

ORIGINAL

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Innovus Prime LLC

FILED
2011 AUG 26 P 2:46
CLERK OF DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF CALIFORNIA

HRL

Innovus Prime LLC

Plaintiff

v.

- (1) LG Electronics Inc.
(2) LG Electronics U.S.A. Inc.
(3) LG Electronics MobileCom
U.S.A., Inc
(4) Pixelworks, Inc.
(5) Zoran Corporation
(6) Toshiba Corporation
(7) Toshiba America, Inc.
(8) Toshiba America Information
Systems, Inc.
(9) Panasonic Corporation
(10) Panasonic Corporation of North
America
(11) Mitsubishi Electric Corporation
(12) Mitsubishi Electric Visual
Solutions America
(13) Mitsubishi Digital Electronics
America, Inc.
(14) Vizio, Inc.
(15) Sharp Corporation
(16) Sharp Electronics
Manufacturing Company
(17) Sharp Electronics Corporation
(18) Funai Electric Co. Ltd
(19) Funai Corporation, Inc

Defendants.

CV 11 422 3
Civil Action No. _____

**COMPLAINT FOR PATENT
INFRINGEMENT**

DEMAND FOR JURY TRIAL

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1 U.S.C. § 1400(b). This proceeding arises, in part, out of business done in this state. LG
2 Electronics, Inc. may be served with process in Korea pursuant to the Hague Convention on the
3 Service Abroad of Judicial and Extrajudicial Documents, Article 1, November 15, 1965 T.I.A.S.
4 No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). LG Electronics, Inc. regularly conducts and transacts
5 business in California, throughout the United States, and within the Northern District of
6 California, itself and/or through one or more subsidiaries, affiliates, business divisions, or business
7 units.
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9 3. On information and belief, Defendant LG Electronics U.S.A., Inc. is a corporation
10 organized and existing under the laws of the State of Delaware with its principal place of business
11 at 1000 Sylvan Avenue, Englewood Cliffs, NJ 07632. This defendant is registered to do business
12 in California and has appointed Corporation Service Company d/b/a CSC Lawyers Incorporating
13 Service Company, 2730 Gateway Oaks Dr., Sacramento, CA 95833 as its agent for service of
14 process. Defendant LG Electronics U.S.A., Inc. regularly conducts and transacts business in
15 California, throughout the United States, and within the Northern District of California, itself
16 and/or through one or more subsidiaries, affiliates, business divisions, or business units.
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18 4. On information and belief, Defendant LG Electronics MobileComm U.S.A, Inc. is
19 a wholly owned subsidiary of LG Electronics, Inc. and is a corporation organized and existing
20 under the laws of the State of California with its principal place of business at 920 Sylvan Avenue,
21 Englewood Cliffs, New Jersey, 07632. This defendant has appointed Alan K. Tse, 10101 Old
22 Grove Road, San Diego, California 92131 as its agent for service of process. Defendant LG
23 Electronics MobileComm U.S.A., Inc. regularly conducts and transacts business in California,
24 throughout the United States, and within the Northern District of California, itself and/or through
25 one or more subsidiaries, affiliates, business divisions, or business units. LG Electronics, Inc., LG
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1 Electronics U.S.A., Inc. and LG Electronics MobileComm U.S.A, Inc. will be referred to herein
2 individually and collectively as "LG Defendants."

3 5. On information and belief, Defendant Pixelworks, Inc., is a corporation organized
4 and existing under the laws of the State of Oregon with its principal place of business at 16760
5 SW Upper Boones Ferry Rd., Ste 101, Portland, Oregon, 97224. This defendant has appointed
6 AW Services, Inc. c/o Ater Wynne LLP, 1331 NW Lovejoy St., Ste 900, Portland, OR 97209 as
7 its agent for service of process. Defendant Pixelworks, Inc. regularly conducts and transacts
8 business in California, throughout the United States, and within the Northern District of
9 California, itself and/or through one or more subsidiaries, affiliates, business divisions, or business
10 units.
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12 6. On information and belief, Defendant Zoran Corporation, is a corporation
13 organized and existing under the laws of the State of Delaware with its principal place of business
14 at 1390 Kifer Rd., Sunnyvale, CA 94086. This defendant has appointed The Prentice-Hall
15 Corporation System, Inc., 2711 Centerville Road, Ste 400, Wilmington, New Castle, DE 19808 as
16 its agent for service of process. Defendant Zoran Corporation regularly conducts and transacts
17 business in California, throughout the United States, and within the Northern District of
18 California, itself and/or through one or more subsidiaries, affiliates, business divisions, or business
19 units.
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21 7. On information and belief, Defendant Toshiba Corporation is a Japanese
22 Corporation with its principal place of business at 1-1, Shibaura 1-chome, Minato-ku, Tokyo 105-
23 8001, Japan. On information and belief, Defendant Toshiba Corporation, is a nonresident of
24 California who engages in business in this state, but does not maintain a regular place of business
25 in this state or a designated agent for service of process in this state. On information and belief,
26 Defendant Toshiba Corporation resides in this jurisdiction within the meaning of 28 U.S.C. §
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1 1400(b). This proceeding arises, in part, out of business done in this state. Defendant Toshiba
2 Corporation may be served with process in Japan pursuant to the Hague Convention on the
3 Service Abroad of Judicial and Extrajudicial Documents, Article 1, November 15, 1965 T.I.A.S.
4 No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). Defendant Toshiba Corporation regularly conducts
5 and transacts business in California, throughout the United States, and within the Northern District
6 of California, itself and/or through one or more subsidiaries, affiliates, business divisions, or
7 business units.

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9 8. On information and belief, Defendant Toshiba America, Inc., is a corporation
10 organized and existing under the laws of the State of Delaware with its principal place of business
11 at 1251 Avenue of the Americas Suite 4110, New York, New York 10020. This defendant has
12 appointed The Corporation Trust Company, Corporation Trust Center 1209 Orange Street,
13 Wilmington, New Castle, DE 19801 as its agent for service of process. Defendant Toshiba
14 America, Inc. regularly conducts and transacts business in California, throughout the United
15 States, and within the Northern District of California, itself and/or through one or more
16 subsidiaries, affiliates, business divisions, or business units.

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18 9. On information and belief, Defendant Toshiba America Information Systems, Inc.,
19 is a corporation organized and existing under the laws of the State of California with its principal
20 place of business at 9740 Irvine Blvd., Irvine, California 92618. This defendant has appointed The
21 Corporation Trust Company, Corporation Trust Center 1209 Orange Street, Wilmington, New
22 Castle, DE 19801 as its agent for service of process. Defendant Toshiba America Information
23 Systems, Inc. regularly conducts and transacts business in California, throughout the United
24 States, and within the Northern District of California, itself and/or through one or more
25 subsidiaries, affiliates, business divisions, or business units. Toshiba Corporation, Toshiba
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1 America, Inc and Toshiba America Information Systems will be referred to herein individually
2 and collectively as "Toshiba Defendants."

