JS 44 CAND (Rev. 12/11)

# CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. *(SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)*

**I. (a) PLAINTIFFS**
Innovus Prime LLC

**DEFENDANTS**
Panasonic Corporation
Panasonic Corporation of North America

**(b)** County of Residence of First Listed Plaintiff   Lyon County Nevada
*(EXCEPT IN U.S. PLAINTIFF CASES)*

12-660 JSC

County of Residence of First Listed Defendant   Osaka Japan
*(IN U.S. PLAINTIFF CASES ONLY)*

NOTE:   IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

**(c)** Attorneys *(Firm Name, Address, and Telephone Number)*
Law Offices of John W. Carpenter LLC
12 Metairie Ct.
Metairie LA 70001   415.577.0698

Attorneys *(If Known)*

(14)

**II. BASIS OF JURISDICTION** *(Place an "X" in One Box Only)*

☐ 1   U.S. Government Plaintiff

☒ 3 Federal Question
*(U.S. Government Not a Party)*

☐ 2   U.S. Government Defendant

☐ 4 Diversity
*(Indicate Citizenship of Parties in Item III)*

**III. CITIZENSHIP OF PRINCIPAL PARTIES** *(Place an "X" in One Box for Plaintiff)*
*(For Diversity Cases Only)* and One Box for Defendant)

| | PTF | DEF | | PTF | DEF |
|---|---|---|---|---|---|
| Citizen of This State | ☐ 1 | ☐ 1 | Incorporated *or* Principal Place of Business In This State | ☐ 4 | ☐ 4 |
| Citizen of Another State | ☐ 2 | ☐ 2 | Incorporated *and* Principal Place of Business In Another State | ☐ 5 | ☐ 5 |
| Citizen or Subject of a Foreign Country | ☐ 3 | ☐ 3 | Foreign Nation | ☐ 6 | ☐ 6 |

