "untimely" disclosure because Plaintiff was denied an opportunity to conduct discovery on Shapiro and to cross-examine Defendants' expert, Dr.

Gray. (*Id.* at 8.) Defendants counter that the timing of disclosure of the Shapiro patent was proper and that it was disclosed to Plaintiff as part of the process of supplementing discovery responses pursuant to Fed. R. Civ. P. 26(e)(2). (Defs.' Resp. to Pl.'s Objections to Report on Obviousness at 4.)

In view of Defendants' contention that they found it necessary and crucial to disclose Shapiro on April 21, 2003, after the Court's March 27, 2003, claim construction order (Defs.' Resp. to Pl.'s Objections to Report on Obviousness at 5), the Court agrees with Defendants. Fed. R. Civ. P. 26(e)(2) does require a party to "seasonably amend a prior response to an interrogatory . . . if the party learns that the response is in some material respect incomplete or incorrect . . . ." *The claim construction order* inevitably and finally narrowed and/or specified the issues in this case.[10] Thus, supplemental disclosure of the Shapiro patent appears to have been proper at that time.

Moreover, Plaintiff addressed Shapiro in its expert declaration and opposition to Defendants' motion for summary judgment. During oral argument, Plaintiff's counsel highlighted that "irrespective of [the late disclosure], we think the Shapiro patent does not, in fact, [do] what ERM says." (Tr. at 14.) Accordingly, the Court finds that Plaintiff has not been unduly prejudiced and that Defendants had justifiable reason for not disclosing the Shapiro patent prior to the Court's issuance of the claim construction order.

As discussed above, Defendants have overcome the presumption of patent validity by clear and convincing evidence as to which there is no genuine dispute, such that a reasonable jury could not find claim 21 of the patent to be nonobvious. Plaintiff, on the other hand, has not put forth sufficient *evidence for a jury to return a verdict in its favor.* Claim 21 clearly lacks the "maintaining updated

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[10] Plaintiff contends that because the Court adopted its proposed claim construction earlier than March 27, 2003, Defendants should have been on notice that said claim construction might be adopted. (Pl.'s Objections to the Report on Obviousness at 7.) This contention is unpersuasive, because the claim construction was not *finalized* until the Court's order on March 23, 2003.

sums" step of claims 1 and 13. Thus claim 21 merely recites the prior art method of performing a tiled DWT. Accordingly, Defendants' motion for partial summary judgment of invalidity of claim 21 based on obviousness is GRANTED.

B. Invalidity of Claims 21-25 and 27-28 of the '835 Patent Under 35 U.S.C. § 112

Defendants attack the validity of claim 21, and the claims dependent on it, based upon the written description and enablement requirements of 35 U.S.C. § 112 ¶ 1. (*See* Report on Invalidity at 4) (citations omitted). Defendants contend that the '835 specification "teaches away" from a method for viewing areas of an image which suffer from "edge artifacts" or "seams." (*Id.* at 6) (citations omitted). Defendants argue that, because it omits the "maintaining updated sums" method, claim 21 defines an invention that is different from that described in the patent specification and is, therefore, in violation of the written description requirement of § 112 ¶ 1. (*Id.* at 4-5) (citations omitted). In essence, Defendants contend that because the goal of the '835 patent is to create seamless DWT, and because "maintaining updated sums" is the method used to rid the DWT-compressed image of "edge artifacts" or "seams," claim 21's omission of the "maintaining updated sums" method necessarily fails to meet the patent specification. (*Id.*) Plaintiffs do not disagree that application of the claim 21 method "could result in a computer display of an image with artifacts at the edges of the tiles, *i.e.*, an image that is *not seamless*," but argue that "the method of claim 21 nonetheless is adequately described in the specification." (*Id.* at 5) (citing Pl.'s Opp'n at 3).

A valid patent requires a written description of the invention that permits persons of ordinary skill in the art to recognize the invention by the written claim. 35 U.S.C. § 112 ¶ 1; *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555 (Fed. Cir. 1991). The written description requirement of § 112 prevents a patentee from narrowly disclosing an invention and then arguing later that the claims cover an invention not described in the patent. *N. Am. Vaccine, Inc. v. Am. Cyanamid Co.*, 7 F.3d 1571, 1577 (Fed. Cir.

1993). However, a patent claim does not fail the written description requirement merely because it omits a particular element. *Reiffen v. Microsoft Corp.*, 214 F.3d 1342, 1348 (Fed. Cir. 2000). Thus, the description does not have to exactly describe the subject matter claimed, but it must clearly allow persons of ordinary skill in the art to recognize that the invention exists as claimed. *See* 35 U.S.C. § 112; *Mahurkar*, 935 F.2d at 1562.

1. *Special Master's Report and Recommendation on Invalidity*

The Special Master concluded that, although the '835 patent teaches away from a non-seamless compression/retrieval methodology, there was a genuine factual issue as to whether the invention of claim 21 finds adequate written description in the patent.[11] (Report on Invalidity at 10.) This determination was based on the Special Master's characterization that the "case law requires a very clear, unambiguous statement in the specification that would exclude the claim at issue in order to hold it lacks written description." (*Id.* at 7) (citation omitted).

The Special Master examined the declaration of the parties' expert witnesses, declared that "[o]n balance, this evidence . . . favors ERM's position," and refuted all three of Plaintiff's expert's contentions. (Report on Invalidity at 8-9.) However, in light of the "clear, unambiguous" standard applied, the Special Master found that a reasonable jury could find the patent claim in question valid. (*Id.* at 10.)

2. *Defendants' Objections*

Defendants request that the Court not adopt the recommendation on written description, arguing that the Special Master applied the wrong legal standard in analyzing the written description requirement

[11] To support the finding that the '835 patent teaches away from the method for viewing areas of an image that suffer from compression edge artifacts, the Special Master pointed to specific paragraphs in the '835 patent description, including the introductory paragraph of the Detailed Description of the Invention. (*See* Report on Invalidity at 6.)

of the '835 patent. (Defs.' Objection to Report on Invalidity at 3; Tr. of Oral Argument at 20.) Defendants allege that the Special Master misconstrued the standard in *Gentry Gallery, Inc. v. Berkline Corp.*, 134 F.3d 1473 (Fed. Cir. 1998), to *require* a statement in the patent specification which clearly and unambiguously excludes the claims so as to lack a written description to support the claim. (Defs.' Objection to Report on Invalidity at 3-4.)

The Court agrees with Defendants' interpretation of the case law governing the written description requirement. The relevant inquiry is whether a reasonable juror could find that the written description was sufficiently detailed to enable one skilled in the art to recognize that the patentee actually invented what was claimed. *Turbocare v. Gen. Elec. Co.*, 264 F.3d 1111, 1119 (Fed. Cir. 2001). As discussed below, there is no requirement that a patent specification clearly and unambiguously exclude the claim at issue.

In *Gentry Gallery*, the Federal Circuit found that the patentee's "disclosure unambiguously limited the location of the controls to the console. Accordingly, the district court clearly erred in finding that he was entitled to claims in which the recliner controls are not located on the console." (Defs.' Objection to Report on Invalidity at 4) (citing *Gentry Gallery*, 134 F.3d at 1480). Defendants contend that although the Federal Circuit in *Gentry Gallery* found that a clear, unambiguous statement in the specification excluded the claims at issue in that case, the Federal Circuit did not indicate that such a statement was *required*. (Defs.' Objections to Report on Invalidity at 4; Tr. of Oral Argument at 20-22.) In fact, in *Turbocare*, decided subsequent to *Gentry Gallery*, the Federal Circuit found just the opposite. The *Turbocare* court addressed a written description issue in the context of the original claim describing a specific location of a spring, and the patentee's subsequent attempt to add dependent claims in which the spring would be located elsewhere. As the court found:

> [The] original disclosure is completely lacking in any description of an embodiment in which the spring is located between the casing shoulders and the inner surface of the outer ring portion of the ring segment. Such an embodiment may have been obvious from [the inventor's] vague reference to a "spring located . . . adjacent to said rings". . . , however, that is not enough to satisfy the written description requirement.

Turbocare, 264 F.3d at 1119 (referencing *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565 (Fed. Cir. 1997)). Thus, the Federal Circuit did not *require* a clear, unambiguous statement in *Turbocare*, but instead affirmed the district court's summary judgment invalidating the claim because the original specification contained a *vague* statement which *might* have suggested the location in the second dependent claim. *Id.*

Given that seamless compression is the only embodiment described in the '835 patent, and that absent the "maintaining updated sums" method, seamless compression cannot be achieved, the Court finds that no reasonable juror could conclude that claim 21 meets the written description requirement of § 112 ¶ 1.[12] Moreover, summary judgment is appropriate where the specification is lacking in any description of an embodiment. *See Turbocare*, 264 F.3d at 1119. As the Federal Circuit has explained:

> While the meaning of terms, phrases, or diagrams in a disclosure is to be explained or interpreted from the vantage point of one skilled in the art, all the limitations must appear in the specification. The question is not whether a claimed invention is an obvious variant of that which is disclosed in the specification. Rather, a prior application itself must describe an invention, and do so in sufficient detail that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought.

Lockwood, 107 F.3d at 1575.

Here, the '835 patent describes a seamless method for DWT compression of images. However, claim 21 lacks the "maintaining updated sums" method required to reach this result. As noted above,

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[12] The Special Master indicated that claim 21 itself provides "some evidence that would allow one of ordinary skill in the art to recognize that the applicant invented what is claimed." (Report on Invalidity at 9.) However, the language in claim 21 alone is not *per se* sufficient to raise a genuine issue of material fact. *See Gentry Gallery*, 134 F.3d at 1480.

without that corrective method, claim 21 merely recites prior art DWT-compression processes. Claim 21, thus, fails the written description requirement. Accordingly, the Court hereby GRANTS Defendants' Motion for Partial Summary Judgment that Certain Claims of U.S. Patent No. 5,710,835 are Invalid.[13]

IV. INFRINGEMENT OF THE '835 PATENT

As the Court previously noted, both Plaintiff's '835 patent and the Defendants' method achieve a result of seamless DWT-compression. Hence, Plaintiff contends that Defendants' patented sliding window method infringes claims 1 and 13 of its '835 patent.