3 10. On information and belief, Defendant Panasonic Corporation is a corporation
4 organized and existing under the laws of Japan with its principal place of business located at 1006
5 Oaza Kadoma, Kadoma City, Osaka 571-8501, Japan. On information and belief, Defendant
6 Panasonic Corporation is a nonresident of California who engages in business in this state, but
7 does not maintain a regular place of business in this state or a designated agent for service of
8 process in this state. On information and belief, Defendant Panasonic Corporation resides in this
9 jurisdiction within the meaning of 28 U.S.C. § 1400(b). This proceeding arises, in part, out of
10 business done in this state. Defendant Panasonic Corporation may be served with process in Japan
11 pursuant to the Hague Convention on the Service Abroad of Judicial and Extrajudicial Documents,
12 Article 1, November 15, 1965 T.I.A.S. No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). Defendant
13 Panasonic Corporation regularly conducts and transacts business in California, throughout the
14 United States, and within the Northern District of California, itself and/or through one or more
15 subsidiaries, affiliates, business divisions, or business units.

16 11. On information and belief, Defendant Panasonic Corporation of North America is a
17 corporation organized and existing under the laws of the State of Delaware with its principal place
18 of business at One Panasonic Way, Panazip 71-1, Secaucus, New Jersey 07094. This defendant
19 has appointed the Corporation Trust Company, Corporation Trust Center, 1209 Orange Street,
20 Wilmington, New Castle, DE, 19801, as its agent for service of process. Defendant Panasonic
21 Corporation of North America regularly conducts and transacts business in California, throughout
22 the United States, and within the Northern District of California, itself and/or through one or more
23 subsidiaries, affiliates, business divisions, or business units. Panasonic Corporation and
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1 Panasonic Corporation of North America will be referred to herein individually and collectively as
2 "Panasonic Defendants."

3 12. On information and belief, Defendant Mitsubishi Electric Corporation is a
4 corporation organized and existing under the laws of Japan with its principal place of business
5 located at Tokyo Building, 2-7-3 Marunouchi Chiyoda-ku Tokyo 100-8310 Japan. On
6 information and belief, Defendant Mitsubishi Electric Corporation is a nonresident of California
7 who engages in business in this state, but does not maintain a regular place of business in this state
8 or a designated agent for service of process in this state. On information and belief, Defendant
9 Mitsubishi Electric Corporation resides in this jurisdiction within the meaning of 28 U.S.C. §
10 1400(b). This proceeding arises, in part, out of business done in this state. Defendant Mitsubishi
11 Electric Corporation may be served with process in Japan pursuant to the Hague Convention on
12 the Service Abroad of Judicial and Extrajudicial Documents, Article 1, November 15, 1965
13 T.I.A.S. No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). Defendant Mitsubishi Electric Corporation
14 regularly conducts and transacts business in California, throughout the United States, and within
15 the Northern District of California, itself and/or through one or more subsidiaries, affiliates,
16 business divisions, or business units.

17 13. On information and belief, Defendant Mitsubishi Electric Visual Solutions America
18 Inc is a corporation organized and existing under the laws of the State of Delaware with its
19 principal place of business at 9351 Jeronimo Rd., Irvine, CA 92618. This defendant has appointed
20 the Corporation Trust Company, Corporation Trust Center, 1209 Orange Street, Wilmington, New
21 Castle, DE, 19801, as its agent for service of process. Defendant Mitsubishi Electric Visual
22 Solutions America Inc regularly conducts and transacts business in California, throughout the
23 United States, and within the Northern District of California, itself and/or through one or more
24 subsidiaries, affiliates, business divisions, or business units.

1 14. On information and belief, Defendant Mitsubishi Digital Electronics America, Inc.
2 is a corporation organized and existing under the laws of the State of Delaware with its principal
3 place of business at 9351 Jeronimo Rd., Irvine, CA 92618. This defendant has appointed the
4 Corporation Trust Company, Corporation Trust Center, 1209 Orange Street, Wilmington, New
5 Castle, DE, 19801, as its agent for service of process. Defendant Mitsubishi Digital Electronics
6 America, Inc. regularly conducts and transacts business in California, throughout the United
7 States, and within the Northern District of California, itself and/or through one or more
8 subsidiaries, affiliates, business divisions, or business units. Mitsubishi Electric Corporation,
9 Mitsubishi Electric Visual Solutions America Inc., Mitsubishi Digital Electronics America, Inc.
10 will be referred to herein individually and collectively as "Mitsubishi Defendants."
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12 15. On information and belief, Defendant Vizio Inc. is a corporation organized and
13 existing under the laws of the State of California with its principal place of business at 39 Tesla,
14 Irvine, CA 92618. This defendant has appointed the CT Corporation System, 818 W. Seventh St.
15 Los Angeles, CA 90017, as its agent for service of process. Defendant Vizio Inc. regularly
16 conducts and transacts business in California, throughout the United States, and within the
17 Northern District of California, itself and/or through one or more subsidiaries, affiliates, business
18 divisions, or business units.
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20 16. On information and belief, Defendant Sharp Corporation is a corporation organized
21 and existing under the laws of Japan with its principal place of business located at 22-22 Nagaike-
22 cho, Abeno-ku, Osaka 545-8522, Japan. On information and belief, Defendant Sharp Corporation
23 is a nonresident of California who engages in business in this state, but does not maintain a regular
24 place of business in this state or a designated agent for service of process in this state. On
25 information and belief, Defendant Sharp Corporation resides in this jurisdiction within the
26 meaning of 28 U.S.C. § 1400(b). This proceeding arises, in part, out of business done in this state.
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1 Defendant Sharp Corporation may be served with process in Japan pursuant to the Hague
2 Convention on the Service Abroad of Judicial and Extrajudicial Documents, Article 1, November
3 15, 1965 T.I.A.S. No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). Defendant Sharp Corporation
4 regularly conducts and transacts business in California, throughout the United States, and within
5 the Northern District of California, itself and/or through one or more subsidiaries, affiliates,
6 business divisions, or business units.
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8 17. Defendant Sharp Electronics Manufacturing Company of America, Inc. is a
9 subsidiary of Sharp Corporation, and is organized and existing under the laws of the State of
10 California with its principal place of business at Sharp Plaza, Mahwah, NJ 07495. This defendant
11 has appointed the CT Corporation System, 818 W. Seventh St. Los Angeles, CA 90017, as its
12 agent for service of process. Defendant Sharp Electronics Manufacturing Company of America,
13 Inc. regularly conducts and transacts business in California, throughout the United States, and
14 within the Northern District of California, itself and/or through one or more subsidiaries, affiliates,
15 business divisions, or business units.
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17 18. Defendant Sharp Electronics Corporation is a subsidiary of Sharp Corporation, and
18 is organized and existing under the laws of the State of New York with its principal place of
19 business at Sharp Plaza, Mahwah, NJ 07495. This defendant has appointed the CT Corporation
20 System, 818 W. Seventh St. Los Angeles, CA 90017, as its agent for service of process. Defendant
21 Sharp Electronics Corporation regularly conducts and transacts business in California, throughout
22 the United States, and within the Northern District of California, itself and/or through one or more
23 subsidiaries, affiliates, business divisions, or business units. Sharp Corporation, Sharp Electronics
24 Manufacturing Company of America, Inc. and Sharp Electronics Corporation will be referred to
25 herein individually and collectively as "Sharp Defendants."
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1 19. On information and belief, Defendant Funai Electric Co., Ltd. is a corporation
2 organized and existing under the laws of Japan with its principal place of business located at 7-7-1
3 Nakagaito, Daito, Osaka 574-0013, Japan. On information and belief, Funai Electric Co., Ltd is a
4 nonresident of California who engages in business in this state, but does not maintain a regular
5 place of business in this state or a designated agent for service of process in this state. On
6 information and belief, Funai Electric Co., Ltd resides in this jurisdiction within the meaning of
7 28 U.S.C. § 1400(b). This proceeding arises, in part, out of business done in this state. Funai
8 Electric Co., Ltd may be served with process in Japan pursuant to the Hague Convention on the
9 Service Abroad of Judicial and Extrajudicial Documents, Article 1, November 15, 1965 T.I.A.S.
10 No. 6638, 20 U.S.T. 361 (U.S. Treaty 1969). Funai Electric Co., Ltd regularly conducts and
11 transacts business in California, throughout the United States, and within the Northern District of
12 California, itself and/or through one or more subsidiaries, affiliates, business divisions, or business
13 units.
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16 20. On information and belief, Defendant Funai Corporation, Inc. is a subsidiary of
17 Funai Electric Co., Ltd and is organized and existing under the laws of the State of California with
18 its principal place of business at 201 Route 17 North, Suite 903 Rutherford, NJ, 07070. This
19 defendant is registered to do business in California and has appointed National Corporate
20 Research, Ltd, 523 W. 6th Street, Ste. 544, Los Angeles, CA 90014 as its agent for service of
21 process. Defendant Funai Corporation, Inc. regularly conducts and transacts business in
22 California, throughout the United States, and within the Northern District of California, itself
23 and/or through one or more subsidiaries, affiliates, business divisions, or business units. Funai
24 Electric Co., Ltd and Funai Corporation, Inc. will be referred to herein individually and
25 collectively as "Funai Defendants."
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22. Venue is proper in this District under 28 U.S.C. §§ 1391 and/or 1400 (b) because Defendants are subject to personal jurisdiction in this District and/or have committed acts within this District giving rise to this action. At a bare minimum, each of the Defendants has delivered infringing products into the stream of commerce with the expectation that they will be purchased by consumers in California, including consumers in the Northern District of California.