**IV. NATURE OF SUIT** *(Place an "X" in One Box Only)*

| CONTRACT | TORTS | FORFEITURE/PENALTY | BANKRUPTCY | OTHER STATUTES |
|---|---|---|---|---|
| ☐ 110 Insurance | **PERSONAL INJURY**    **PERSONAL INJURY** | ☐ 625 Drug Related Seizure of Property 21 USC 881 | ☐ 422 Appeal 28 USC 158 | ☐ 375 False Claims Act |
| ☐ 120 Marine | ☐ 310 Airplane    ☐ 365 Personal Injury - | ☐ 690 Other | ☐ 423 Withdrawal 28 USC 157 | ☐ 400 State Reapportionment |
| ☐ 130 Miller Act | ☐ 315 Airplane Product     Product Liability | | | ☐ 410 Antitrust |
| ☐ 140 Negotiable Instrument |     Liability    ☐ 367 Health Care/ | | | ☐ 430 Banks and Banking |
| ☐ 150 Recovery of Overpayment | ☐ 320 Assault, Libel &     Pharmaceutical | | **PROPERTY RIGHTS** | ☐ 450 Commerce |
|    & Enforcement of Judgment |     Slander     Personal Injury | | ☐ 820 Copyrights | ☐ 460 Deportation |
| ☐ 151 Medicare Act | ☐ 330 Federal Employers'     Product Liability | | ☒ 830 Patent | ☐ 470 Racketeer Influeneed and |
| ☐ 152 Recovery of Defaulted |     Liability    ☐ 368 Asbestos Personal | | ☐ 840 Trademark |     Corrupt Organizations |
|    Student Loans | ☐ 340 Marine     Injury Product | | | ☐ 480 Consumer Credit |
|    (Excl. Veterans) | ☐ 345 Marine Product     Liability | **LABOR** | **SOCIAL SECURITY** | ☐ 490 Cable/Sat TV |
| ☐ 153 Recovery of Overpayment |     Liability    **PERSONAL PROPERTY** | ☐ 710 Fair Labor Standards | ☐ 861 HIA (1395ff) | ☐ 850 Securities/Commodities/ |
|    of Veteran's Benefits | ☐ 350 Motor Vehicle    ☐ 370 Other Fraud |     Act | ☐ 862 Black Lung (923) |     Exchange |
| ☐ 160 Stockholders' Suits | ☐ 355 Motor Vehicle    ☐ 371 Truth in Lending | ☐ 720 Labor/Mgmt. Relations | ☐ 863 DIWC/DIWW (405(g)) | ☐ 890 Other Statutory Actions |
| ☐ 190 Other Contract |     Product Liability    ☐ 380 Other Personal | ☐ 740 Railway Labor Act | ☐ 864 SSID Title XVI | ☐ 891 Agricultural Acts |
| ☐ 195 Contract Product Liability | ☐ 360 Other Personal     Property Damage | ☐ 751 Family and Medical | ☐ 865 RSI (405(g)) | ☐ 893 Environmental Matters |
| ☐ 196 Franchise |     Injury    ☐ 385 Property Damage |     Leave Act | | ☐ 895 Freedom of Information |
| | ☐ 362 Personal Injury -     Product Liability | ☐ 790 Other Labor Litigation | |     Act |
| |     Med. Malpractice | ☐ 791 Empl. Ret. Inc. | | ☐ 896 Arbitration |
| **REAL PROPERTY** | **CIVIL RIGHTS**    **PRISONER PETITIONS** |     Security Act | **FEDERAL TAX SUITS** | ☐ 899 Administrative Procedure |
| ☐ 210 Land Condemnation | ☐ 440 Other Civil Rights    ☐ 510 Motions to Vacate | | ☐ 870 Taxes (U.S. Plaintiff |     Act/Review or Appeal of |
| ☐ 220 Foreclosure | ☐ 441 Voting     Sentence | |     or Defendant) |     Agency Decision |
| ☐ 230 Rent Lease & Ejectment | ☐ 442 Employment    **Habeas Corpus:** | | ☐ 871 IRS—Third Party | ☐ 950 Constitutionality of |
| ☐ 240 Torts to Land | ☐ 443 Housing/    ☐ 530 General | |     26 USC 7609 |     State Statutes |
| ☐ 245 Tort Product Liability |     Accommodations    ☐ 535 Death Penalty | | | |
| ☐ 290 All Other Real Property | ☐ 445 Amer. w/Disabilities -    ☐ 540 Mandamus & Other | **IMMIGRATION** | | |
| |     Employment    ☐ 550 Civil Rights | ☐ 462 Naturalization Application | | |
| | ☐ 446 Amer. w/Disabilities -    ☐ 555 Prison Condition | ☐ 463 Habeas Corpus - | | |
| |     Other    ☐ 560 Civil Detainee - |     Alien Detainee | | |
| | ☐ 448 Education     Conditions of |     (Prisoner Petition) | | |
| |     Confinement | ☐ 465 Other Immigration Actions | | |

**V. ORIGIN** *(Place an "X" in One Box Only)*

☒ 1 Original Proceeding    ☐ 2 Removed from State Court    ☐ 3 Remanded from Appellate Court    ☐ 4 Reinstated or Reopened    ☐ 5 Transferred from another district *(specify)*    ☐ 6 Multidistrict Litigation

**VI. CAUSE OF ACTION**

Cite the U.S. Civil Statute under which you are filing *(Do not cite jurisdictional statutes unless diversity)*:
35 U.S.C. Sec 271 et seq

Brief description of cause:
Complaint for Patent Infringement

**VII. REQUESTED IN COMPLAINT:**

☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23

DEMAND $

CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes   ☐ No

**VIII. RELATED CASE(S) IF ANY**

*(See instructions)*:    JUDGE   James Ware     DOCKET NUMBER   C 11-04223

**IX. DIVISIONAL ASSIGNMENT (Civil L.R. 3-2)**
(Place an "X" in One Box Only)    ☐ SAN FRANCISCO/OAKLAND    ☐ SAN JOSE    ☐ EUREKA

DATE   2/8/12     SIGNATURE OF ATTORNEY OF RECORD

1  JOHN W. CARPENTER (Cal. Bar No. 221708)
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   Metairie, LA 70001-3032
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   Email: john@jwcarpenterlaw.com
5
   *Attorneys for Plaintiff,*
6  *Innovus Prime LLC*
7
                    IN THE UNITED STATES DISTRICT COURT
8
9              FOR THE NORTHERN DISTRICT OF CALIFORNIA
10

11 | Innovus Prime LLC | Civil Action No. **12 0660** |
12 | Plaintiff | |
13 | v. | |
14 | | **COMPLAINT FOR PATENT INFRINGEMENT** |
15 | Panasonic Corporation Panasonic Corporation of North America | |
16 | | **DEMAND FOR JURY TRIAL** |
17 | Defendants | |
18

19

20              **COMPLAINT FOR PATENT INFRINGEMENT**

21

22      Plaintiff, Innovus Prime LLC ("Plaintiff Innovus Prime"), hereby alleges for its Complaint

23 against Panasonic Corporation and Panasonic Corporation of North America, on personal

24 knowledge as to their own actions and on information and belief as to the actions of others, as

25 follows:

26

27

## NATURE OF THE CASE

This is an action arising under the Patent Laws and Statutes of the United States in which Plaintiff seeks to recover for patent infringement, and for any and all damages and costs flowing there from.

