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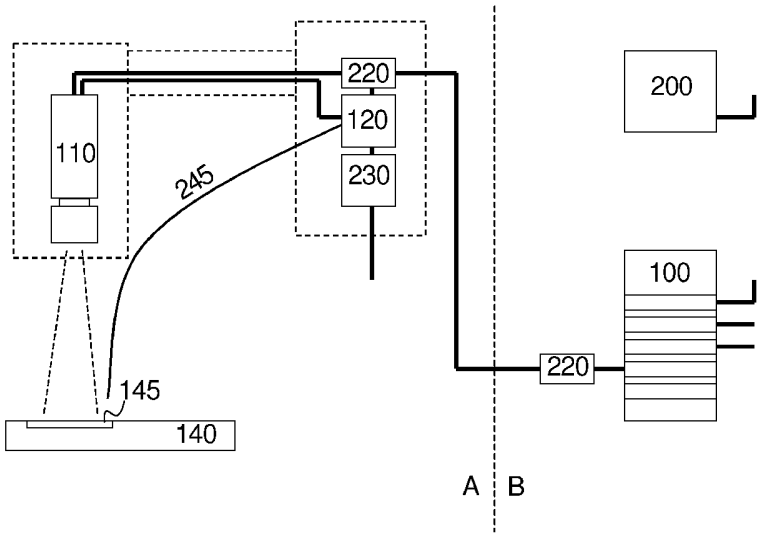
(54) **Title:** A METHOD FOR TESTING ELECTRONIC DEVICES



(57) **Abstract:** The present invention relates to a method for testing the display of an electronic device, in which method changes occuring in the display of the device are examined. The method comprises the steps of measuring the representation properties of the display of the electronic device, running a test video on the display of said electronic device, the test video comprising images marked with a predetermined identifier, and imaging said display, detecting a change of images in the test data, computing and analyzing disturbances in the imaged measurement data on the basis of the information contained in the test video. Furthermore, the invention relates to a system, a synchronization module, a testing data product, a computer software product, and an analysis system.

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A METHOD FOR TESTING ELECTRONIC DEVICES

Field of the invention

The present invention relates to a method for testing electronic devices, in which method the display of said electronic device is imaged for obtaining measurement data, and changes on the display of the electronic device are examined. The invention also relates to a system for testing electronic devices, which system comprises a camera device for recording changes on the display of the electronic device and for obtaining measurement data. Furthermore, the invention relates to a synchronization module, a testing data product, a computer software product, as well as an analysis system.

Background of the invention

The standards for existing electronic devices and for those under development are continuously increasing, and partly for that reason, the devices in question have been subjected to legal obligations, such as the protective standards on EMC (Electro Magnetic Compatibility), which define whether the electronic device in question interferes with other devices or whether other devices interfere with said device. Such immunity of an electronic device to interference can be measured, for example, by EMC tests. The source of the interference, to which the device is subjected, may be any external or internal phenomenon. External phenomena to be mentioned include other electric devices (for example, microwave ovens) or static electricity, and internal phenomena of the device include high frequencies and powers as well as oscillators.

In the testing of devices with a display, for example wireless devices, interference can be examined by imaging the display, for example with a camera, to obtain a digital video which is visually observed afterwards to find points where the operation of the device was disturbed by EMC testing. The visual analysis of test videos is subjective and does

not allow a precise measurement or automatic testing. Furthermore, because the analysis is carried out first after the test, the test cannot be interrupted when a defect is detected. This is another reason why the testing time of the electronic device becomes longer. The automation of the testing may be based on a comparison between the measured image and a reference image. For this, the images must be synchronized. In the testing of analog image tubes, for example a CRT, the measurement can be synchronized directly with the electronic components or signals of the vertical or horizontal scanning lines of the picture element circuit of the image tube, because the device to be tested is not wireless.