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1 26. Plaintiff Innovus Prime LLC repeats and incorporates by reference each of the
2 allegations contained in Paragraphs 1 and 25 above, and further alleges as follows:

3 27. On information and belief, without a license or permission from Plaintiff Innovus
4 Prime LLC, LG Defendants have infringed one or more claims of the '350 Patent in the State of
5 California, in this judicial district, and elsewhere in the United States by importing, making, using,
6 selling or offering for sale products that embody and/or practice the invention for processing a
7 picture signal to obtain a picture signal having improved properties. LG Defendants are thus liable
8 for infringement of the '350 Patent pursuant to 35 U.S.C. § 271. Without limitation, several
9 examples of LG Defendants' infringing products include the products listed on Appendix B which
10 is attached hereto. LG Defendants' infringement of the '350 Patent has caused substantial damage
11 to Plaintiff Innovus Prime LLC.
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13 28. On information and belief, without a license or permission from Plaintiff Innovus
14 Prime LLC, Defendant Pixelworks Inc. has infringed one or more claims of the '350 Patent in the
15 State of California, in this judicial district, and elsewhere in the United States by importing,
16 making, using, selling or offering for sale products that embody and/or practice the invention for
17 processing a picture signal to obtain a picture signal having improved properties. Defendant
18 Pixelworks Inc. is thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271.
19 Without limitation, several examples of Defendant Pixelworks Inc.'s infringing products include
20 the PW9800 family of products including the PW9800-10G and PW9800-30G. Defendant
21 Pixelworks Inc.'s infringement of the '350 Patent has caused substantial damage to Plaintiff
22 Innovus Prime LLC.
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24 29. On information and belief, without a license or permission from Plaintiff Innovus
25 Prime LLC, Defendant Zoran Corporation has infringed one or more claims of the '350 Patent in
26 the State of California, in this judicial district, and elsewhere in the United States by importing,
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1 making, using, selling or offering for sale products that embody and/or practice the invention for
2 processing a picture signal to obtain a picture signal having improved properties. Defendant Zoran
3 Corporation is thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271.
4 Without limitation, several examples of Defendant Zoran Corporation's infringing products
5 include the SupraFRC® family of products including the SupraFRC® 201 Frame Rate
6 Conversion (FRC) processor and SupraFRC® 301 processor. Defendant Zoran Corporation's
7 infringement of the '350 has caused substantial damage to Plaintiff Innovus Prime LLC.
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9 30. On information and belief, without a license or permission from Plaintiff Innovus
10 Prime LLC, Toshiba Defendants have infringed one or more claims of the '350 Patent in the State
11 of California, in this judicial district, and elsewhere in the United States by importing, making,
12 using, selling or offering for sale products that embody and/or practice the invention for
13 processing a picture signal to obtain a picture signal having improved properties. Toshiba
14 Defendants are thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271.
15 Without limitation, several examples of Toshiba Defendants' infringing products include the
16 products listed on Appendix C which is attached hereto. Toshiba Defendants' infringement of the
17 '350 Patent has caused substantial damage to Plaintiff Innovus Prime LLC.
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19 31. On information and belief, without a license or permission from Plaintiff Innovus
20 Prime LLC, Panasonic Defendants have infringed one or more claims of the '350 Patent in the
21 State of California, in this judicial district, and elsewhere in the United States by importing,
22 making, using, selling or offering for sale products that embody and/or practice the invention for
23 processing a picture signal to obtain a picture signal having improved properties. Panasonic
24 Defendants are thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271.
25 Without limitation, several examples of Panasonic Defendants' infringing products include the
26 VIERA® family of television products, including models TC-L32DT30 (DT30 Series), TC-
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1 L37DT30 (DT30 Series), TC-L42D30 (D30 Series), TC-L42E30 (E Series), and TC-L42U30
2 (U30 Series), and projectors including models PT-AE3000U, PT-AE4000U, and PT-AE7000.
3 Panasonic Defendants' infringement of the '350 Patent has caused substantial damage to Plaintiff
4 Innovus Prime LLC.

5 32. On information and belief, without a license or permission from Plaintiff Innovus
6 Prime LLC, Mitsubishi Defendants have infringed one or more claims of the '350 Patent in the
7 State of California, in this judicial district, and elsewhere in the United States by importing,
8 making, using, selling or offering for sale products that embody and/or practice the invention for
9 processing a picture signal to obtain a picture signal having improved properties. Mitsubishi
10 Defendants are thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271.
11 Without limitation, several examples of Mitsubishi Defendants' infringing products include the
12 products listed on Appendix D which is attached hereto. The infringing products further include
13 projectors including model HC9000D. Mitsubishi Defendants' infringement of the '350 Patent
14 has caused substantial damage to Plaintiff Innovus Prime LLC.