## THE PARTIES

1.      Plaintiff Innovus Prime is a Nevada limited liability company with a principal place of business at 900 Lafayette Street, Suite 708, Santa Clara, CA 95050.

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

3.      On information and belief, Defendant Panasonic Corporation of North America is a corporation organized and existing under the laws of the State of Delaware with its principal place of business at One Panasonic Way, Panazip 71-1, Secaucus, New Jersey 07094. On information and belief, this Defendant is a wholly owned subsidiary of Defendant Panasonic Corporation.

Defendant Panasonic Corporation of North America has appointed the Corporation Trust Company, Corporation Trust Center, 1209 Orange Street, Wilmington, New Castle, DE, 19801, as its agent for service of process. Defendant Panasonic Corporation of North America regularly conducts and transacts business in California, throughout the United States, and within the Northern District of California, itself and/or through one or more subsidiaries, affiliates, business divisions, or business units. Panasonic Corporation and Panasonic Corporation of North America will be referred to herein individually and collectively as "Panasonic Defendants."

## JURISDICTION AND VENUE

4.      This is an action under the Patent Laws of the United States, Title 35 of the United States Codes, namely, 35 U.S.C. §§ 1 et seq. including 35 U.S.C. §§ 271 and 281, *et seq*, because Panasonic Defendants committed acts of patent infringement within the United States and this judicial district. Accordingly, this Court has subject matter jurisdiction of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

5.      Venue is proper in this District under 28 U.S.C. §§ 1391 and/or 1400 (b) because Panasonic 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 Panasonic Defendants has delivered infringing products into the stream of commerce with the expectation that they will be purchased and used   by consumers in California, including consumers in the Northern District of California.

6.      Plaintiff Innovus Prime has a place of business in this District.

## PLAINTIFF'S PATENT

7.      On January 18, 1994, the  United States Patent and Trademark Office duly and legally issued U.S. Patent No. 5,280,350 ("the '350 Patent"), entitled "Method and Apparatus for

Processing a Picture Signal to Increase the Number of Displayed Television Lines Using Motion Vector Compensated Values." A copy of the '350 Patent is attached to this Complaint as Appendix A.

8.    By reason of an assignment, Plaintiff Innovus Prime owns all rights, title and interest in the '350 Patent. The '350 Patent concerns *inter alia* embodiments for a method for processing a picture signal to obtain a picture signal having improved properties.

## COUNT I
## INFRINGEMENT OF U.S. PATENT NO. 5,280,350

9.    Plaintiff Innovus Prime repeats and incorporates by reference each of the allegations contained in Paragraphs 1 through 8 above, and further alleges as follows:

10.    On information and belief, without a license or permission from Plaintiff Innovus Prime, Panasonic Defendants infringed one or more claims of the '350 Patent in the State of California, in this judicial district, and elsewhere in the United States by having imported, made, used, sold or offered for sale claimed embodiments of the invention(s) that embody and/or practiced the invention(s) for processing a picture signal to obtain a picture signal having improved properties.  On information and belief, Panasonic Defendants' infringement of one or more claims of the '350 Patent occurred individually, or while acting in concert and/or through the same or series of transactions.  Panasonic Defendants are thus liable for infringement of the '350 Patent pursuant to 35 U.S.C. § 271 literally and/or under the doctrine of equivalents.  Without limitation, several examples of Panasonic Defendants' infringing products include   the VIERA® family of television products, including models TC-L32DT30 (DT30 Series), TC-L37DT30 (DT30 Series), TC-L42D30 (D30 Series), TC-L42E30 (E Series), and TC-L42U30 (U30 Series), and projectors including models PT-AE3000U, PT-AE4000U, and PT-AE7000. Panasonic

1  Defendants' infringement of the '350 Patent has caused substantial damage to Plaintiff Innovus

2  Prime.

3      11.    To the extent that facts learned in discovery show that Panasonic Defendants'

4  infringement of the '350 Patent had been willful, Plaintiff Innovus Prime reserves the right to

5  request such a finding at time of trial.