One quality assessment of television receivers and displays is described, for example, in the brochure by Rohde & Schwartz, "EMS Test System Audio and Video R&S TS9980 - Measuring the electromagnetic susceptibility of sound and TV broadcast receivers, satellite and DVB receivers". In this publication, the testing is based on a comparison with a reference image. The test images are recorded by a video camera from the displays of the devices to be tested. In the method, at least five reference images are recorded, from which an average regression function is computed. The above-mentioned function gives the estimated threshold by the maximum deviation of the measured values. After this, a required interference signal is used, and one or more test images are recorded in each variant of the interference variable (frequency or level). After this, a regression function is computed at each stage of assessment. If the deviation is greater than that defined in the reference image, visible image interference can be expected to appear in the image. In the testing, a CCD cellular camera is used for recording images, which camera is covered with a dark hood to avoid interfering light. The RGB (Red, Green, Blue) signal from the camera is transferred to an image analysis unit. For synchronizing the image with a refresh rate, the synchronization signal must be input in the camera. These two signal buses apply fiber optics to avoid electromagnetic oscillation. The product in question has been developed for the measurement of

electromagnetic interference in a television set, as well as for the measurement of electronic devices that can be galvanically coupled during the testing (for example, TFT television). Such a method is not suitable, as such, for the testing of *e.g.* a mobile phone, because the interface should be wireless or optical. Moreover, for example LCD/TFT displays do not comprise such analog vertical or horizontal synchronization circuits that are used in said image tube technology.

Consequently, it can be appreciated that a method that would allow the testing of a device without a galvanic connection and would thus be suitable for the testing of, for example, a mobile phone, is not known from prior art. The present invention discloses one such solution that is also suitable for the testing of other devices than just mobile phones, and that is, furthermore, not dependent on the method of connection.

Summary of the invention

The aim of this invention is to provide a solution for the testing of electronic devices, which solution is both efficient and accurate.

The method according to the invention is primarily characterized in that the method comprises the steps of measuring the representation properties of the display of the electronic device; running testing data on the display of said electronic device, the testing data being suitable for the display and comprising images marked with a predetermined identifier; identifying a change of images in the testing data by means of the predetermined identifier; computing and analyzing disturbances in the measurement data on the basis of information included in the testing data.

The system according to the invention is primarily characterized in that the system comprises a synchronization module for synchronizing the measurement of the representation properties of the display of the electronic device, data transmission means for transmitting suitable testing data to the display of the electronic device, the testing data

comprising images marked with a predetermined identifier, as well as an analysis device for detecting a change of images in the testing data on the basis of the predetermined identifier, and measurement data for computing and analyzing interference on the basis of the information included in the testing data.

The testing data product according to the invention is primarily characterized in that said first test image comprises at least one synchronization area comprising a first identifier, and said one second test image comprises at least one synchronization area in an area corresponding to the synchronization area of said first test image, which synchronization area of said second test image comprises a second identifier, wherein said storage means comprises several test images in such a way that the synchronization area of each test image in question differs from the synchronization area of the preceding test image, and that said first and at least second test image further comprise at least one locating mark to define an active area.

The synchronization module according to the invention is primarily characterized in that the synchronization module comprises means for receiving a measuring signal about the representation properties of the display, a low-pass filter for suppressing the interference signal from said measurement signal, means for generating a synchronization pulse, as well as for adjusting it on the basis of an electronic response time.

The computer software product according to the invention is primarily characterized in that the measurement data comprises information about the representation properties of the display of the electronic device, wherein the instructions to be implemented in the computer are adapted to identify the single images of the measurement data and to carry out an image analysis on said measurement data.

The analysis system according to the invention is primarily characterized in that the measurement data comprises information

about the representation properties of the display of the electronic device, wherein said measurement system is adapted to identify the single images of the measurement data and to carry out an image analysis on said measurement data.

Other embodiments of the invention will be described in the attached dependent claims.

The invention provides a precise method for testing various displays, such as liquid crystal or plasma displays (for example LCD, TFT, OLED displays). By this method, it is also possible to automate the immunity testing of a device comprising said display (for example EMC, EMS, ESD, PET testing). Thanks to the automated and optimized arrangement according to the invention, the displays of various electronic devices, such as mobile phones, can be measured at various display refresh rates, with various display electro-optical response times, operating system delays and various video image rates. Up to date, these delays, which are independent of each other, have induced *e.g.* ghost images and corresponding interference due to the asynchronized imaging. They have prevented the automation of the analysis and disturbed the visual examination. Furthermore, in so far as the test results of existing techniques depend subjectively on the observations of the testing person, the test results according to the invention are objective and comparable with each other. Thanks to the invention, the testing can be automated, since the precise measurement makes automatic analysing possible. Among other things, this accelerates the testing time and saves costs.