To rule on the issue of patent infringement, the Court must first look at whether the accused patent literally infringes on the other patent. *See, e.g., Markman v. Westview Instruments*, 52 F.3d 967, 1000 (Fed. Cir. 1995). If no literal infringement is found, the Court must then consider whether the accused patent infringes under the doctrine of equivalents. *See Warner-Jenkinson v. Hilton Davis Chemical Co.*, 520 U.S. 17, 21 (1997) (citing *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 609 (1950)). According to that doctrine, a patent is infringed if the disputed claims perform substantially the same function in substantially the same way, to achieve the same result. *Warner-Jenkinson*, 520 U.S. at 25; *see Graver Tank*, 339 U.S. at 608.

"To support a summary judgment of noninfringement it must be shown that, on the correct claim construction, no reasonable jury could have found infringement on the undisputed facts or when all reasonable factual inferences are drawn in favor of the patentee." *Techsearch, L.L.C. v. Intel Corp.*, 286 F.3d 1360, 1371 (Fed. Cir. 2002) (citing *Network, L.L.C. v. Centraal Corp.*, 242 F.3d 1347, 1351 (Fed. Cir. 2001)). Alternatively, "the trial court should grant summary judgment in any case where no

[13] The parties have agreed that with respect to the written description requirement, the validity of the dependent claims is tied to the validity of claim 21. (*See* Report on Invalidity at 10 n.13) (citing Tr. at 104:12-105:8). Therefore, in light of the Court's finding that claim 21 is invalid, claims 22-25 and 27-28 are necessarily invalid as well. Because the Court finds claim 21 and its dependent claims invalid under the written description requirement, it need not consider the enablement requirement.

reasonable factfinder could find equivalence." *Techsearch*, 286 F.3d at 1371 (citing *Sage Prods. v. Devon Indus., Inc.*, 126 F.3d 1420, 1423 (Fed. Cir. 1997)).

A. Special Master's Report and Recommendation on Noninfringement

1. *Literal Infringement*

The Special Master concluded that Defendants' digital image compressing method does not infringe claims 1 and 13 of Plaintiff's '835 patent. (Report on Noninfringement at 11-15.) The Special Master determined that Defendants' patent did not literally infringe the '835 patent because the former does not include the "maintaining updated sums" method of element four of claims 1 and 13 of the '835 patent. (Report on Noninfringement at 15.) Crucial to this determination was the Court's earlier construction of the claim limitation "maintaining updated sums of said DWT coefficients" to mean "summing the DWT coefficients of one tile together with overlapping DWT coefficients from one or more adjacent tiles." (Order of March 27, 2003 at 3, Dkt. No. 237; Report on Noninfringement at 11.)

Defendants argued that "the ERM method is not concerned with correcting edge artifacts to produce a seamless image, because it does not generate edge artifacts." (Report on Noninfringement at 11.) Plaintiff maintained that "performing a DWT *necessarily* generates coefficients that are 'outside of the input'" and, more specifically, "when the ERM method performs a vertical DWT on the lines of the buffer, it *necessarily* develops coefficients that derive from and overlap with adjacent tile(s) . . . ." (*Id.* at 11-12.)

The Special Master determined that Plaintiff's quoted argument has no merit "because the DWT coefficients that are summed in the vertical DWT filtering step of the ERM method . . . are not *overlapping*." (*Id.* at 13.) In essence, in the ERM method, the horizontal DWT coefficients are generated by a DWT filtering applied *only* to that row, but are not influenced by any other row. (*Id.* at 14.) Because "overlapping" necessarily included DWT coefficients from one or more adjacent tiles, the

Special Master concluded the ERM method lacks the overlapping requirement necessary according to the Court's claim construction of the '835 patent's "maintaining updated sums" method. (*Id.*) "Plaintiff did not point out or submit any evidence of specific facts to support its contention that the ERM method 'does, in fact, add 'overlapping' coefficients'" nor did it submit any "affidavit or declaration of any witness in opposition to the motion on noninfringement." (*Id.* at 14-15.) The Special Master, thus, found no literal infringement because the ERM method did not include step four, the "maintaining updated sums" step, in claims 1 and 13 of the '835 patent. (*Id.*)

2. *Infringement Under the Doctrine of Equivalents*

The Special Master next considered whether the ERM method infringed the '835 patent under the doctrine of equivalents. Defendants asserted that its "sliding window" method departs substantially from the step of "maintaining updated sums" recited in claims 1 and 13 of the '835 patent, and thus cannot be deemed equivalent. (*Id.* at 15.) Plaintiff, however, contends that any differences between the ERM method and its '835 patent are insubstantial. (*Id.* at 16.)

The Special Master noted that the doctrine of equivalents cannot be applied to entirely ignore a limitation of claim:

> Infringement may not be found under the doctrine of equivalents if a limitation is missing, that is, not replaced with an equivalent substitute. But as explained in *Corning Glass Works v. Sumitomo Electric U.S.A., Inc.*, 868 F.2d 1251 (Fed. Cir. 1989), the substituent need not be in the exact same location specified by the claim. If, in the context of the invention, the substituent substantially performs the same function to achieve the same result in the same way as the required limitation, that limitation is satisfied.

(Report on Noninfringement at 16-17) (quoting *Zygo Corp. v. Wyko Corp.*, 79 F.3d 1563, 1568 (Fed. Cir. 1996).

As the Special Master had found in consideration of literal infringement, the DWT coefficients do not overlap in the ERM method. (*Id.* at 17.) Defendants conceded "that its method achieves the

same result as the step of 'maintaining updated sums,' in that a seamless DWT of the input image ultimately results." (*Id.* at 18.) Thus, the Special Master determined that the patents were functionally equivalent under the *Walker-Jenkinson* framework for doctrine of equivalents.

However, Defendants contended that there was a substantial difference in the *way* the ERM method accomplishes this function. (*Id.*) Unlike a mere showing of a substantial similarity in function, a substantial similarity in the *way* a function is achieved *can* support a judgment of noninfringement. *See Zygo*, 79 F.3d at 1569-70. The Special Master determined that "the uncontroverted evidence supports ERM's position that the ERM method does not require add-back or corrections to DWT coefficients because it never produces overlapping DWT coefficients." (Report on Noninfringement at 19) (citing Gray Decl. ¶ 14).

Plaintiff indicated that it had "no reason to rely on the doctrine of equivalents, although it reserve[d] the right to do so." (*Id.* at 20.) In that respect, the Special Master noted that Defendants' Noninfringment Motion did address the doctrine of equivalents and Plaintiff had the opportunity to respond. (*Id.*) The Special Master determined that Plaintiff had offered no evidence to contradict ERM's showing that it does not infringe under the doctrine of equivalents. (*Id.*) ("The mere recital of the *Graver Tank* . . . mantra that the accused device performs 'the same function, in the same way, to achieve the same result,' without more, does not create a genuine issue of material fact as to whether an accused device infringes by equivalents.") (quoting *Moore U.S.A., Inc. v. Standard Register Co.*, 229 F.3d 1091, 1113 (Fed. Cir. 2000)).

B. Plaintiff's Objections

In objecting to the Special Master's recommendation that the Court grant Defendants' Motion for Partial Summary Judgment of Noninfringement, Plaintiff recites its contentions produced in opposition to the motion. Plaintiff argues that the Special Master's finding of noninfringement is erroneous because

it is based on the mistaken belief that the accused ERM software does not produce overlapping coefficients. (Pl.'s Objections at 4.)

Plaintiff submits that the Special Master's conclusion disregards his own earlier finding in the Report on Claim Construction that the "respective DWT coefficients overlap because of the expansive nature of the transform . . . ." (*Id.* at 3.) Plaintiff further argues that the Report on Noninfringement improperly reopened the claim construction stage of this case by ascribing a new and special meaning to the term "overlapping." (*Id.* at 4; *see also* Tr. of Oral Argument at 4-6.)

Defendants counter that the Special Master had applied the term "overlapping" consistently with the Court's earlier construction that "maintaining updated systems means summing the DWT coefficients of one tile together with *overlapping* DWT coefficients from one or more adjacent tiles." (Defs.' Resp. to Pl.'s Objections at 2-3) (citing Report on Claim Construction at 36) (emphasis in original). In addition, at oral argument, Defendants' counsel noted that the Special Master had considered and rejected Plaintiff's argument that "summing" and "overlapping" are inherent in the DWT-compression process. (Tr. of Oral Argument at 15.) Defendants' counsel contended that instead of providing his own evidence, Plaintiff's expert pointed to Defendants' expert evidence and asked the Special Master to agree with Plaintiff's inference. (*Id.*)

The Court agrees with the findings and recommendation of the Special Master, as outlined above. The Special Master did not ascribe a greater meaning to the term "overlapping," but instead utilized the Court's construction of "maintaining updated sums" which necessarily requires "overlapping" of coefficients from adjacent tiles. Because the DWT coefficients do not overlap in the ERM method, the evidence supports the Special Master's recommendation. This is especially so given that Plaintiff submitted no evidence to support its contention that the ERM method does actually add overlapping coefficients. (Report on Noninfringement at 15.)

In addition, Plaintiff's expert's declaration was significantly lacking evidentiary support in comparison to Defendants' expert's declaration. As Defendants' counsel noted at oral argument, their expert "followed the *Graham* factors as required by the Supreme Court," and were not refuted by Plaintiff's expert. (Tr. of Oral Argument at 17.)

Accordingly, the Court adopts the Special Master's recommendation that Defendants ERM's method does not infringe claims 1 and 13 of Plaintiff's '835 patent, either literally or under the doctrine of equivalents. Defendants' Motion for Partial Summary Judgment of Noninfringement is, therefore, GRANTED.