15 33. On information and belief, without a license or permission from Plaintiff Innovus
16 Prime LLC, Defendant Vizio Inc. has infringed one or more claims of the '350 Patent in the State
17 of California, in this judicial district, and elsewhere in the United States by importing, making,
18 using, selling or offering for sale products that embody and/or practice the invention for
19 processing a picture signal to obtain a picture signal having improved properties. Defendant Vizio
20 Inc. is thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271. Without
21 limitation, several examples of Defendant Vizio Inc.'s infringing products include the products
22 listed on Appendix E which is attached hereto. Defendant Vizio Inc.'s infringement of the '350
23 has caused substantial damage to Plaintiff Innovus Prime LLC.
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1 34. On information and belief, without a license or permission from Plaintiff Innovus
2 Prime LLC, Sharp Defendants have infringed one or more claims of the '350 Patent in the State of
3 California, in this judicial district, and elsewhere in the United States by importing, making, using,
4 selling or offering for sale products that embody and/or practice the invention for processing a
5 picture signal to obtain a picture signal having improved properties. Sharp Defendants are thus
6 liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271. Without limitation, several
7 examples of Sharp Defendants' infringing products include the products listed on Appendix F
8 which is attached hereto. Sharp Defendants' infringement of the '350 Patent has caused
9 substantial damage to Plaintiff Innovus Prime LLC.
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11 35. On information and belief, without a license or permission from Plaintiff Innovus
12 Prime LLC, Funai Defendants have infringed one or more claims of the '350 Patent in the State of
13 California, in this judicial district, and elsewhere in the United States by importing, making, using,
14 selling or offering for sale products that embody and/or practice the invention for processing a
15 picture signal to obtain a picture signal having improved properties. Funai Defendants are thus
16 liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271. Without limitation, several
17 examples of Funai Defendants' infringing products include LC401SS2 (sold under the Sylvania
18 brand name) and LC401EM2 (sold under the Emerson brand name). Funai Defendants'
19 infringement of the '350 Patent has caused substantial damage to Plaintiff Innovus Prime LLC.
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21 36. To the extent that facts learned in discovery show that Defendants' infringement of
22 the '350 Patent has been willful, Plaintiff Innovus Prime LLC reserves the right to request such a
23 finding at time of trial.
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25 37. As a result of these Defendants' infringement of the '350 Patent, Plaintiff Innovus
26 Prime LLC has suffered monetary damages in an amount not yet determined.
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1 **DEMAND FOR JURY TRIAL**

2 Pursuant to Fed.R.Civ.P. 38, Plaintiff Innovus Prime LLC requests a trial by jury on all issues
3 allowable by law.
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5 **PRAYER FOR RELIEF**

6 WHEREFORE, Plaintiff Innovus Prime LLC prays for the following relief:
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8 A. For decree and judgment against Defendants and all in privity with Defendants that the
9 '350 Patent is valid and enforceable;
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11 B. For decree and judgment against Defendants and all in privity with Defendants that the
12 '350 Patent has been infringed by Defendants and that Defendants are liable as patent infringers;
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14 C. For decree and judgment against Defendants and all in privity with Defendants requiring
15 Defendants to pay Plaintiff Innovus Prime LLC its damages, costs, expenses, and prejudgment and
16 post-judgment interest for Defendants' infringement of the '350 Patent under 35 U.S.C. § 284;
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18 D. An award to Plaintiff Innovus Prime LLC for enhanced damages resulting from the
19 knowing, deliberate, and willful nature of Defendants' prohibited conduct with notice being made
20 at least as early of the date of the filing of this Complaint, as provided under 35 U.S.C. § 284;
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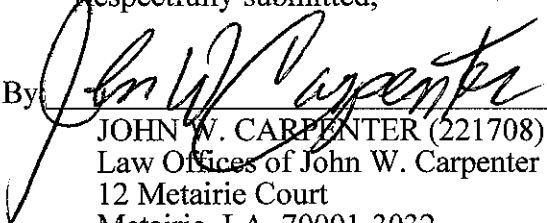
22 E. A decree and judgment finding that this is an exceptional case within the meaning of 35
23 U.S.C. § 285 and awarding to Plaintiff Innovus Prime LLC its reasonable attorneys' fees
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25 F. For such other and further relief which should appear just and equitable to this Court.
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Dated: August 26, 2011.

Respectfully submitted,

By 
JOHN W. CARPENTER (221708)
Law Offices of John W. Carpenter LLC
12 Metairie Court
Metairie, LA 70001-3032
Telephone: (415) 577-0698
Facsimile: 1-866-410-6248

*Attorneys for Plaintiff,
Innovus Prime LLC*



US005280350A

United States Patent [19]
DeHaan et al.

[11] **Patent Number:** **5,280,350**
 [45] **Date of Patent:** **Jan. 18, 1994**

[54] **METHOD AND APPARATUS FOR PROCESSING A PICTURE SIGNAL TO INCREASE THE NUMBER OF DISPLAYED TELEVISION LINES USING MOTION VECTOR COMPENSATED VALUES**

4,924,305 5/1990 Nakagawa et al. 358/140 X
 4,989,090 1/1991 Campbell et al. 358/140
 5,001,563 3/1991 Doyle et al. 358/140
 5,021,870 6/1991 Moyoe et al. 358/140 X
 5,036,393 7/1991 Samad et al. 358/140

FOREIGN PATENT DOCUMENTS

0395271 10/1990 European Pat. Off. .

OTHER PUBLICATIONS

G. de Haan et al., "New Algorithm For Motion Estimation", Proceedings of the Third International Workshop on HDTV, Torino, 1989.

Primary Examiner—Victor R. Kostak
Attorney, Agent, or Firm—Michael E. Marion

[75] **Inventors:** Gerard DeHaan; Gerrit F. M. DePoortere, both of Eindhoven, Netherlands
 [73] **Assignee:** U.S. Philips Corporation, New York, N.Y.
 [21] **Appl. No.:** 751,290
 [22] **Filed:** Aug. 29, 1991
 [30] **Foreign Application Priority Data**