6

7      12.    As a result of these Panasonic Defendants' infringement of the '350 Patent,

8  Plaintiff Innovus Prime has suffered monetary damages in an amount not yet determined.

9

10

## DEMAND FOR JURY TRIAL

Pursuant to Fed.R.Civ.P. 38, Plaintiff Innovus Prime requests a trial by jury on all issues

allowable by law.

## CERTIFICATION OF INTERESTED PARTIES OR PERSONS

Pursuant to Civil L.R. 3-16, the undersigned certifies that the following listed person,

association of persons, firms, partnerships, corporations (including parent corporations) or other

entities (i) have a financial interest in the subject matter in controversy or in a party to the

proceeding, or (ii) have a non-financial interest in that subject matter or in a party that could be

substantially affected by the outcome of the proceeding:

Innovus Prime LLC

## PRAYER FOR RELIEF

WHEREFORE, Plaintiff Innovus Prime prays for the following relief:

A.      For decree and judgment against Panasonic Defendants and all in privity with Panasonic Defendants that the '350 Patent is valid and enforceable;

B.      For decree and judgment against Panasonic Defendants and all in privity with Panasonic Defendants that the '350 Patent had been infringed by Panasonic Defendants and that Panasonic Defendants are liable as patent infringers;

C.      For decree and judgment against Panasonic Defendants and all in privity with Panasonic Defendants requiring Panasonic Defendants to pay Plaintiff Innovus Prime its damages, costs, expenses, and prejudgment and post-judgment interest for Panasonic Defendants' infringement of the '350 Patent under 35 U.S.C. § 271 and 28 U.S.C. § 1961;

D.      For such other and further relief which should appear just and equitable to this Court.

Dated: February 8, 2012.             Respectfully submitted,

By: _____

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*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**

[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
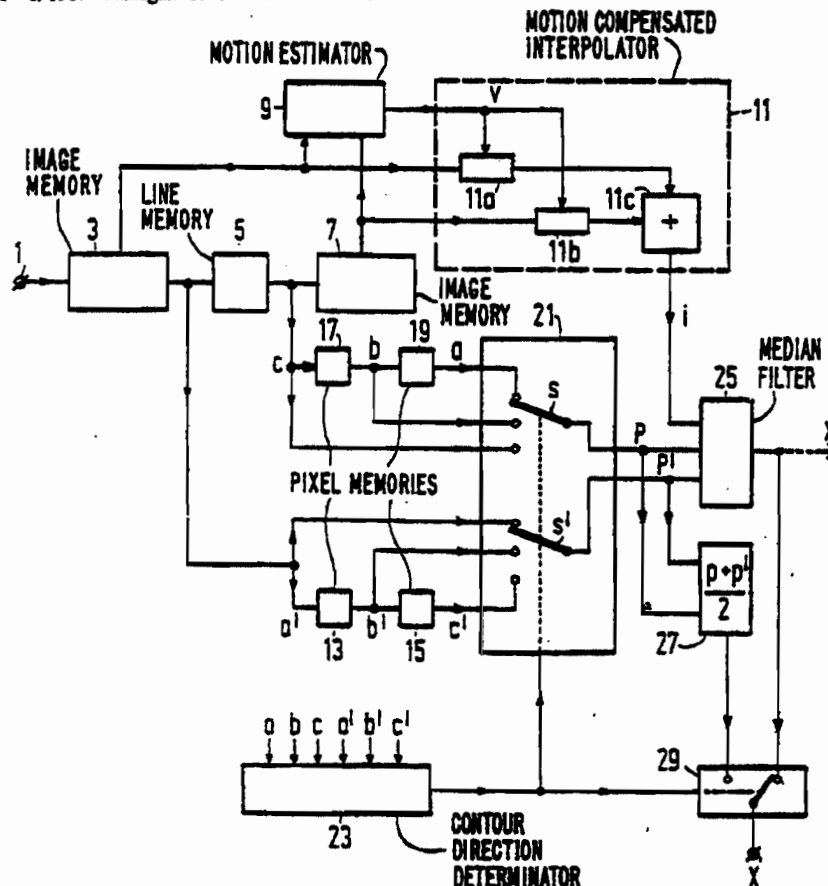
[56] **References Cited**