A requirement for the automation is a calibration function, in which a reference video recorded in an undisturbed environment is compared, image by image, with a video or an image series recorded during testing. Because the item to be tested may move in relation to the camera during the test, the calibration can be performed automatically during the test, thereby automating the measurement. This reference video calibration function also makes it possible to change the devices

to be tested in a flexible way between the tests, as well as eliminates the harmful effect of optical phenomena (for example, the Moire phenomenon) from the measurement.

Description of the drawings

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 shows a simplified example of a system according to the invention,

Fig. 2 shows a more detailed example of the system according to the invention,

Fig. 3 shows a more detailed example of an analysis device according to the invention,

Fig. 4 shows one example of a user interface according to the invention,

Fig. 5 shows one example of a test image according to the invention,

Fig. 6 shows yet another example of a system according to the invention, and

Fig. 7 shows an example of steps 610 to 620 in Fig. 6.

Detailed description of the invention

The present invention relates to the immunity testing of electronic devices, such as EMC testing, but it will be obvious that the arrangement according to the invention can also be used in other application

domains including, for example, production EMC test equipment (PET) or the testing and validation of components and modules.

In this specification, a mobile phone will be described as an example of an electronic device, but it will be obvious for a person skilled in the art that also other devices with a display, such as a personal digital assistant, a portable computer, flat screen television sets, portable game consoles, video cameras, digital cameras, and portable DVD players, etc. can be tested by means of the system according to the invention. The reason for using the mobile phone as an example is that its synchronization with the refresh rate, for example by a galvanic connection, may cause interference in the testing. Consequently, the testing may not necessarily comply with the requirements. In this example, the connection to the refresh rate is implemented by fibre optics.

One embodiment of the system according to the invention is shown in a reduced manner in Fig. 1. The system is an automatic monitoring system based on machine vision, which can be used to detect visual changes in displays during interference testing. Such changes include, for example, noise, an image break, refresh failures, colour failures, changes or stops in the video playback speed, *etc.* The system comprises a camera device 110, a synchronization module 120, as well as an analysis device 100. The camera device 110 is coupled to a synchronization module 120 as well as to an analysis device 100 by means of cables 115, 105, respectively. The synchronization means are coupled by fibre optics to the electronic device 140 to be tested. In Fig. 1, reference numeral 130 indicates an area defined by broken lines, inside which no other electronic devices can be introduced in the vicinity of the device to be tested, for successful testing. In the arrangement according to the invention, the representation properties of the display 145 of the device 140 to be tested, that is, the refresh rate, the electro-optical response time and the video image rate, are measured, for example, by fibre optics together with the synchronization module 120 or a measuring card. In some cases, the

measurement of the representation properties of the display can also be implemented wholly by means of a camera device in such a way that a specific image sensor area of the camera measures the representation properties of the display and synchronizes the cell area imaging the rest of the display. The arrangement according to the invention also utilizes testing data suitable for the display, such as a test image or a test video (Fig. 5), which are run on the display 145 of the device to be tested. In the test video, the even and odd images are marked with synchronization identifiers in such a way that a change of images can be detected. In this specification, the test video is given as an example, but it will be obvious that this test video can be replaced by one or more test images.

Figure 5 shows one example of an image 500 in a test video, comprising a synchronization area 505, locating marks 501a, 501b, 501c, as well as an image identifier 510. The synchronization area 505 of the image can be marked, for example, in such a way that the odd images of the video (odd image identifier) are marked with a black pixel and the even images with a bright pixel. By means of the synchronization area 505 (for example, said alternating white and black) it is possible to detect when the image 500 of the test video is changed in reality. The image rate may vary, for both external and internal reasons, and it is unpredictable. The synchronization area 505 may comprise identifying information other than said colouring. Examples include a changing graphic pattern or another changing visual identifier.