V. CONCLUSION

The Court adopts the Special Master's recommendation with respect to the obviousness of claim 21 and GRANTS Defendants' Motion for Partial Summary Judgment That Certain Claims of U.S. Patent No. 5, 710,835 are Invalid. The Court further adopts the Special Master's recommendation that Defendants' method does not infringe claims 1 and 13 of Plaintiff's '835 patent and GRANTS Defendants' Motion for Partial Summary Judgment of Noninfringement. The Court does not adopt the Special Master's recommendation with respect to summary judgment on the invalidity of certain claims of the '835 patent and GRANTS Defendants' Motion for Summary Judgment of Invalidity of Claim 21 and its dependent claims.

SO ORDERED this 16 day of March, 2004.

CHIEF UNITED STATES DISTRICT JUDGE

US005710835A

United States Patent [19]

Bradley

[11] Patent Number: 5,710,835

[45] Date of Patent: Jan. 20, 1998

[54] **STORAGE AND RETRIEVAL OF LARGE DIGITAL IMAGES**

[75] Inventor: **Jonathan N. Bradley**, Los Alamos, N. Mex.

[73] Assignee: **The Regents of the University of California, Office of Technology Transfer**, Alameda, Calif.

[21] Appl. No.: **557,475**

[22] Filed: **Nov. 14, 1995**

[51] Int. Cl.[6] G06K 9/42; G06K 9/36

[52] U.S. Cl. 382/233; 382/298; 348/399

[58] Field of Search 382/232, 240, 382/260, 261, 263, 264, 278, 298, 276, 282; 348/397, 398, 403, 411; 364/572

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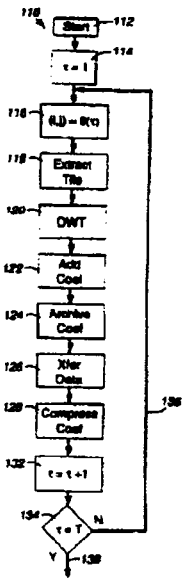
Primary Examiner—Dwayne Bost
Assistant Examiner—Brian L. Johnson
Attorney, Agent, or Firm—Ray G. Wilson

[57] **ABSTRACT**

Image compression and viewing are implemented with (1) a method for performing DWT-based compression on a large digital image with a computer system possessing a two-level system of memory and (2) a method for selectively viewing areas of the image from its compressed representation at multiple resolutions and, if desired, in a client-server environment. The compression of a large digital image I(x,y) is accomplished by first defining a plurality of discrete tile image data subsets $T_i(x,y)$ that, upon superposition, form the complete set of image data I(x,y). A seamless wavelet-based compression process is effected on I(x,y) that is comprised of successively inputting the tiles $T_i(x,y)$ in a selected sequence to a DWT routine, and storing the resulting DWT coefficients in a first primary memory. These coefficients are periodically compressed and transferred to a secondary memory to maintain sufficient memory in the primary memory for data processing. The sequence of DWT operations on the tiles $T_i(x,y)$ effectively calculates a seamless DWT of I(x,y). Data retrieval consists of specifying a resolution and a region of I(x,y) for display. The subset of stored DWT coefficients corresponding to each requested scene is determined and then decompressed for input to an inverse DWT, the output of which forms the image display. The repeated process whereby image views are specified may take the form an interaction with a computer pointing device on an image display from a previous retrieval.

28 Claims, 6 Drawing Sheets

Microfiche Appendix Included
(3 Microfiche, 319 Pages)