Sep. 3, 1990 [EP] European Pat. Off. 90202330.8

[51] **Int. Cl.⁵** H04N 7/01

[52] **U.S. Cl.** 358/140; 358/105; 358/167

[58] **Field of Search** 358/105, 140, 136, 166, 358/167, 11; H04N 7/01

References Cited

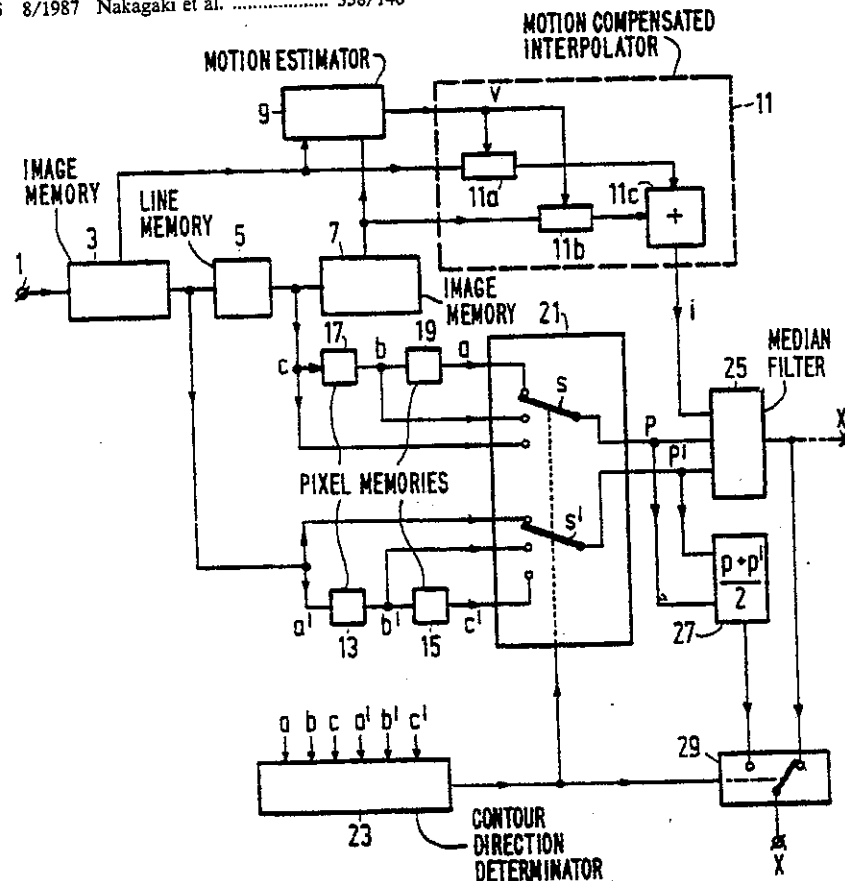
U.S. PATENT DOCUMENTS

4,684,985 8/1987 Nakagaki et al. 358/140

6 Claims, 2 Drawing Sheets

ABSTRACT

After a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field (II) from picture information of at least one neighboring field (I, III), the additional line is vertically filtered to remove artifacts caused by motion estimation errors.