### U.S. PATENT DOCUMENTS

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

| | | | |
|---|---|---|---|
| 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 | Moyoc 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

[57] **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.
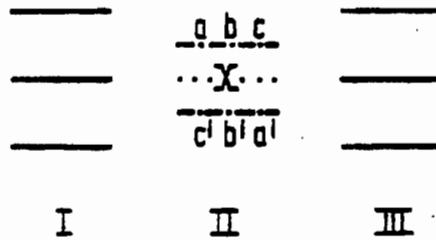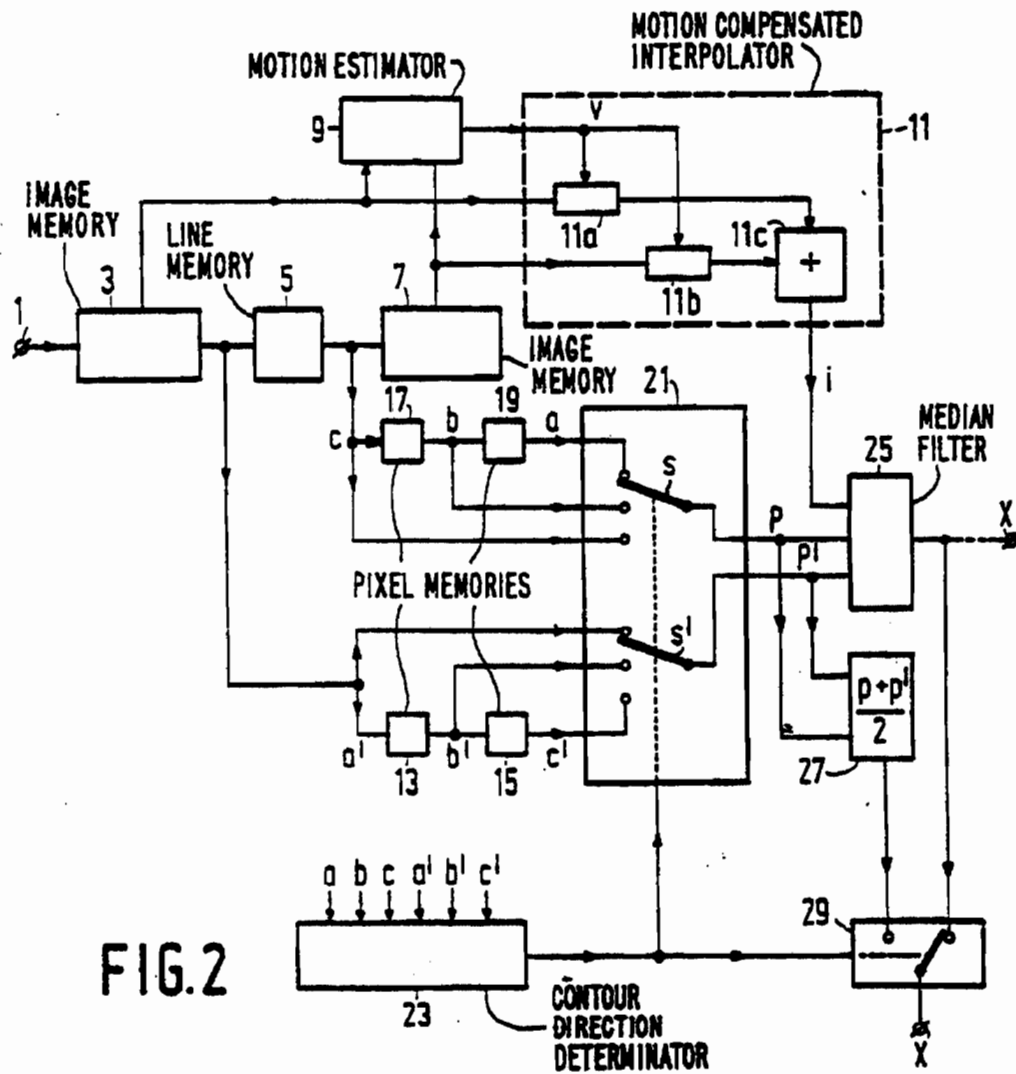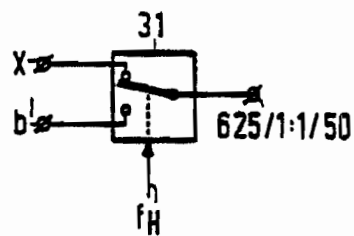
6 Claims, 2 Drawing Sheets