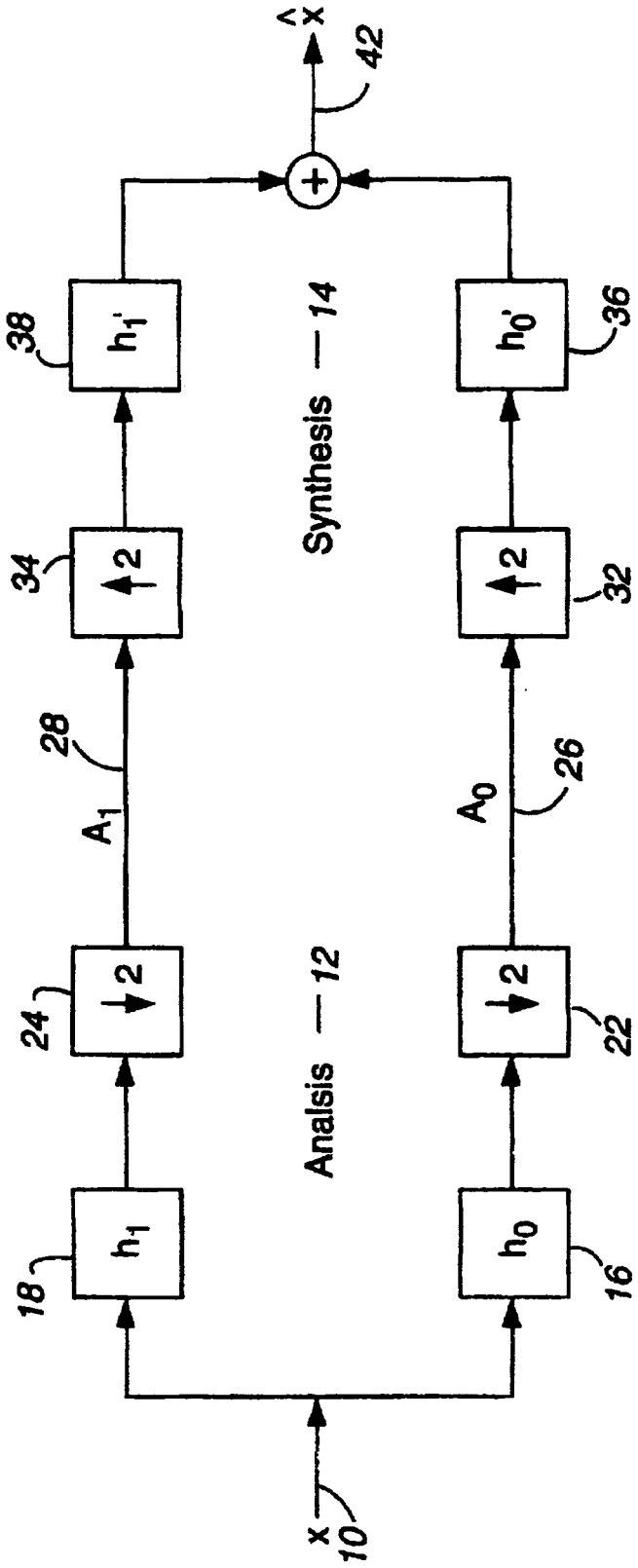


Fig. 1
Prior Art

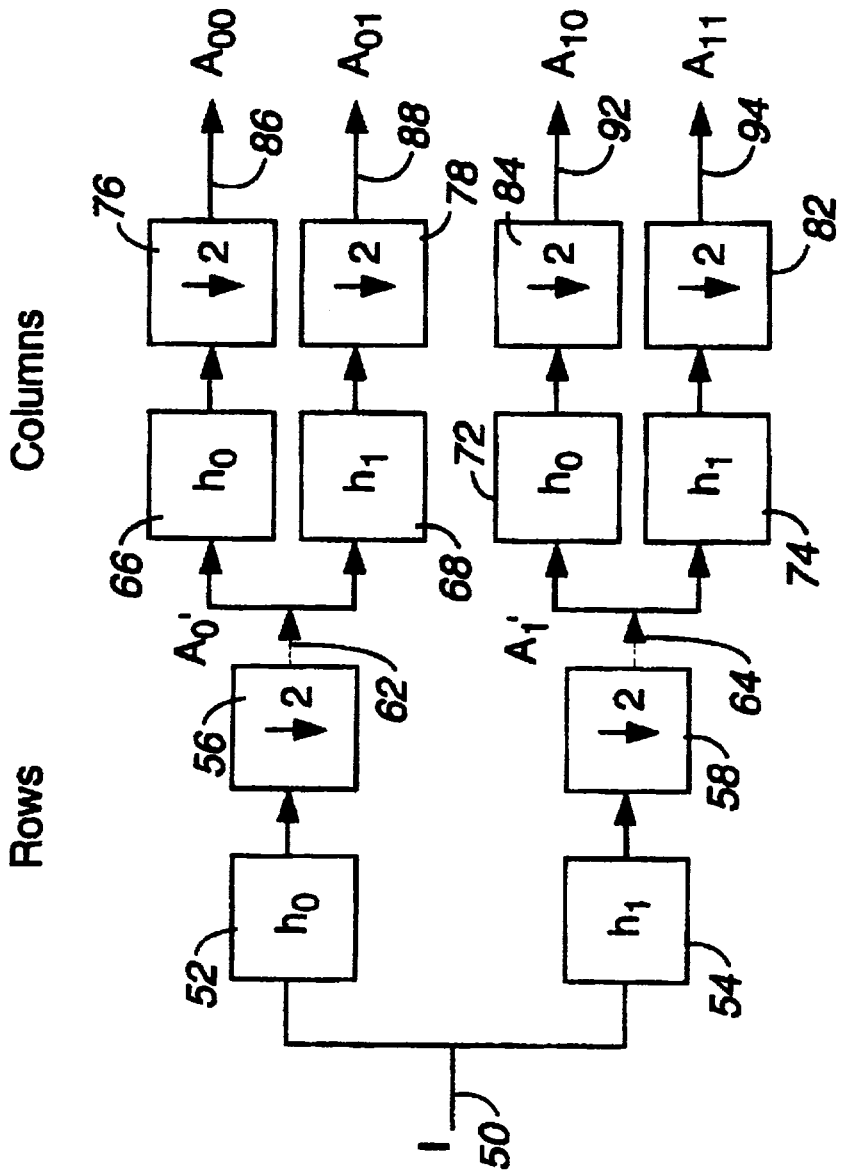


Fig. 2
Prior Art

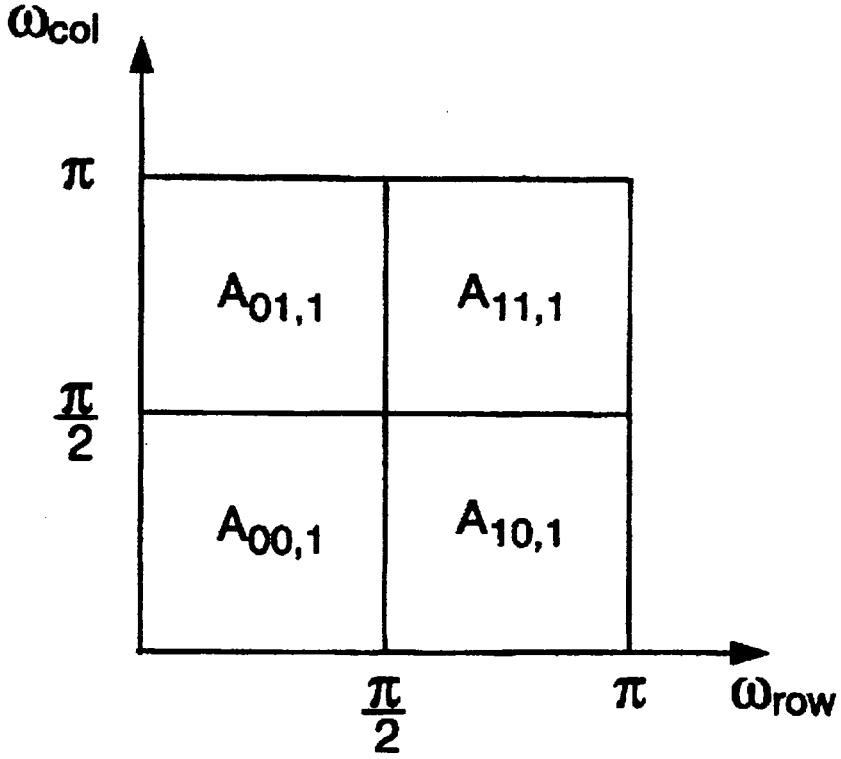
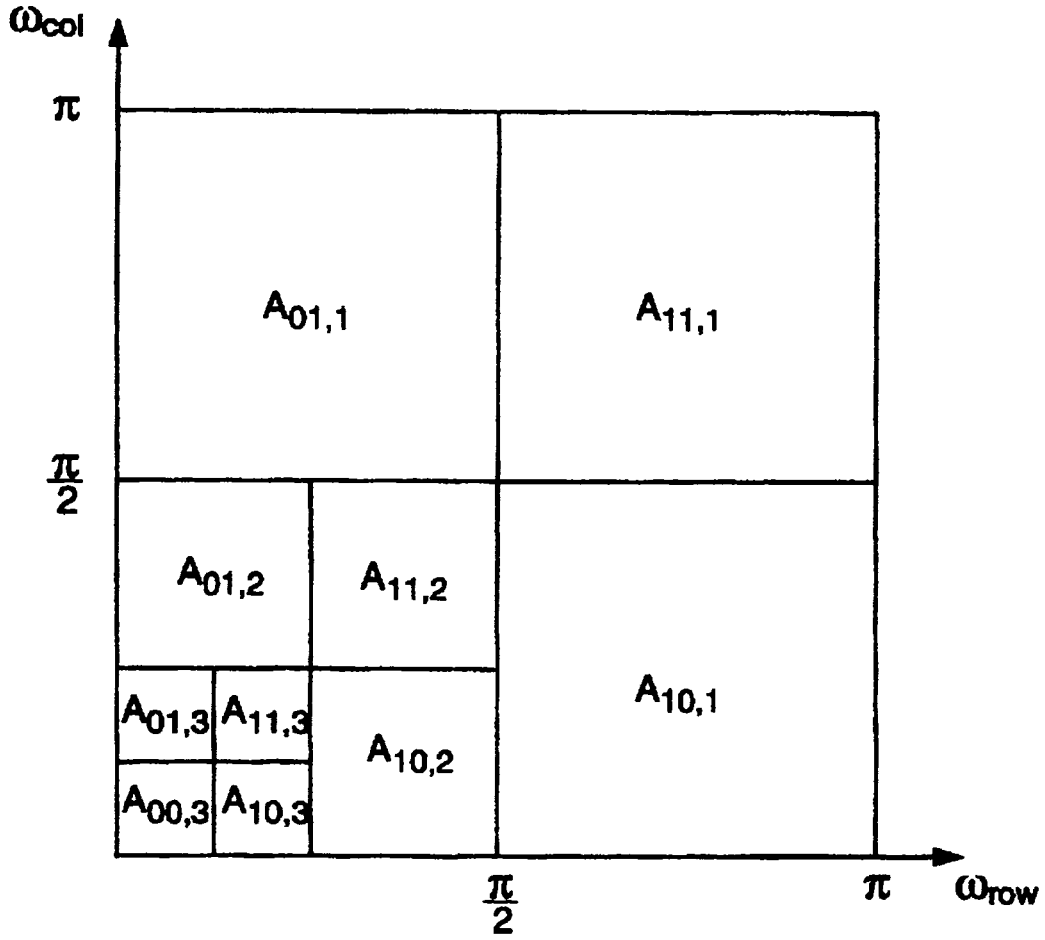


Fig. 3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π
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$\frac{\pi}{2}$
π
ω_{row}

Fig. 4

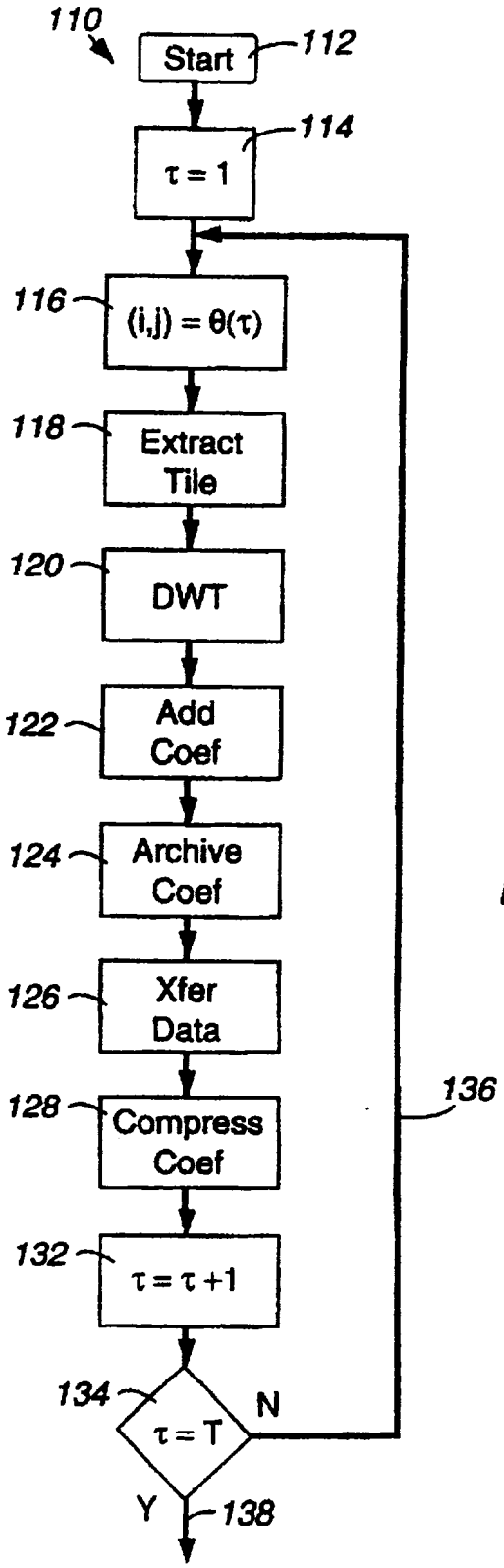
110
Start
112
τ = 1
114
(i,j) = θ(τ)
116
Extract Tile
118
DWT
120
Add Coef
122
Archive Coef
124
Xfer Data
126
Compress Coef
128
τ = τ +1
132
τ = T
134
N
Y
138
136

Fig. 5

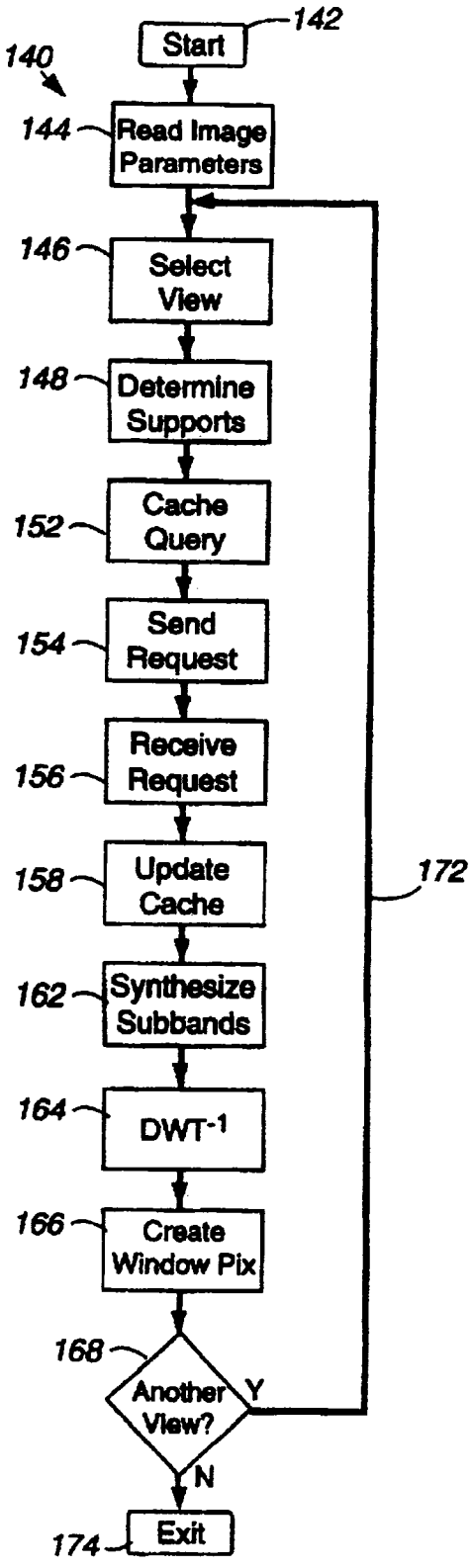
140
142
Start
144
Read Image Parameters
146
Select View
148
Determine Supports
152
Cache Query
154
Send Request
156
Receive Request
158
Update Cache
162
Synthesize Subbands
164
DWT-1
166
Create Window Pix
168
Another View?
Y
N
172
174
Exit

Fig. 6

STORAGE AND RETRIEVAL OF LARGE DIGITAL IMAGES

This invention relates to digital imaging and, more particularly, to the storage and retrieval of data contained in very large digital images. This invention was made with government support under Contract No. W-7405-ENG-36 awarded by the U.S. Department of Energy. The government has certain rights in the invention.