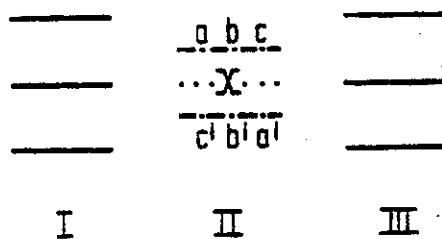


FIG. 1

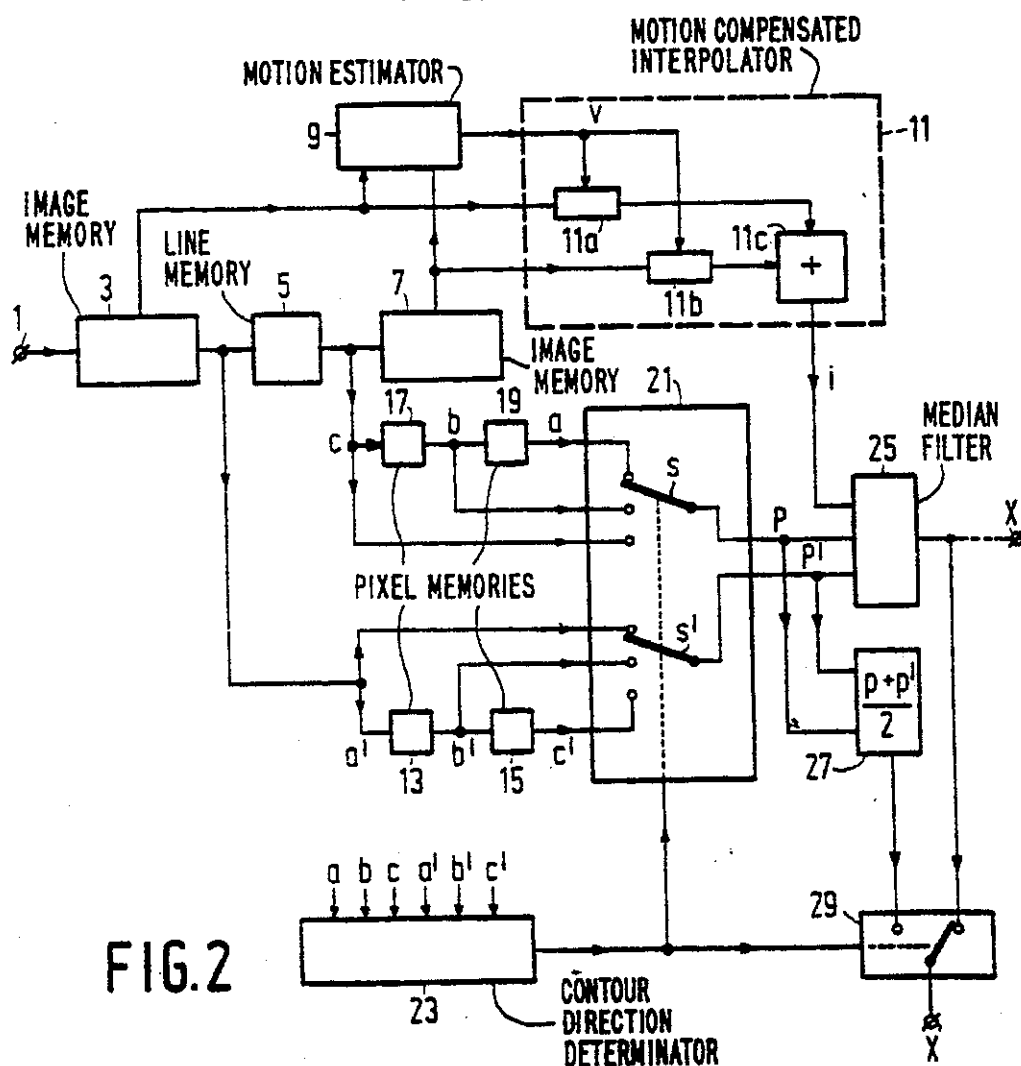


FIG. 2

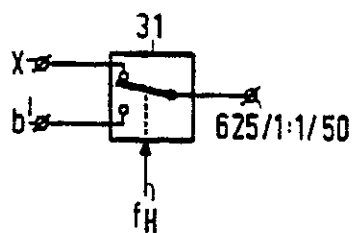


FIG. 3A

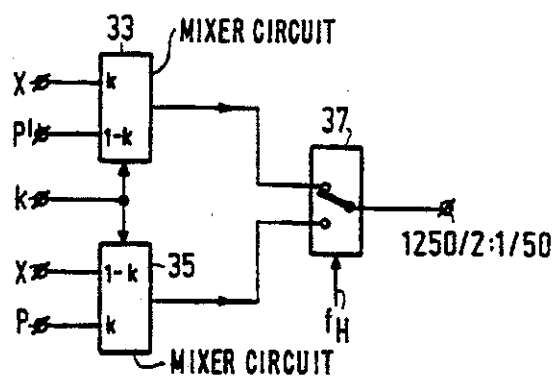


FIG. 3B

625/2:1/50

625/1:1/50

1250/2:1/50

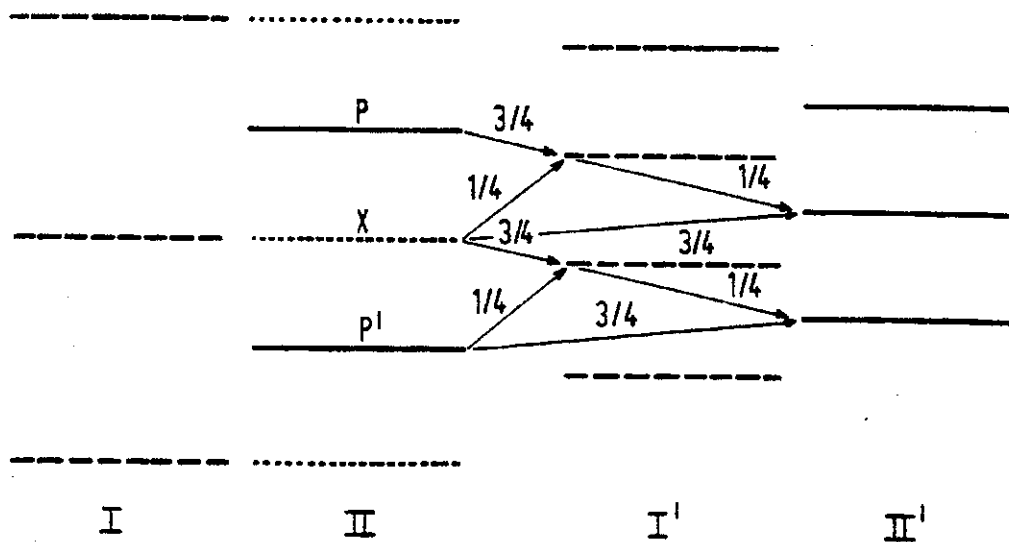


FIG. 4

METHOD AND APPARATUS FOR PROCESSING A PICTURE SIGNAL TO INCREASE THE NUMBER OF DISPLAYED TELEVISION LINES USING MOTION VECTOR COMPENSATED VALUES

BACKGROUND OF THE INVENTION

The invention relates to a method and an apparatus for processing a picture signal to obtain a picture signal having improved properties, such as being noninterlaced or having a doubled line number, while still being interlaced.

EP-A 0 361 558 describes a method and an apparatus of this kind. Therein, a median is determined of signals from two adjacent lines in a given field of the picture signal and from one line of a field preceding the given field and lying vertically between the two adjacent lines in the given field. Preferably, a direction of a contour is determined also, to control the apparatus such that it supplies the median if the contour direction is substantially vertical, and that it supplies an average of the signals from the two adjacent lines otherwise. The supplied signal is multiplexed with the signals of the given field to obtain the non-interlaced picture signal or is processed with the signals of the given field to obtain a field of an interlaced picture signal having the doubled line number.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method and an apparatus which offer a better picture display quality than the prior art.

For this purpose, a first aspect of the invention provides a method of processing a line- and field-sequentially assembled picture signal, comprising the steps of:

- performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field; and
- vertically filtering said additional line using at least one of said adjacent lines of said given field.

A second aspect of the invention provides an apparatus for processing a line- and field-sequentially assembled picture signal, comprising:

- means for performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field; and
- means for vertically filtering said additional line using at least one of said adjacent lines of said given field.

These aspects of the invention are based on the recognition that the quality of the viewed image can be considerably improved by the use of motion compensated values rather than direct values from the interjacent line of the preceding field.

If a motion vector compensated interpolation is considered good enough, the vertical filtering operation can be dispensed with and the non-interlaced or doubled line number output signal can be obtained by a third aspect of the invention which provides an apparatus for processing a line- and field-sequentially picture signal, comprising:

- means for performing a motion vector compensated interpolation to obtain additional lines between each time two adjacent lines of a given field from picture information of at least one neighboring field; and

means for combining said additional lines and said adjacent lines to form a field having twice a number of lines of said given field.

These and other (more detailed) aspects of the invention will be described and elucidated with reference to the drawings and examples.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 schematically shows a number of lines from three successive fields of the picture signal;

FIG. 2 shows an apparatus according to the invention;

FIG. 3A and 3B show two postprocessors to be added to the apparatus of FIG. 2; and

FIG. 4 shows a representation of line number doubling and progressive scan conversion operations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

FIG. 1 schematically shows a number of lines from three successive fields I, II and III. Between two existing lines (indicated by bars and dots) in field II, a new line (indicated by dots only) is to be interpolated. The present invention provides a new method and apparatus for obtaining the pixel value X on that new line. The method of the invention basically consists of two steps:

1. obtain by motion compensated interpolation an interpolated value from at least the neighboring field I.
2. perform a spatial filtering on the interpolated value to remove artifacts caused by motion estimation errors.

The present invention does not require any specific motion compensated interpolation method; in principle, any method will do. The preferred motion estimator to be used in the motion compensated interpolation has been described in the article "New Algorithm for Motion Estimation", presented by G. de Haan and H. Huijgen at the Third International Workshop on HDTV, Torino 1989. As motion artifacts will be removed by step 2, it is not necessary to use a costly high quality motion compensated interpolation method to obtain high quality results. However, if the motion vector compensated interpolation would yield satisfactory results, the spatial filtering might be dispensed with completely. If artifacts introduced by the spatial filtering are worse than motion vector compensation artifacts, it might even be preferred to omit the spatial filtering. Having regard to the present state of the art in motion vector compensation, it is preferred to perform the spatial postfiltering after the motion vector compensated interpolation.

If the present invention is considered starting from the spatial filtering, the output quality of the spatial filtering is considerably improved by the prior motion compensated interpolation which already provides a reasonable first guess.

If we focus on the spatial postfiltering, a simple implementation would take the median of the pixel value b on the line above the line to be interpolated, the motion compensated interpolated value and the pixel value b' on the line below the line to be interpolated. As set out in U.S. Pat. No. 4,740,842, incorporated herein by reference, it is alternatively possible to determine a contour direction first, by evaluating the pixel value pairs (a, a'), (b, b') and (c, c'). The pair which gives the smallest difference between the two pixel values is called the pair (p, p'); this pair (p, p') is then used in the median

filtering instead of the pair (b, b'). However, in a preferred embodiment which follows a teaching of EP-A 0 361 558, incorporated herein by reference, it is first determined whether the pair (p, p') which gives the smallest difference between the two pixel values, corresponds to the vertical direction, i.e. whether (p, p')=(b, b'). If this is true, then the median of the pixel values b, b' and the motion compensated interpolated value is determined, in the other case, the average of the pixel values p and p' is outputted as the interpolation result. In an elaboration of this embodiment, the median is also chosen when there is no clear preference for an oblique direction like e.g. the (a, a') or (c, c') direction, which inter alia may occur when the image shows little contrast or is noisy, or when the contour direction is substantially horizontal. Consequently, the preferred filtering direction might be different from a determined edge direction.