By means of the location marks 501a, 501b, 501c, the active area of the display can be defined accurately, and also the position of the display can be defined by means of a particular colour comparison (a separate fixed colour for each corner). The image identifier 510 indicates which single image is in question. This makes an accurate analysis for a reference video possible. The image identifier 510 may be encoded by a known encoding method to increase reliability. Examples to be mentioned include redundant encoding and Hamming

encoding. The image identifier 510 can be selected to be either a numeral block (0, 1) or a binary block (identification by either optical text recognition or by means of intensity on gray scale and coordinates). The test video comprises more than one image, every second image comprising a synchronization area of a different colour. It is thus possible to detect a change of images.

On the display, it is possible to change the locations of the synchronization area 505 and of the image identifier 510 of the test video by programming. The single images 500 of the test video are designed so that all the defined interference types could be detected as efficiently as possible by image analysis. These interference types include, for example, changes in the video playback speed, increased noise, horizontal/vertical shift/mirrorring, changes in the intensity, and increased noise in the edge zones. The video playback rate can be seen from the image rate so that changes in the speed of the synchronization signal are detected in connection with image capture. The difference image analysis can be used for monitoring the quantity of noise as well as for detecting changes in the intensity. By means of the difference image analysis, it is possible to detect both local changes in the image (for example, in the edge zones) as well as changes affecting the whole image.

We shall now return to Fig. 1, in which the detection of said synchronization areas is implemented by the synchronization module 120. In the arrangement according to the invention, the defects/disturbances are computed on the basis of the content of the test video. The single images of the test video can be counted, for example, on the basis of a number of another identifier. The single images can be compared with reference image material with the help of said individual image identifier. The reference image material and the measured image data are compared with each other by the image analysis according to the invention, and the difference measurement of this comparison is reported. Figure 4 shows, in a very reduced manner, a user interface divided for reporting and analysis. The user interface

may comprise, for example, an event browsing field 420 comprising a time label of the event and a list of visible disturbances in each event during the testing. It is possible to obtain further information and history data on each disturbance by "opening" the event in question. The further information is retrieved from an interference database (Fig. 2). In addition to this, the user interface may present the disturbances of a selected single event as thumbnails 415, through which visible disturbances can be viewed and browsed. Furthermore, the user interface comprises an event player 400, by means of which the occurred disturbances can be presented and observed in more detail. In addition, the user interface may comprise a field for a verbal description 405 of the interference. The interference reporting according to the invention is presented in the report field 410 of the user interface, a difference measurement graph being depicted on its time axis. From the difference measurement graph, the user can see the disturbances/defects in the test at one glimpse. This difference measurement graph is presented in the field in such a way that disturbances above a division line 411 can be interpreted as visible defects, whereas disturbances below the division line 411 are not visible to the human eye. Furthermore, the difference measurement graph can be used for browsing the recorded video forward/backward.

The basic components of the analysis system according to the invention were shown in Fig. 1. The example of the analysis system shown in Fig. 2 gives slightly more details. In this example, the analysis system is divided between two physical spaces A, B. The testing space A comprises a camera device 110 set to record the display 145 of an electronic device 140. The high-resolution camera device 110 is coupled to a synchronization module 120 as well as to a fibre converter 220, and it is arranged to transfer synchronized images on the display 145 of the electronic device to be tested, on the basis of runnable videos. The synchronization module 120 is further connected to the display 145 of the electronic device by fibre optics 245. The synchronization module 120 (the module may be a commercial card with programmable filterings, or these functions may be implemented

by circuits) comprises a transducer and a signal circuit generating a synchronization signal.

The analysis space B comprises an analysis device 100 according to the invention, such as a personal computer. This analysis device 100 may comprise a WLAN/Bluetooth connection or another local area network connection as well as other connections providing a data transmission connection to an external device 200. The device 200 can be used, for example, for displaying live video from a camera and for performing optical adjustments in the test space A (for example, adjustment of the optics/angle of the camera and its effect on the image).