BACKGROUND OF THE INVENTION

A microfiche appendix containing 1 microfiche card with a total of 183 frames is attached hereto. The program listing set out in the microfiche contains material that is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure, as it appears in the patent and Trademark Office patent file or records, but otherwise reserves all copyright rights whatsoever.

Many applications exist that require the storage and retrieval of very large digital images. Examples of such data sets include a Landsat Thematic Mapper (TM) scene, a mosaic of digital orthophotos (digitized aerial photographs), or a high resolution scan of a photographic negative. As used herein, the term "image" means any large two-dimensional array of numeric data even if that data may not typically be referred to as an "image," e.g., digital elevation data.

Due to the prodigious amounts of data present in such images, data compression is of significant importance to improve the utilization of computer storage and transmission resources. The image dimensions under consideration are significantly larger than can be viewed on a computer monitor. If a user can only view image subsections at full resolution, a display may contain less than one percent of the image. Under such circumstance, it is difficult to form in the viewer an overall picture of the image or to locate particular features of interest. Viewing the image at less than full resolution permits larger regions of the image to be displayed or even an entire image.

Certain computer-implemented image data compression schemes used in the prior art are subband coding techniques, discussed in more detail below. The image data is separated into a number of subimages that are referred to as "subbands" since each contains information from a different band of spatial frequencies in the image. Compressing the subbands separately facilitates matching the overall compression algorithm to the image statistics. A recent mathematical development, the discrete wavelet transform (DWT), has significant theoretical overlap with the methods developed for generating the image subbands. For this reason, the term "subband decomposition" has come to be synonymous with a DWT. This terminology is used here.

For very large image dimensions complications arise in the computation of the DWT. The prior art discusses techniques for implementing the DWT where it is implied that the entire image data array is stored in computer main memory and that the computer-processed algorithm can readily access all of the image pixels. For very large images the memory involved in performing a DWT can become prohibitive. For example, consider an image that is of dimension 50,000×50,000 pixels, i.e., consisting of 2.5 billion pixels. If the transform is implemented in 32-bit precision floating point arithmetic then 10 gigabytes of computer memory are required (not including work space). Clearly, some method is required for paging data from computer memory and computing the DWT in sections.

Although one could divide the image array into rectangular subsections and perform a DWT on each of these independently, this would be undesirable for two reasons. First, there would be wavelet transform boundary conditions in the interior of the image data which could potentially result in compression artifacts. Furthermore, the implementation of a local multiscale retrieval routine is complicated by these interior boundaries.

In accordance with the present invention, a method is provided for the seamless wavelet-based compression of very large contiguous images and for accessing arbitrary locations in the image at a variety of resolutions.

Accordingly, it is an object of the present invention to provide for retrieving from the compressed representation an image subsection from any location within the image with dimensions that are suitable for display.

It is another object of the present invention to permit a user to interactively specify image regions for display and rapidly retrieve the image regions.

Yet another object of the present invention is to permit the user to navigate, or "browse," over the database forming the image.

One other object of the present invention is to provide for recalling the image at a variety of resolutions.

Additional objects, advantages and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

SUMMARY OF THE INVENTION

To achieve the foregoing and other objects, and in accordance with the purposes of the present invention, as embodied and broadly described herein, this invention may comprise (1) a method for performing DWT-based compression on a large digital image with a computer system possessing a two-level system of memory and (2) a method for selectively viewing areas of the image from its compressed representation at multiple resolutions and, if desired, in a client-server environment. The two-level memory system refers to primary and secondary memories. The primary memory is typically much smaller than the secondary memory but is more accessible by the processor.

The compression of a large digital image $I(x,y)$ is accomplished by first defining a plurality of discrete tile image data subsets $T_{ij}(x,y)$ that, upon superposition, form the complete set of image data $I(x,y)$. A seamless wavelet-based compression process is effected on $I(x,y)$ that is comprised of successively inputting the tiles $T_{ij}(x,y)$ in a selected sequence to a DWT routine, adding corrections that are passed from previous invocations of the DWT routine on other $T_{ij}(x,y)$, and storing the resulting DWT coefficients in a first primary memory. These coefficients are periodically compressed and transferred to a secondary memory to maintain sufficient memory in the primary memory for data processing. In the absence of the compression step, the sequence of DWT operations on the tiles $T_{ij}(x,y)$ effectively calculates a seamless DWT of $I(x,y)$ that can be viewed as an "overlap-add" realization of the DWT. The seamless DWT process transforms $I(x,y)$ to a set of DWT coefficients to form a set of subbands that embody a hierarchical representation of low-resolution representations of the image data array $I(x,y)$.

Data retrieval consists of specifying a resolution and a region of I(x,y) for display. The subset of stored DWT coefficients corresponding to each requested scene is determined and then decompressed for input to an inverse DWT, the output of which forms the image display. The repeated process whereby image views are specified may take the form an interaction with a computer pointing device on an image display from a previous retrieval.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

FIG. 1 is a schematic diagram of a prior art two-channel forward (analysis) and inverse (synthesis) discrete wavelet transformation (DWT) of an input data array.

FIG. 2 is a schematic diagram of a two dimensional DWT process realized with multiple applications of the analysis portion of the system shown in FIG. 1.

FIG. 3 illustrates the four subbands formed from an image array by application of the DWT shown in FIG. 2.

FIG. 4 illustrates the frequency support of a subband decomposition resulting from repeated applications of the system shown in FIG. 3.

FIG. 5 is a flow diagram for DWT data compression according to one embodiment of the present invention.

FIG. 6 is a flow diagram for decompressing data according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is concerned in part with a computer-implemented subband compression scheme for large images. The advantageous use of a two-level system of computer memory provides for the efficient local computation of the DWT in conjunction with a spatially adaptive coding scheme, allowing seamless image compression with minimal memory requirements. Furthermore, the invention provides for rapidly retrieving image views of arbitrary dimension and location at a variety of resolutions from the compressed data.

The invention advantageously uses the DWT for two purposes. The DWT is used as a preprocessing step in a computer to facilitate data compression. The subdivision of the input image data array into a set of image subbands that are coded separately facilitates matching the compression algorithm to the image statistics. Moreover, the DWT is also used to provide for multiscale data retrieval. Due to the multiresolution nature of the DWT, a description of the image at a variety of resolutions is inherent in the DWT decomposition, thus facilitating multiscale retrieval of the compressed data in accordance with the present invention.

DEFINITIONS

columns: Samples per line in an image.

compressed data: Either compressed image data or table specification data or both.

compression: Reduction in the number of bits used to represent source image data.

(digital) image: A two-dimensional array of data.

downsampling: A procedure by which the spatial resolution of an image is reduced.

DWT: (discrete wavelet transform) A linear transformation, implemented by a multirate filter bank, that maps a digital input signal to a collection of output subbands.

Huffman coding: An entropy coding procedure that assigns a variable length code to each input symbol.

Huffman table: The set of variable length codes required in a Huffman coder.

image data: Either source image data or reconstructed image data.

lossless: A descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedures(s) is identical to the input to the encoding procedure(s).

RGB images: A "red-green-blue" image, i.e., a digital image that is stored as three monochromatic images, each of which represents one of the three primary color components.

quantization table: The set of quantization values (i.e., bin widths) used to quantize DWT coefficients within the subbands.

quantize: The act of performing the quantization procedure for a DWT coefficient.

sample: One element in the two-dimensional array that comprises an image.

upsampling: A procedure by which the spatial resolution of an image is increased.

PRIOR ART SUBBAND CODING

The first stage in a computer implementation of a DWT-based lossy image compression algorithm entails a DWT decomposition of the input image. In the case of multispectral imagery (which includes RGB images), an interspectral transform may be applied at this stage immediately before or after the DWT. Following the image transformation, the DWT coefficients are quantized. This is the lossy portion of the algorithm and maps the DWT coefficients into a stream of quantizer indices. Finally, the stream of quantizer indices are compressed with a lossless technique. Image decompression is achieved by inverting the lossless compression, decoding the quantizer symbols, and then performing an inverse DWT. A discussion of the use of the DWT in image compression can be found in J. N. Bradley et al., "The Wavelet-Scalar Quantization Compression Standard for Digital Fingerprint Images," Proc. of IEEE International Symposium on circuits and Systems, May 31–Jun. 2, 1994.

FIG. 1 is a flow diagram of a computer processor implementation for a one-dimensional forward (analysis) and inverse (synthesis) DWT and forms a basic building block in the two-dimensional DWT implementation used in the invention. The input to the analysis section is the discrete-time signal×10 to analysis section 12 and synthesis section 14 The discrete-time sequences A_0 26 and A_1 28 are the output subband signals from the analysis section and form the input to synthesis section 14. The systems h_0 16 and h_1 18 form a lowpass-highpass finite impulse response (FIR) filter pair that separates the low and high frequency components of×10. The systems 22 and 24 denoted by ↓2 are "downsamplers" that discard every second sample in the filter outputs. The analysis system is said to be "critically sampled", i.e., data is output from the system at the same rate as it is input. Due to the downsampling operations 22 and 24, A_0 26 and A_1 28 are full band signals that embody, respectively, the low and high frequency information in×10.