FIG. 2 shows an apparatus which performs this last mentioned, preferred implementation of the invention. An input I is connected to a series arrangement of a first image memory 3, a line memory 5 and a second image memory 7. Information from both image memories 3 and 7 is used in a motion estimator 9 to determine a motion vector v. The motion estimator 9 may be of any known kind. Preferably, estimator 9 is the estimator described in the article "New Algorithm for Motion Estimation" mentioned above. Another possibility would e.g. be a block motion estimator which compares fields II and I to determine which pixels in field I correspond to a given block in field II. It will be appreciated that if the motion is estimated for blocks, motion vectors are obtained which are not only valid for the bar-dot existing lines in field II, but also for the dotted interjacent lines to be interpolated. The motion vector v and picture information from the image memories 3 and/or 7 are used in a motion compensated interpolator 11 to obtain an interpolated value i.

The motion compensated interpolator 11 comprises a vector controlled delay 11a which receives the picture information from the first image memory 3, a vector controlled delay 11b which receives picture information from the second image memory 7, and an adder 11c receiving output signals of both vector controlled delays 11a and 11b and supplying the interpolated value i. The vector controlled delays 11a and 11b supply their output signals in dependence on the motion vector v.

It will be appreciated that it is more economic to shift information from one field only rather than to perform a motion compensated averaging operation on information from two fields. However, previously, motion compensated averaging was preferred because the averaging action contributed to a removal of motion artifacts. As according to the present invention the motion compensated interpolation is followed by a vertical filtering to remove motion artifacts, it is no longer necessary to use information from two fields in the motion compensated interpolation, so that the more economic motion compensated shift of information from one field only becomes possible without a loss of image display quality.

If a motion compensated shift from only one field is performed, the vector controlled delay 11a and the adder 11c can be dispensed with; in that case the motion compensated interpolator 11 consists of the vector controlled delay 11b.

An output of the first image memory 3 supplies the pixel value a' and is connected to a series arrangement

of two pixel memories 13 and 15 whose outputs supply the pixel values b' and c', respectively. An output of the line memory 5 supplies the pixel value c and is connected to a series arrangement of two pixel memories 17 and 19 whose outputs supply the pixel values b and a, respectively. The pixel values a, b, c and a', b', c' are applied to two switches S and S' of a switching device 21 which is controlled by a contour direction determinator 23 which may be as described in U.S. Pat. No. 4,740,842 or EP-A 0 361 558. Switch S supplies pixel value p while switch S' supplies the pixel value p'.

The motion compensated interpolated value i and the pixel values p and p' are applied to a median filter 25 which may be as described in U.S. Pat. No. 4,740,842. As shown by an interrupted line, in a simple embodiment of the invention the median filter 25 supplies the output value X. However, as discussed hereinbefore, in a preferred embodiment, the median of the pixel values i, p and p' is only supplied as the output value if the preferred filtering direction determined by the contour direction determinator 23 is the vertical direction. This implies that in this preferred embodiment instead of the pixel values p and p', the pixel values b and b' can be applied to the median filter 25, while there is no need for the pixel values b and b' to be applied to the switching device 21, so that the switches S and S' can become two-state switches instead of three-state switches.

As-described in a copending Application (PHN 13.436), the contour direction may instead of the pixels a', b', c' of a line lying in the same field and adjacent to the line on which the pixels a, b, c are positioned, use pixels from an interjacent line of the preceding field or from the interjacent line shown in FIG. 1 which is calculated by the motion compensated interpolator 11. As this interjacent line is closer to the line on which the pixels a, b, c are positioned, a more accurate contour direction determination is obtained. It will be evident from copending Application (PHN 13.436) that the contour direction determiner may determine more than 3 preferred filtering directions; in that case, switching device 21 and the number of pixel memories should be adapted accordingly.

To determine the average of p and p' which is to be supplied if the preferred filtering direction is oblique, the pixel values p and p' are supplied to an averager 27. The output of the median filter 25 and an output of the averager 27 are supplied to respective inputs of a switch 29. The switch 29 is controlled by the contour direction determiner 23 to supply the median filter output signal if the preferred filtering direction is vertical, and to supply the averager output signal if the preferred filtering direction is oblique, i.e. e.g. along a-a' or c-c'.

The man skilled in the art will appreciate that, as described in EP-A 0 361 558, the switch 29 may be a mixer performing a soft switch.

The apparatus shown in FIG. 2 can be used in a picture signal processing circuit constituting an interlaced-to-progressive scanning conversion circuit when, as shown in FIG. 3A, the output of the switch 29 is connected to a first input of a line compression-and-multiplex circuit 31, a second input of which is connected to receive the pixel value b'. The line compression-and-multiplex circuit 31 compresses the line periods of the picture signals applied to the inputs thereof with a factor 2 and then supplies, line-alternatingly, a picture signal supplied by the switch 29 and thereafter compressed, or a compressed input picture signal. A progressively scanned picture signal is then available at an

output of the line compression-and-multiplex circuit 31, which result is denoted by 625/1:1/50, wherein 625 indicates the number of lines per picture, 1:1 stands for non-interlaced or progressive scan, and 50 indicates the number of fields. Such a line compression-and-multiplex circuit 31 is known per se and may, for example, be in the form of the cascade arrangement of the elements 223 and 244 in FIG. 3 of U.S. Pat. No. 4,740,842.

in FIG. 3A of the present Application only the multiplex action of the line compression-and-multiplex circuit 31 is symbolized.

The interpolation filter may alternatively be used in a picture signal processing circuit forming a line number doubling circuit which preserves interlace. To that end, as shown in FIG. 3B, the output of the switch 29 is connected to a first input of a first position-interpolation circuit designed as a mixer circuit 33, to a second input of which the signal from the picture element p' is applied, and to a first input of a second position-interpolation circuit designed as a mixer circuit 35, to a second input of which the signal from the picture element p is applied. Since the signals of the picture elements p' and p are applied to the second inputs of the respective mixer circuits 33 and 35, also the mixing operations performed by these mixer circuits 33 and 35 are contour dependent. Control inputs of the mixer circuits 33 and 35, receive a weighting factor k the value of which, for an appropriate relative positioning of the lines of the output signal, is equal to $\frac{1}{4}$ during the first field of each picture and equal to $\frac{3}{4}$ during the second field of each picture. Outputs of the mixer circuits 33 and 35 are connected to respective inputs of a line compression-and-multiplex circuit 37, from an output of which the interlaced output signal can be taken with double the number of lines. This output signal is indicated by 1250/2:1/50. For simplicity reasons, again only the multiplex action of block 37 is symbolized in FIG. 3B.

In FIG. 4 the operation of the interlaced-to-progressive scanning conversion circuit of FIG. 3A and of the line number doubling circuit of FIG. 3B which preserves interlace is illustrated in greater detail. In a left-hand column I broken lines indicate lines of a first interlaced input field and in a left-hand centre column H solid lines indicate lines of a second input field, the lines of the first and second input fields together forming an interlaced 625/2:1/50 input picture signal. In the left-hand centre column III the lines of the output signal X at the output of the switch 29 are represented by dotted lines. If the lines of the second field and the lines of the output signal X are combined by the line compression-and-multiplex circuit 31 as is shown in the left-hand centre column, a picture signal is obtained with a non-interlaced or progressive scanning, denoted 1:1, so that the 625/1:1/50 picture signal is formed.