a b c

··· X ···

c¹ b¹ a¹

I          II          III

# FIG.1

MOTION ESTIMATOR

MOTION COMPENSATED
INTERPOLATOR

9

v

11

IMAGE
MEMORY

LINE
MEMORY

11a

11c

11b

+

3

5

7

1

IMAGE
MEMORY

i

17

19

21

25

MEDIAN
FILTER

c

b

a

s

P

X

PIXEL MEMORIES

p¹

a¹

b¹

c¹

s¹

p+p¹
2

13

15

27

a b c a¹ b¹ c¹

29

# FIG.2

23

CONTOUR
DIRECTION
DETERMINATOR

X

X ⌀

b' ⌀

31

625/1:1/50

f_H

## FIG.3A

33    MIXER CIRCUIT

X ⌀      k

P' ⌀     1-k

k ⌀

X ⌀      1-k    35

P ⌀      k

37

1250/2:1/50

f_H

MIXER CIRCUIT

## FIG.3B

625 / 2 : 1/50

625/1:1/50                    1250/2:1/50

P          3/4

1/4          1/4

X          3/4          3/4

1/4          1/4

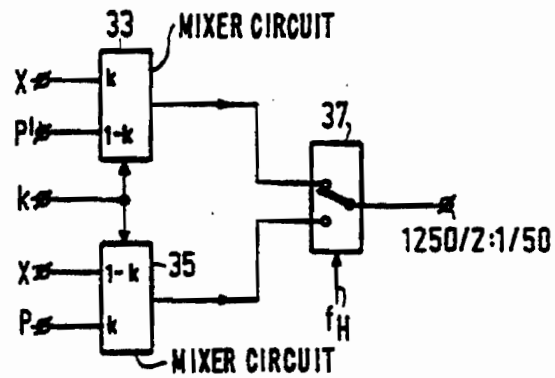P'          1/4          3/4

I                    II                    I'                    II'
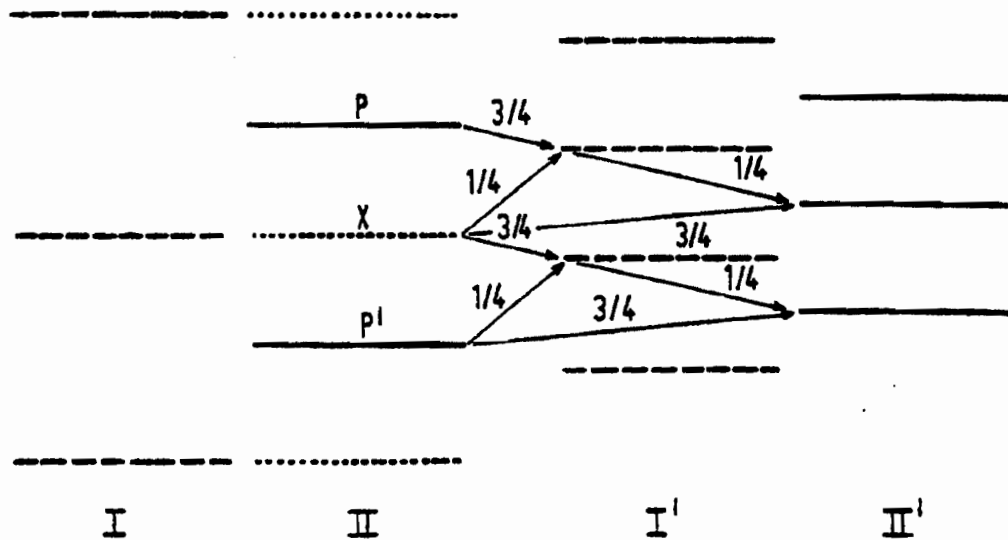
## FIG.4

1

# 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

2

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 11, 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 alteratively 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 11, 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 II 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 averageing operation on information from two fields. However, previously, motion compensated averageing was preferred because the averageing 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 the 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

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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 ¼ during the first field of each picture and equal to ¾ 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=¼ or k=¾).

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

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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 liens 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.

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.

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.

*   *   *   *   *