The process shown in FIG. 1 also inputs the subband signals A_0 26 and A_1 28 to a synthesis section 14 that synthesizes the signal x̂ 42. The systems h_0' 36 and h_1' 38 form another lowpass-highpass FIR filter pair and the systems 32 and 34 denoted by ↑2 are "upsamplers" that increase the signal sampling rate by inserting a zero between samples. If the four digital filters, h_0 16 and h_1 18, and h_0' 36 and h_1' 38, shown in FIG. 1 are chosen appropriately, x̂

42 is equal to×10, i.e. synthesis section 14 shown in FIG. 1 inverts the operation performed by analysis section 12.

Separable realizations are often used for the two-dimensional DWT analysis and synthesis procedures, i.e., implementations where the corresponding one-dimensional procedure shown in FIG. 1 is applied separately to each image row and column. FIG. 2 depicts a separable two-dimensional forward DWT. The analysis system of FIG. 1 is first applied to each row of image I 50 through FIR filter pair h_0 52 and h_1 54, with downsamplers 56 and 58 to split each row into a lowpass and highpass subband. The lowpass subband from each image row is written as a row into the temporary array A_0' 62. Similarly, the highpass subband of each row is written as a row in the temporary array A_1' 64.

The columns in each temporary array are then each processed with a one-dimensional DWT of FIG. 1. The lowpass subband array A_0' is processed through FIR filter pair h_0 66 and h_1 68, with downsamplers 76 and 78 to further split each column into lowpass-lowpass and lowpass-highpass subbands. The highpass subband array A_1' is processed through FIR filter pair h_0 72 and h_1 74, with downsamplers 82 and 84 to further split each column into highpass-lowpass and highpass-highpass subbands.

This basic system shown in FIG. 2 thus splits the input image $I=A_{00,0}$ into four subbands, $A_{00,1}$ 86, $A_{01,1}$ 88, $A_{10,1}$ 92, $A_{11,1}$ 94, with appropriate frequency supports as illustrated in FIG. 3. In this $A_{ij,k}$ subband notation, the i and j subscripts denote the filter path that was used in their creation. The first subscript refers to the row operation and the second to the column operation with a "0" indicating a lowpass operation and "1" a highpass operation. For example, subband A_{10} 92 is created by a highpass filtering on the image rows followed by lowpass filtering on the columns of A_1' 64. The image is resolved into four subbands that contain different frequency components of the original image, from which the original image can be synthesized, as discussed for FIG. 1.

Finer frequency partitions are produced by cascading the system of FIG. 2. Typically, the lowpass-lowpass subband is repeatedly output to this same process, resulting in an "octave-scaled" decomposition. FIG. 4 illustrates the frequency support of a subband decomposition resulting from three cascades. The third subscript in the subband notation denotes the level of recursion in the decomposition. Let L denote the number of levels in the cascade. Note the $A_{00,s}$ for $1 \le s < L$ exist at intermediate stages of the process.

It is sometimes convenient to express the octave-scaled DWT of I(x,y), i.e., the collection of subbands $A_{ij,k}(u,v)$ as $\hat{I}(s,u,v)$, where s denotes a one dimensional ordering of the subbands. For example, in the subband notation shown in FIG. 4, $s=i+2j+3(L-k)$, and $\hat{I}(0,u,v)$, $\hat{I}(1,u,v)=A_{0,1,L}(u,v)$, . . . , $\hat{I}(3L,u,v)=A_{11,1}(u,v)$.

The input to the one-dimensional DWT depicted in FIG. 1 is assumed to be of infinite duration. Effecting the DWT on a finite length signal, e.g., an image row or column, necessitates the definition of transform boundary conditions. The boundary conditions define a signal extension, i.e., a definition of the signal outside of its domain. A boundary condition that is commonly used is the periodic extension in which the finite length signal is viewed as one period of an infinite periodic waveform. Another example is zero boundary conditions in which the signal is viewed as padded with zeros. Yet another example is reflected boundary conditions where the signal is extended by performing a mirror image of the data.

SUBBAND DECOMPOSITION OF LARGE IMAGES

The invention consists of two main procedures: a compression routine and a decompression (browsing) routine. The compression routine proceeds in a similar fashion as WSQ compression with the advantageous use of a two-level system of memory to accommodate the large image dimensions. In accordance with one aspect of the invention, the image is subdivided into a number of tiles, each of which is processed by a DWT routine. The DWT routine uses tile-dependent boundary conditions and data transfers with invocations of the DWT routine on other image tiles to effectively produce the same output as the DWT routine would output if applied to the entire image while providing a more advantageous usage of both primary and secondary memory. The process can be viewed as an overlap-add implementation of the DWT. The preferred implementation of the invention is based on the four-channel separable DWT of FIG. 2. Clearly, non-separable and M-channel filter banks are also applicable.

The Compression Routine

Referring now to FIG. 5, the compression routine outputs the compressed data in a compressed image data (CID) file which is structured for rapid local multiscale retrieval. The image data is assumed to exist on secondary memory, e.g., a computer hard drive memory, and may be contained in a single file or as a mosaic of subimages with each subimage contained in a separate file. The image data is denoted by I(x,y), where x and y are integers such that $0 \le x < W_I$ and $0 \le y < H_I$. The tile images are of the same dimensions as I(x,y) but have support restricted to a $W_t \times H_t$ subset of the (x,y) coordinates. More specifically,

$$T_{ij}(x,y) = \begin{cases} I(x,y), (x,y) \in \text{supp}[T_{ij}(x,y)] \\ 0, \text{otherwise} \end{cases}$$

where

$$\text{supp}[T_{ij}(x,y)] = \{(x,y) | t_{00,ij} \le x \le t_{01,ij},\ t_{10,ij} \le y \le t_{11,ij}\}$$

and where the four corners of a tile are given by

$t_{00,ij} = iW_t$,
$t_{01,ij} = \min((i+1)W_t - 1,\ W_{I-1})$
$t_{10,ij} = jH_t$
$t_{11,ij} = \min((j+1)H_t - 1,\ H_{I-1})$.

The number of tile images is given by

$$T = \left\lceil \frac{W_I}{W_t} \right\rceil \left\lceil \frac{H_I}{H_t} \right\rceil$$

There are no restrictions on the image dimensions and it is not necessary that W_I be divisible by W_t or that H_I be divisible by H_t. The tile images for $i = \lceil W_I/W_t \rceil - 1$ and $j = \lceil H_I/H_t \rceil - 1$ are allowed to have support regions smaller than $W_t \times H_t$. The present invention recognizes that I(x,y) can be represented as a superposition of the tiles, where

$$I(x,y) = \sum_i \sum_j T_{ij}(x,y) \quad (1)$$

and since the DWT is a linear transformation, the DWT of I(x,y) can be obtained by summing the DWT's of the $T_{ij}(x,y)$, i.e.,

$$\hat{I}(s,u,v) = \sum_i \sum_j \hat{T}_{ij}(s,u,v), \quad (1a)$$

where s is defined above. As will be described below, performing a DWT separately on the tile images allows for a DWT-based compression to occur on the image with minimal memory requirements.

The T_{ij} are processed sequentially in the compression routine. This requires a one-dimensional ordering of the T_{ij} that is denoted by $\theta(\tau)=(i,j)$. (That is, the τth image tile to be

wavelet transformed is $T_{\theta(\tau)}$.) The sum in Eqn. (1a) is not evaluated following the computation of all $\hat{T}_{ij}(s,u,v)$. Rather, this sum is updated after each τ iteration as

$$\hat{I}_{\theta}(s,u,v) = \sum_{\tau=1}^{\tau} \hat{T}_{\theta(\tau)}(s,u,v). \quad (2)$$

After a given $\hat{T}_{\theta(\tau)}(s,u,v)$ has been calculated, this update involves only those $(s,u,v) \in \text{supp}[\hat{T}_{\theta(\tau)}(s,u,v)]$. (Note that since h_0 and h_1 are FIR that the $\hat{T}_{ij}$ have finite support). In the compression routine, the result from Eqn. (1a) is never stored in its entirety. Periodically, some or all of the DWT coefficients are compressed and written to secondary memory. Those coefficients eligible for compression are

$$\{\hat{T}_{\theta(\tau)}(s,u,v) | \hat{T}_{\theta(\tau)}(s,u,v) = \hat{I}(s,u,v)\}. \quad (3)$$

By sequentially effecting a DWT on each image tile and updating the sum in Eqn. (2), a DWT-compression of the entire image can be effected with an efficient use of primary memory.

The compression routine is parameterized by W_t, H_t, W_p, and H_p as well as the number of levels L in the subband decomposition; a bit-rate parameter R that specifies the compression ratio; and the analysis filters h_0 and h_1. A flow chart of the compression process is depicted in FIG. 5. The routine 110 is started 112 with τ=1 and consists of a loop 136 indexed by τ that iterates on the T_{ij}. The first routine encountered in the loop is Extract Tile 118, which reads the pixel values contained in $\text{supp}[T_{ij}]$ from the image data and stores them in primary memory. The image tile is stored in a data structure that contains a description of its support as well as a pointer to the pixel values.

Subroutine DWT 120 (Discrete Wavelet Transform) is then invoked. In practice the DWT of each T_{ij} is not effected by operating on the zero-padded $W_t \times H_t$ array. It is only necessary to provide memory for those values of $T_{ij}(x,y)$ where $(x,y) \in \text{supp}[T_{ij}(x,y)]$. The one-dimensional DWT routine operates on the rows and columns of the tile data array with appropriate boundary conditions. The boundary conditions employed in the various calls to the one-dimensional DWT routine are dependent upon the location of tile T_{ij} in I. Reflected boundary conditions are used if the corresponding boundary of T_{ij} coincides with a boundary of I, otherwise zero boundary conditions are used. Note that DWT 120 effects an expansive transform, that is, the number of non-zero coefficients emanating from the routine is generally greater than the number of pixels that are input to it.