In a right-hand centre column I' bold broken lines indicate lines of a first output field of the line number doubling circuit of FIG. 3B. The lines of the first and second output fields in the columns I' and II' form together the interlaced 1250/2:1/50 picture signal with double the number of lines. As is indicated by means of arrows, the interlace denoted by 2:1, is obtained in that the weighting factor k of FIG. 1 applied to the control inputs of the respective mixer circuits 33 and 35 changes its value from field to field ($k=\frac{1}{4}$ or $k=\frac{3}{4}$).

After having read this description, a person skilled in the art will be able to design numerous variations. All these variations are considered to be part of the field of the invention. For example, the output signal of the

switch 29 can be used for forming an image signal having twice the field number of the input signal.

We claim:

1. A method of processing a line and field sequentially assembled picture signal, comprising the steps of:
 - performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field;
 - vertically filtering said additional line using at least one of said adjacent lines of said given field, wherein said vertically filtering step includes determining a median of signals from said additional line and from two lines adjacent to said additional line;
 - determining a direction of a contour in a picture of said picture signal to obtain a preferred filtering direction;
 - obtaining an average of two pixel values on said two adjacent lines in the direction of the contour; and
 - supplying said median if said preferred filtering direction is vertical, and supplying said average otherwise.
2. A method of processing a line and field sequentially assembled picture signal, comprising the steps of:
 - performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field;
 - vertically filtering said additional line using at least one of said adjacent lines of said given field, wherein said additional line and said adjacent lines of said given field are multiplexed to form a non-interlaced picture signal.
3. A method of processing a line and field sequentially assembled picture signal, comprising the steps of:
 - performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field;
 - vertically filtering said additional lines using at least one of said adjacent lines of said given field, wherein said additional line and said adjacent lines of said given field are processed to form a field of an interlaced picture signal having a doubled line number.
4. Apparatus for processing a line and field sequentially assembled picture signal, comprising:
 - means for performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least one neighboring field; and
 - means for vertically filtering said additional line using at least one of said adjacent lines of said given field; wherein said vertically filtering means further include:
 - means for determining a median of signals from said additional line and from two lines adjacent to said additional line;
 - means for determining a direction of a contour in a picture of said picture signal to obtain a preferred filtering direction;
 - means for obtaining an average of two pixel values on said two adjacent lines in the direction of said contour; and
 - means for supplying said median if said preferred filtering direction is vertical, and supplying said average otherwise.

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5. Apparatus for processing a line and field sequentially assembled picture signal, comprising:
means for performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least on neighboring field; and
means for vertically filtering said additional line using at least one of said adjacent lines of said given field; wherein said vertically filtering means include means for multiplexing said additional line and said adjacent lines of said given field to form a field of an interlaced picture signal having a doubled line number.

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6. Apparatus for processing a line and field sequentially assembled picture signal, comprising:
means for performing a motion compensated interpolation to obtain an additional line between two adjacent lines of a given field from picture information of at least on neighboring field; and
means for vertically filtering said additional line using at least one of said adjacent lines of said given field; wherein said vertically filtering means include means for processing said additional line and said adjacent lines of said given field to form a non-interlaced picture signal.

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APPENDIX B - LIST OF ALLEGED INFRINGING LG PRODUCTS

Televisions

32LE5300

32LG60

32LG70

37LG60

42LD520

42LD550

42LE5300

42LE5350

42LE5400

42LG60

42LG70

42LGX

42LK520

42LV520

42LV5400

42LV5500

47LD500

47LD520

47LD650

47LE5350

47LE5400

47LG60

47LG70

47LG90

47LGCX

47LK520

47LV5500

52LD550

52LG60

52LG70

55LD520

55LD650

55LE5400

55LE5500

55LK520

55LV5500

60LD550

32LD520

32LD550

Projectors

CF3D

CF181D

32LE5400
32LH40

37LE5300
37LH40
37LH55

42LBX
42LE5500
42LE7300
42LG60
42LGX
42LH40
42LH50
42LH55
42LH90
42SL80
42SL90

46LD550

47LBX
47LE5500
47LE7300
47LE7500
47LG60
47LH40
47LH50
47LH55
47LH85
47LH90
47LX6500
47LX9500
47SL80
47SL90

52LBX
52LG60

55LE7300
55LE7500
55LE8500
55LH40
55LH50
55LH55
55LH85
55LH90
55LHX
55LX6500
55LX9500

APPENDIX C- LIST OF ALLEGED INFRINGING TOSHIBA PRODUCTS

Televisions

55G310U
55G300U
55HT1U
55SL417U
55SL412U
55S41U
55TL515U
55UL605U
55UX600U
55VX700U
55WX800U

47TL515U

46G310U
46G300U
46SL417U
46SL412U
46UL605U
46UX600U
46VX700U
46WX800U

42SL417U
42TL515U

40G300U
40UL605U
40UX600U

32TL515U

APPENDIX D - LIST OF ALLEGED INFRINGING MITSUBISHI PRODUCTS

Televisions

WD-92840

WD-82840

WD-82838

WD-82740

WD-82738

WD-73840

WD-73838

WD-73740

WD-73738

WD-73640

WD-73C11

WD-73638

WD-73C10

WD-65838

WD-65738

WD-65638

WD-65C11

WD-60738

WD-60638

WD-60C10

L75-A94

L75-A91

LT-55265

LT-55164

LT-55154

LT-52153

LT-46265

LT-46164

LT-46153

LT-40164

LT-40153

APPENDIX E - LIST OF ALLEGED INFRINGING VIZIO PRODUCTS

Televisions

XVT3D650SV

E550VA

E550VL

E551VA

E551VL

M550NV

M550SV

VF550M

VF550XVT1A

VF551XVT

VF552XVT

XVT3D554SV

XVT553SV

E3D470VX

E470VA

E470VL

E472VL

M470NV

M470SV

M470VT

M470VT

SV470M

SV470XVT1A

SV471XVT

SV472XVT

VL470M

VT470M

XVT3D474SV

XVT472SV

XVT473SV

E3D420VX

E420VA

E420VL

E421VA

E421VL

E421VO

E422VA

M3D420SR

M420NV

M420SR

M420SV

M420VT

M421NV
M421VT
SV420M
SV420XVT
SV421XVT
SV422XVT
VL420M
VT420M
XVT3D424SV
XVT3D474SV
XVT423SV

E370VA
E371VA
M370VT
SV370XVT
XVT373SV

SV320XVT
XVT323SV

APPENDIX F - LIST OF ALLEGED INFRINGING SHARP ELECTRONICS CORP. PRODUCTS

Televisions

LC-70LE735U
LC-70LE734U
LC-70LE733U
LC-70LE732U

LC-60LE925UN
LC-60LE835U
LC-60LE832U
LC-60LE831U
LC-60LE830U
LC-60LE633U
LC-60LE632U
LC-60E88UN

LC-52LE835U
LC-52LE830U

LC-46LE835U
LC-46LE832U
LC-46LE830U

LC-40LE835U
LC-40LE830U