Figure 3 shows an example of the analysis device 100 according to the invention in more detail. The analysis device 100, such as a personal computer in this example, may comprise one or more test databases 300 for recording the test results and the videos with defects. Furthermore, the analysis device 100 comprises analysis software 320 and, if necessary, video software 330, configuration software 340, and an interface 350. Furthermore, the analysis device 100 comprises a reporting service 310 that makes automated reporting possible. The analysis software 320 receives from the camera device recorded material about the display during the testing. By some data transmission technique 3, the video software 330 may be connected to *e.g.* a portable computer or a personal digital assistant for the purpose of transmitting live video image supplied by the analysis device for adjusting the camera device. The analysis device 100 may be arranged in a data transmission connection with the testing device, for example via a GPIB connection 351 (General Purpose Interface Bus). Furthermore, the analysis device 100 may also be in a data transmission connection 341 with other systems, for example via an Ethernet.

Figure 6 shows another example of the system according to the invention. The figure shows the device 140 to be tested, and a camera

device 110. The device 140 to be tested provides measurement signals 610 relating to the representation properties of the display. These measurement signals 610 are used for computing/generating synchronization signals 620. The system also comprises a database 630 in which the reference or calibration video(s) 640 is (are) recorded. The system comprises means 650 for comparing the reference video 640 and the recorded video. The system may also comprise other measurement data or measurement equipment 660. Furthermore, the system comprises an analysis device 100 adapted to implement computation, filtering as well as analysis and alarms. In addition, the system is adapted to record measurement results in a test database 300 and further to report the measurement via user interfaces and reporting applications 310.

Further, Fig. 7 shows an example of the steps 610 to 620 shown in Fig. 6 and of the functions of the synchronization modules according to the invention. The signal components mentioned in the example are only examples of possible components, which will be obvious for a person skilled in the art. The synchronization module is adapted to filter out the interference signal, which may be caused by ambient light, or the like, from the measurement material 710 (raw signal) measured on the representation properties of the display (Fig. 713). The signal is subjected to low-pass and high-pass filtering 715, after which the low-pass filtered signal 711 indicates the change of successive images on the display and the high-pass filtered signal indicates the refresh rate of the display. The low-pass filter may cut out undesired refresh peaks of the signal, wherein the cut-off frequency can be converted, depending on the display to be examined.

After the filtering, the signals 720 are directed further to generate a synchronization pulse (725). The synchronization pulses 730 are delayed 735 (or advanced) for the time of the electro-optical response of the display. The delayed synchronization pulses 740, ready to use, are transmitted 745 to be prolonged (or shortened) by the time of the electro-optical response of the display, to produce prolonged precise

synchronization signals 750, which are coupled to the external shutter release input of the camera device. In the arrangement according to the invention, the timing is important because of various optical or electric properties of the display, and variations in the response times. The synchronization module can be coupled at a distance from the device to be examined, by means of fibre optics utilizing collimation optics. Consequently, the surrounding areas of the test video do not disturb the generation of the synchronization signal.

It will be obvious for a person skilled in the art that the system according to the invention may also comprise other functions than those described above, to improve the efficiency of the arrangement of the invention. Furthermore, it will be obvious that the system according to the invention may also provide other automatic functions, for example for inputting data and maintaining data. The embodiments according to the invention are examples of the arrangement according to the invention, wherein a person skilled in the art will appreciate that the system according to the invention may involve a countless number of other databases and systems to which the present system is in a data transmission connection.

For example, in the analysis system of the present invention, it is also possible to use only a camera (*e.g.* a CMOS camera device, or the like) for synchronizing the measurement, instead of a separate synchronization module. In this case, the synchronization would be carried out inside the camera device in such a way that a cell is used separately for synchronizing the imaging, and the rest of the image area is used for normal imaging. The arrangement according to the invention has been described for immunity testing, but the invention is suitable for use in the measurement of the display of a device in general. In other words, the measurement method according to the invention can be utilized, *inter alia*, in the validation of displays and, for example, in the production testing or development by a display manufacturer. Furthermore, statistical properties, according to which

the test result is determined, can be utilized in the testing. Thus the testing data can be, for example, a series of images containing an invariable image (for example, a monochrome display or a freeze frame). However, also in this series of images, the changing images can be identified by means of the synchronization area. Such an application is particularly suitable for such measuring of a display, where the image is to be stable within certain limits.

The above-described different embodiments of the invention can be combined to provide various embodiments of the invention, which are, as such, in accordance with the spirit of the invention. Therefore, the above-presented examples must not be interpreted as restrictive to the invention, but the embodiments of the invention may be freely varied within the scope of the inventive features presented in the claims hereinbelow.