Subroutine Add Coefficient 122 is invoked to retrieve the data transfers for $\hat{T}_{i-1,j}$ and $\hat{T}_{i,j-1}$ that were stored on primary or secondary memory by an invocation of subroutine Xfer Data 126 (see below) for an earlier iteration of τ, and then adds them to $\hat{T}_{i,j}$, effectively performing the update in Eqn. (2). Note that this process implies a restriction on θ. Clearly, processing on $T_{ij}(x,y)$ cannot proceed if it has not already occurred on tiles $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$.

Subroutine Archive Coefficient 124 is then invoked, which stores in primary memory those wavelet coefficients in Eqn. (3) that were not stored earlier in a coefficient archive. Subroutine Xfer Data 126 stores the data that is recalled in later calls to Add Coef. 122. Two data segments are stored: those that are used when Add Coef. 122 is called for $T_{i,j+1}$

$$\{\hat{T}_{ij}(u,v) | (u,v) \in \text{supp}[\hat{T}_{ij}] \cup \text{supp}[\hat{T}_{i+1,j}]\}$$

and those that are used when Add Coef. 122 is called for $T_{i+1,j}$

$$\{\hat{T}_{ij}(u,v) | (u,v) \in \text{supp}[\hat{T}_{ij}] \cap \text{supp}[\hat{T}_{i+1,j}] - \text{supp}\hat{T}_{i+1,j}\}.$$

The data transfers are accomplished via temporary storage on either primary or secondary memory. Note that it is assumed that

$$\text{supp}[\hat{T}_{ij}] \cap \text{supp}[\hat{T}_{i+2,j}] = \phi$$

and

$$\text{supp}[\hat{T}_{ij}] \cap \text{supp}[\hat{T}_{i,j+2}] = \phi$$

for all i and j.

Periodically, in subroutine Compress Coefficient 128, some or all of the DWT coefficients in archive are compressed and written to secondary memory, i.e., they are dumped. Thus, the compression routine proceeds with primary memory continuously being allocated in Archive Coef. 124 and freed in Compress Coef. 128. The τ index is then indexed 132 to τ+1 and the loop is repeated 136 until τ=T 138., i.e., the number of tiles, and the routine is terminated 138.

In the preferred implementation of the invention, the compression includes scalar quantization followed by zero-run length and Huffman coding of the quantizer indices. (Other quantization strategies and lossless coding procedures are clearly applicable at this point.) The scalar quantization requires that a bit allocation be performed that selects a bin-width for each subband based on local image statistics. For a given dump it is preferred that all subband statistics correspond to roughly the same region in I. Although a particular dump may not involve compression of coefficients from all subbands, statistics from all subbands will be utilized in performing an overall bit allocation. The result is a spatially adaptive image compression scheme with the scalar quantizer bin widths and the Huffman codeword lengths a function of spatial location on the image. The number of invocations of DWT 120 between dumps is subband dependent. On each coefficient dump a single Huffman table is generated for each subband that is output.

A two-level hierarchy of coefficient blocking is used in the compression process. The first level is necessitated by the fact that the wavelet coefficient archive must be periodically purged (Compress Coef 128), whereupon a rectangular subsection of a subband (i.e., a block) is coded. Moreover, before a dump occurs, each subband block that is output is blocked further into smaller subblocks. The second level of blocking is to provide for fast access to an arbitrary section of the CID file during image browsing. Upon output in secondary memory, the larger block is referred to as a Huffman block and has header information that describes the Huffman table, the quantizer characteristic, the block support, and an offset table describing the relative offset in the compressed data record of each subblock. The smaller block is referred to as a Huffman subblock. Each Huffman subblock within a particular Huffman block is typically compressed with the same quantizer characteristic and Huffman table. The CID file has an offset table that describes the offset of each compressed Huffman block.

The Browse Routine

The browse routine 140 shown in flow diagram form in FIG. 6 accesses the CID computer memory file generated by compression routine 110 shown in FIG. 5 and generates pixel values for a sequence of window displays. The procedure has the capability for operating in a distributed environment, i.e., where the data is to be decompressed on a different computing platform than where the CID file resides. The client computer sends requests to the server computer that in turn transmits compressed data necessary for synthesizing a monitor window display. The client computer performs the operation of decompressing the received data and creating the computer monitor display. The routine on the client computer side provides for the management of a cache memory that contains data from previous accesses to the CID file. Any requested data contained in the cache may be retrieved from cache memory instead of from the server computer. The caching scheme is

advantageous when an application is limited by transmission bandwidth and is not typically used when the decompression executable file and the CID file reside on the same platform.

Since the subbands $A_{00,s}$ for $0 \le s \le L$ are obtained by repeated applications of lowpass filtering and two-fold downsampling, they form low resolution representations of the original image data. Browse routine **140** exploits this multiscale property of the subband decomposition. When specifying a view, the user is restricted to selecting a resolution that is a power-of-two times the original image resolution. The display generation then involves the synthesis of the appropriate subsection of $A_{00,s}$ from the CID file. Thus, browse routine **140** extracts a relatively small subset of the wavelet coefficients that is then input to an (L-s)-level inverse DWT.

A request for data from subband $A_{ij,s}(x,y)$ is described by the set of (x,y) coordinates defining the subregion to be extracted. This set is denoted by $a_{ij,s}$ where

$a_{ij,s}=\{(x,y)|x_{ij,s,0} \le x \le x_{ij,s,1},\ y_{ij,s,0} \le y \le y_{ij,s,1}\}$.

Note that since the window is assumed to be rectangular the $a_{ij,s}$ are rectangular also. Recall that a view at scale s requires wavelet coefficients from $A_{00,s}$. For s≠L these coefficients are not stored explicitly but must be synthesized from a subset of the coefficients contained in the CID file. The request specifies subsets $a_{ij,s}$ for (s,i,j) in K where $K=\{0,0,0\} \cup \{(0,1,1),(1,0,1),(1,1,1)|s<l \le L\}$.

An overview of browse routine **140** is shown in FIG. **6**. Procedure **140** is initiated **142** and begins by reading header information **144** from the CID file that describes the overall structure of this file. The structure information includes the number of levels in the subband decomposition, the image width and height, the supports and coefficient values of the synthesis filters, and an offset table describing the locations of table data and compressed data records. The procedure then invokes subroutine Select View Parameters **146** where the parameters specifying a view request are input. These parameters include the resolution s and the window support $a_{00,s}$.

At this point subroutine Determine Supports **148** is invoked, which evaluates the sets $a_{ij,s}$ specifying the wavelet coefficients that must be synthesized from the CID file. The subsets at level s are related to $a_{00,s-1}$ by the following

$$x_{ij,s,0}=\left\lceil \frac{x_{00,s-1,0}-l_{i1}}{2} \right\rceil$$

$$x_{ij,s,1}=\left\lfloor \frac{x_{00,s-1,1}-l_{i0}}{2} \right\rfloor$$

$$y_{ij,s,0}=\left\lceil \frac{y_{00,s-1,0}-l_{j1}}{2} \right\rceil$$

$$y_{ij,s,1}=\left\lfloor \frac{y_{00,s-1,1}-l_{j0}}{2} \right\rfloor$$

where the support of the synthesis filters is given by

$\text{supp}\{h_0\}=[l_{00},l_{01}]$

$\text{supp}\{h_1\}=[l_{10},l_{11}]$.

Subroutine Determine Supports **148** entails the evaluation of these equations for s<l<L.

The cache exists on the client and is composed of a cache memory and a cache table. The cache memory contains data from previous subrequest transmissions from the server. For each entry in cache memory there is a cache table entry describing its support. The support of the l-th cache entry for subband $A_{ij,s}$ is denoted by the cache table entry $c_{ij,s,l}$. After a window request is made, subroutine Cache Query **152** (see FIG. **7**) accesses the cache table and generates a description of the requested data that is contained in cache memory. Clearly, during the first call to Cache Query **152** the cache will be empty. The cache data entries will typically be Huffman compressed coefficient indices but may also contain decompressed wavelet coefficients. The cache data entries may exist on primary or secondary memory.

For subband $A_{ij,s}$, zero or more cache entries exist. The support of the cache table entries, denoted by $c_{ij,s,l}$, for $1 \le l \le N_{ij,s}$, describe the subset of wavelet coefficients contained in the corresponding cache memory entry. The data from $A_{ij,s}$ that must be obtained from the server is given by

$\{(A_{ij,s}(x,y)|(x,y) \in R_{ij,s})\}$ for all $(s,i,j) \in K$,

where

$$R_{ij,s}=a_{ij,s} \cap \overline{\left(\bigcup_l a_{ij,l} \right)}.$$

This describes the subset of $A_{ij,s}$ required for display that is not present in cache memory. The data that is then transferred from the CID file on the client to the server are the records having support $r_{ij,s,l}$ such that

$r_{ij,s,l} \cap R_{ij,s} \neq \emptyset$.

These records may be Huffman subblocks or some subset thereof.

Following Cache Query **152** the client transmits **154** the request and waits for the requested data. The server sends **154** the request in the form of a packet of subrequests, each of which consists of compressed data of a rectangular region from a particular subband. The subrequests are received **156** and subroutine Update Cache **158** stores the subrequests from the data transfer in cache memory, purges the least recently used cache entries, and records each cache hit encountered in Cache Query **152**. Subroutine Synthesize Subbands **162** is then invoked to decompress the quantizer indices from the compressed data in the request transfer and reconstructs the wavelet coefficients. The procedure then invokes subroutine DWT Inverse **164**, which synthesizes the required subset of $a_{00,s}$.