Claims:

1. A method for testing electronic devices, in which method the display of said electronic device is imaged for obtaining measurement data, and changes on the display of the electronic device are examined, **characterized** in that the method comprises the steps of
   - measuring the representation properties of the display of the electronic device,
   - running testing data suitable for the display on the display of said electronic device, the testing data comprising images marked with a predetermined identifier,
   - detecting a change of images in the testing data by means of the predetermined identifier,
   - computing and analysing disturbances in the measurement material on the basis of information contained in the testing data.

2. The method according to claim 1, **characterized** in that a test video or a test image is run on the display of the electronic device.

3. The method according to claim 1 or 2, **characterized** in that the change of images is detected on the basis of a synchronization area in the images, the synchronization area of the image containing different image information than the synchronization area of the preceding image.

4. The method according to claim 1 or 2 or 3, **characterized** in that the representation properties of the display are measured by fibre optics which may comprise one or more fibres.

5. The method according to claim 1 or 2 or 3, **characterized** in that the representation properties of the display are measured by a camera.

6. The method according to any of the claims 1 to 5, **characterized** in comparing the measuring material with reference image material, and reporting the result of the formed image analysis.

7. The method according to claim 6, **characterized** in defining the result of the formed analysis image on one or more measurement graphs.

8. The method according to claim 7, **characterized** in browsing the results of the image analysis from one or more measurement graphs.

9. The method according to any of the preceding claims 1 to 8, **characterized** in that disturbances visible to the human eye are defined and trigger an alarm.

10. The method according to any of the claims 1 to 9, **characterized** in measuring the refresh rate, the electro-optical response time and the image rate of the display.

11. The method according to any of the preceding claims 1 to 10, **characterized** in testing a mobile device, such as a mobile phone.

12. A system for testing electronic devices, which system comprises a camera device for imaging changes occurring in the display of the electronic device and for obtaining measurement material, **characterized** in that the system comprises
    - a synchronization module for synchronizing the measurement of the representation properties of the display of the electronic device,
    - data transmission means for transmitting suitable testing data to the display of the electronic device, the testing

data comprising images marked with a predetermined identifier, and

- an analysis device for detecting a change in the images of the testing data on the basis of a predetermined identifier and for computing and analyzing disturbances in the measurement material on the basis of information included in the testing data.

13. The system according to claim 12, **characterized** in that the testing data comprises a test video or a test image.

14. The system according to claim 12 or 13, **characterized** in that the testing data comprises images with a synchronization area containing image information different from that in the synchronization area of the preceding image.

15. The system according to claim 12 or 13 or 14 **characterized** in that the system comprises fibre optics between the synchronization device and the electronic device to be measured, for measuring the representation properties of the display.

16. The system according to claim 12 or 13 or 14 **characterized** in that said camera device is adapted to measure the representation properties of the display.

17. The system according to any of the claims 12 to 16, **characterized** in that the system comprises a database for storing test results and videos containing defects.

18. The system according to any of the claims 12 to 17, **characterized** in that the system comprises a user interface for reporting the test results.

19. A synchronization module for generating a synchronization signal, **characterized** in that the synchronization module comprises
    - means for receiving a measuring signal of the representation properties of a display,
    - a low-pass filter for eliminating an interference signal from said measurement signal,
    - means for generating a synchronization pulse as well as for adjusting it on the basis of the electronic response time.

20. A testing data product comprising a storage means for storing at least a first test image and at least one second test image, **characterized** in that
    - said first test image comprises at least one synchronization area comprising a first identifier, and
    - said one second test image comprises at least one synchronization area in a location corresponding to the synchronization area of said first test image, the synchronization area of said second test image comprising a second identifier,
    - wherein said storage means comprises several test images in such a way that the synchronization area of each test image in question differs from the synchronization area of the preceding test image, and that
    - said first test image and at least one second test image also comprise at least one locating mark for defining an active area.

21. The testing data product according to claim 20, **characterized** in that said first test image and at least one second test image comprise an image identifier for specifying images in a stream of images.