But DWT Inverse **164** does not calculate the actual pixel values that are used in the window display. This is done by Create Window Pix **166** with the data output by DWT Inverse **164**. As an example, the output of DWT Inverse **164** may be in floating point format in which case Create Window Pix **166** casts these values to one-byte words (after a possible rescaling). In another case, the data retrieved may be two-byte words containing, e.g., elevation data. Create Window Pix **166** in this case may generate a shaded relief view of the data. At this step in the browse procedure, if another window is requested **168** the procedure returns **172** to subroutine Select View **146**. Otherwise, the program is terminated **174**.

The decompression routine discussed above limits the obtainable browse image resolution to a power-of-two times the original image resolution. The generation of arbitrary resolution can be provided by retrieving the closest power-of-two resolution greater than that requested and then performing an interpolation process.

The invention is primarily intended for use in an interactive application. Initially, the user views a low-resolution representation of the image on a computer monitor that provides an icon of a large portion of, or perhaps the entire, image scene. By using a computer pointing device, such as a mouse, the user can interact with the low resolution image to specify a region and length scale (an image view) for display. These parameters are then passed to the decompression routine which retrieves the desired view. This process may be repeated with the user interacting with the original

low-resolution scene or with subsequent images returned by the decompression routine. During such repeated applications of the decompression routine, the invention also allows for the management of an image cache to store the results of previous data accesses. By utilizing the image cache, the process described herein needs only to retrieve that data requested by the query that is not in cache memory. The caching scheme is particularly advantageous if the data is being accessed over a data link that is slow compared to the computational time associated with the decompression processing.

It will be understood that the above description and the claim nomenclature is presented in a two-dimensional representation for ease of description and nomenclature. The process is equally applicable to a one-dimensional process and a three-dimensional process. Only the designation of subscripts is different and the use of two-dimensional nomenclature should not be construed as limiting the scope of the claimed invention.

The foregoing description of the invention has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto.

What is claimed is:

1. A method for selectively viewing areas of an image at multiple resolutions in a computer having a primary memory for data processing and a secondary memory for data storage, the method comprising the steps of:

storing a complete set of image data array I(x,y) representing said image in a first secondary memory of said computer;

defining a plurality of discrete tile image data $T_{ij}(x,y)$ subsets, where said complete set of image data I(x,y) is formed by superposition of said discrete tile image data $T_{ij}(x,y)$;

performing one or more discrete wavelet transformation (DWT)-based compression processes on each said tile image data $T_{ij}(x,y)$ in a selected sequence to output each said discrete tile image data $T_{ij}(x,y)$ as a succession of DWT coefficients in a succession of subband sets, where one subband of each set is a low-resolution representation of said discrete tile image data $T_{ij}(x,y)$ to form a sequence of low-resolution representations of said image data array I(x,y) to selected resolutions;

maintaining updated sums of said DWT coefficients from said discrete tile image $T_{ij}(x,y)$ to form a seamless DWT of said image and storing said sums in a first primary memory location of said computer;

periodically compressing said sums and transferring said compressed sums to a second secondary memory to maintain sufficient memory in said primary memory for data processing, wherein said second secondary memory contains stored DWT wavelet coefficients;

selecting a viewing set of said image data array I(x,y) to be viewed at a desired resolution;

determining a viewing subset of said stored DWT wavelet coefficients that support said viewing set of said image data at said desired resolution; and

forming from said subset of said stored DWT wavelet coefficients a computer display of said viewing set of said image data at said desired resolution.

2. A method according to claim 1, wherein the step of performing one or more DWT of each said tile image data includes the step of setting all image data value to zero outside said tile image data to form a tile data array that is supported only over said tile image data subset $T_{ij}(x,y)$ and performing said DWT over said entire tile data array.

3. A method according to claim 1, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

4. A method according to claim 2, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

5. A method according to claim 1, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

6. A method according to claim 2, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

7. A method according to claim 3, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

8. A method according to claim 4, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

9. A method according to claim 1, wherein the step of selecting a viewing set of said image data I(x,y) to be viewed at a selected resolution comprises the steps of specifying a set of coordinates (x,y) from said image data array I(x,y) and reading related stored information that includes the number of resolution levels for said subband sets, image width and height, supports and coefficient values for synthesis filters, and an offset table describing the locations of table data and compressed data records.

10. A method according to claim 1, wherein the step of selecting a viewing subset of said stored DWT wavelet coefficients includes the step of extracting wavelet coefficients corresponding to said viewing set and the corresponding synthesis filters for decompressing said wavelet coefficients.

11. A method according to claim 1, further including the step of establishing a cache memory for storing decompressed wavelet coefficients for each said computer display that is formed.

12. A method according to claim 11, wherein the step of selecting a viewing subset of said stored DWT wavelet coefficients includes a first step of determining whether said coefficients are stored in said cache memory.

13. A method for compressing a large digital image for storage in a computer memory, the method comprising the steps of:

storing a complete set of image data array I(x,y) representing said image in a first memory location of said computer;

defining a plurality of discrete tile image data $T_{ij}(x,y)$ subsets of said I(x,y), where said I(x,y) is formed by superposition of said $T_{ij}(x,y)$;

performing on a computer one or more discrete wavelet transformation (DWT)-based compression processes over each said tile image data $T_{ij}(x,y)$ in a selected sequence to output each said $T_{ij}(x,y)$ as a succession of DWT coefficients in a succession of subband sets, where one subband of each set is a low-resolution representation of said $T_{ij}(x,y)$ to form a sequence of low-resolution representations of said I(x,y) to selected resolutions; and

maintaining updated sums of said DWT coefficients from said discrete tile image $T_{ij}(x,y)$ to form a seamless DWT of said I(x,y) and storing said sums in a second memory location of said computer.

14. A method according to claim 13, further including the step of:

periodically compressing said sums and transferring said compressed sums to a second secondary memory to maintain sufficient memory in said primary memory for data processing.

15. A method according to claim 13, wherein the step of performing one or more DWT of each said tile image data includes the step of setting all image data value to zero outside said tile image data to form a tile data array that is supported only over said tile image data subset $T_{ij}(x,y)$ and performing said DWT over said entire tile data array.

16. A method according to claim 13, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

17. A method according to claim 15, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

18. A method according to claim 13, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

19. A method according to claim 14, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}((x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

20. A method according to claim 15, wherein the step of maintaining updated sums of said DWT coefficients includes the step of retrieving updated sums of DWT coefficients for $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ and adding to coefficients for $T_{ij}(x,y)$.

21. A method for selectively viewing areas of an image at multiple resolutions in a computer having a primary memory for data processing and a secondary memory for data storage, the method comprising the steps of:

storing a complete set of image data array I(x,y) representing said image in a first secondary memory of said computer;

defining a plurality of discrete tile image data $T_{ij}(x,y)$ subsets, where said complete set of image data I(x,y) is formed by superposition of said discrete tile image data $T_{ij}(x,y)$;

performing one or more discrete wavelet transformation (DWT)-based compression processes on each said tile image data $T_{ij}(x,y)$ in a selected sequence to output each said discrete tile image data $T_{ij}(x,y)$ as a succession of DWT coefficients in a succession of subband sets, where one subband of each set is a low-resolution representation of said discrete tile image data $T_{ij}(x,y)$ to form a sequence of low-resolution representations of said image data array I(x,y) to selected resolutions;

selecting a viewing set of said image data array I(x,y) to be viewed at a desired resolution:

determining a viewing subset of said DWT wavelet coefficients that support said viewing set of said image data at said desired resolution; and

forming from said subset of said DWT wavelet coefficients a computer display of said viewing set of said image data at said desired resolution.

22. A method according to claim 21, wherein the step of performing one or more DWT of each said tile image data includes the step of setting all image data value to zero outside said tile image data to form a tile data array that is supported only over said tile image data subset $T_{ij}(x,y)$ and performing said DWT over said entire tile data array.

23. A method according to claim 21, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

24. A method according to claim 22, where said selected sequence for performing said DWT compression on said tile image data $T_{ij}(x,y)$ is to compress tile image data $T_{i-1,j}(x,y)$ and $T_{i,j-1}(x,y)$ before compressing $T_{ij}(x,y)$.

25. A method according to claim 21, wherein the step of selecting a viewing set of said image data I(x,y) to be viewed at a selected resolution comprises the steps of specifying a set of coordinates (x,y) from said image data array I(x,y) and reading related stored information that includes the number of resolution levels for said subband sets, image width and height, supports and coefficient values for synthesis filters, and an offset table describing the locations of table data and compressed data records.

26. A method according to claim 1, wherein the step of selecting a viewing subset of said DWT wavelet coefficients includes the step of extracting wavelet coefficients corresponding to said viewing set and the corresponding synthesis filters for decompressing said wavelet coefficients.

27. A method according to claim 21, further including the step of establishing a cache memory for storing decompressed wavelet coefficients for each said computer display that is formed.

28. A method according to claim 27, wherein the step of selecting a viewing subset of said DWT wavelet coefficients includes a first step of determining whether said coefficients are stored in said cache memory.

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CERTIFICATE OF SERVICE

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT
NO. 05-1062
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Lizardtech

vs.

Earth Resources Mapping, Inc.
----------X

EDWARD T. O'CONNELL
13 WILLIAM ST. APT. 2
GARFIELD, NJ 07026

I, being duly sworn according to law and being over the age of 18, upon my oath depose and say that:

on December 22, 2004

I served the within Brief of the Plaintiff-Appellant Lizardtech, Inc. in the above captioned matter upon:

Stewart M. Brown, Esq.
Gray, Cary, Ware & Freidenrich
401 B Street
Suite 2000
San Diego, CA 92101

via **Federal Express**

Unless otherwise noted, 12 copies have been sent to the court on the same date as above for filing via Federal Express.

MICHAEL DESANTIS
Notary Public, State of New York
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Commission Expires Jan. 31, 2006

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CERTIFICATE OF COMPLIANCE

I, Philip P. Mann, hereby certify that the total word count in the brief is **12,735** words in Times New Roman, 14 pt. type and that it has complied with the Federal Rules of Civil Procedure, Rule 32(a)(7).

Respectfully Submitted,

Philip P. Mann

Philip P. Mann

Date: December 22, 2004