22. A computer software product comprising computer executable instructions for analyzing measurement data obtained from an electronic device, **characterized** in that the measurement data comprises information about the representation properties of the display of the electronic device, wherein the computer executable instructions are adapted to identify the single images of the measurement data and to carry out an image analysis of said measurement data.

23. The computer software product according to claim 22, **characterized** by instructions for determining defects visible to the human eye and for triggering an alarm of them.

24. An analysis system for testing an electronic device for analyzing measurement data obtained from a camera device, **characterized** in that the measurement data comprises information about the representation properties of the display of the electronic device, wherein said analysis system is adapted to identify the single images of the measurement data and to perform an image analysis of said measurement data.

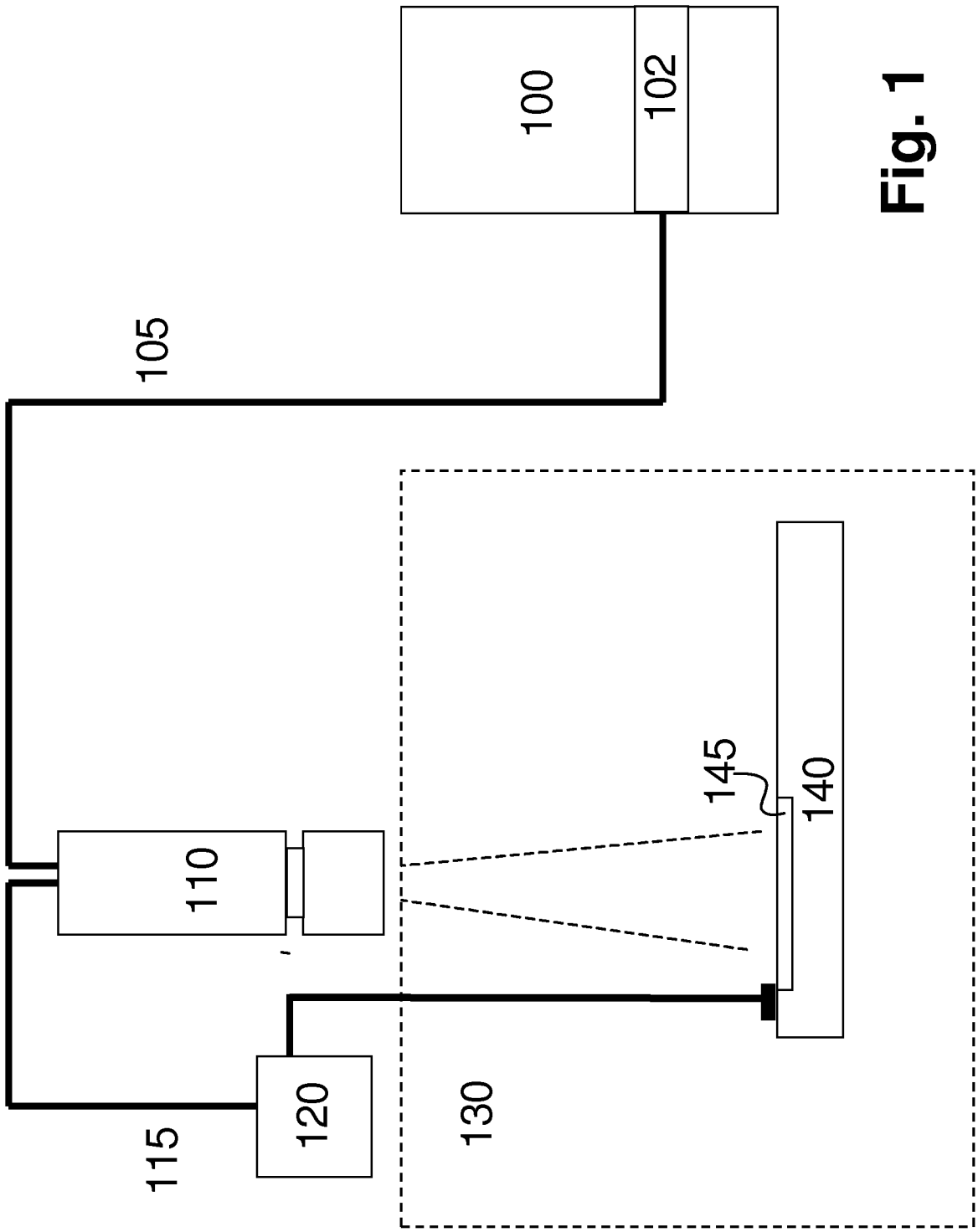


Fig. 1

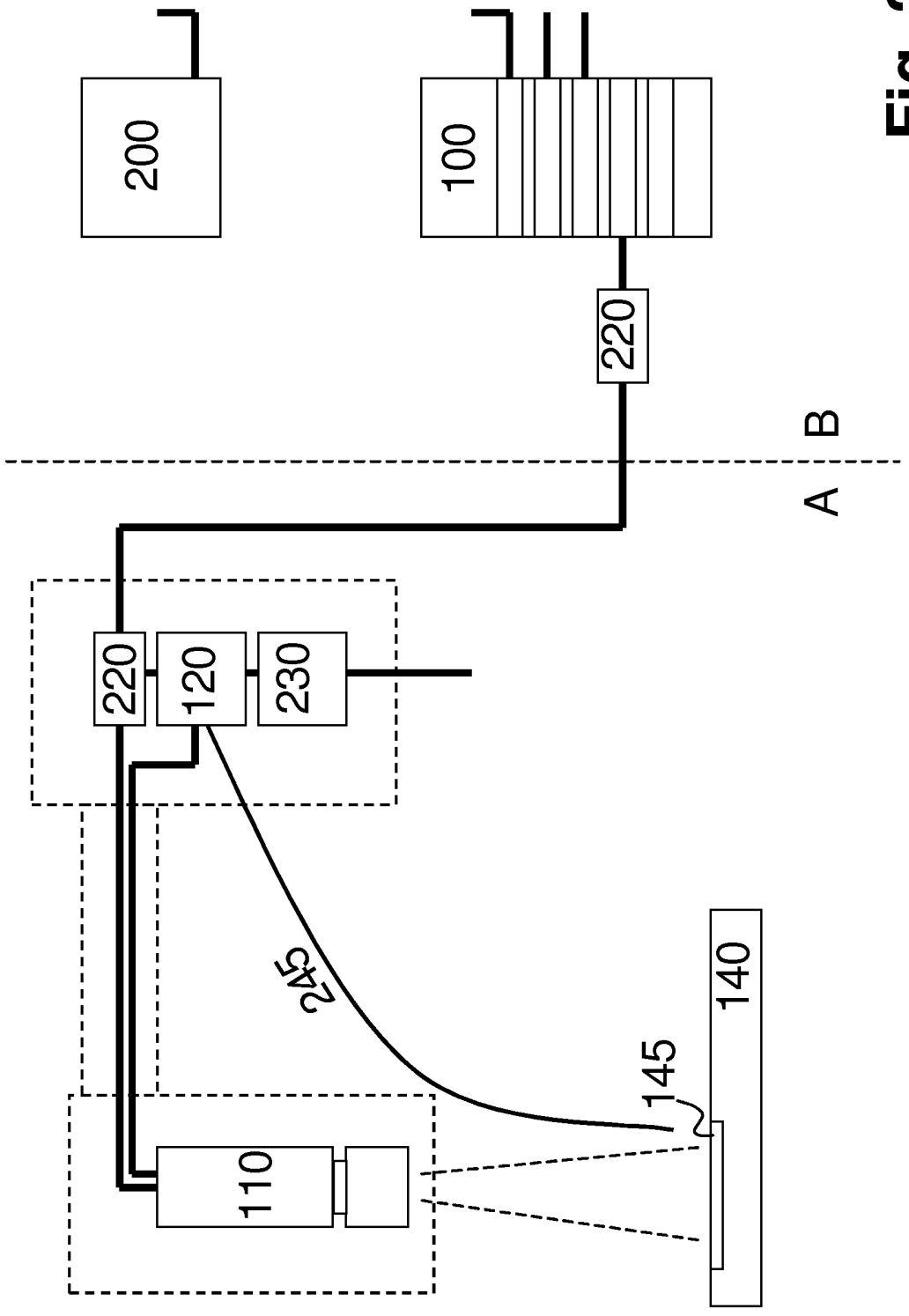


Fig. 2

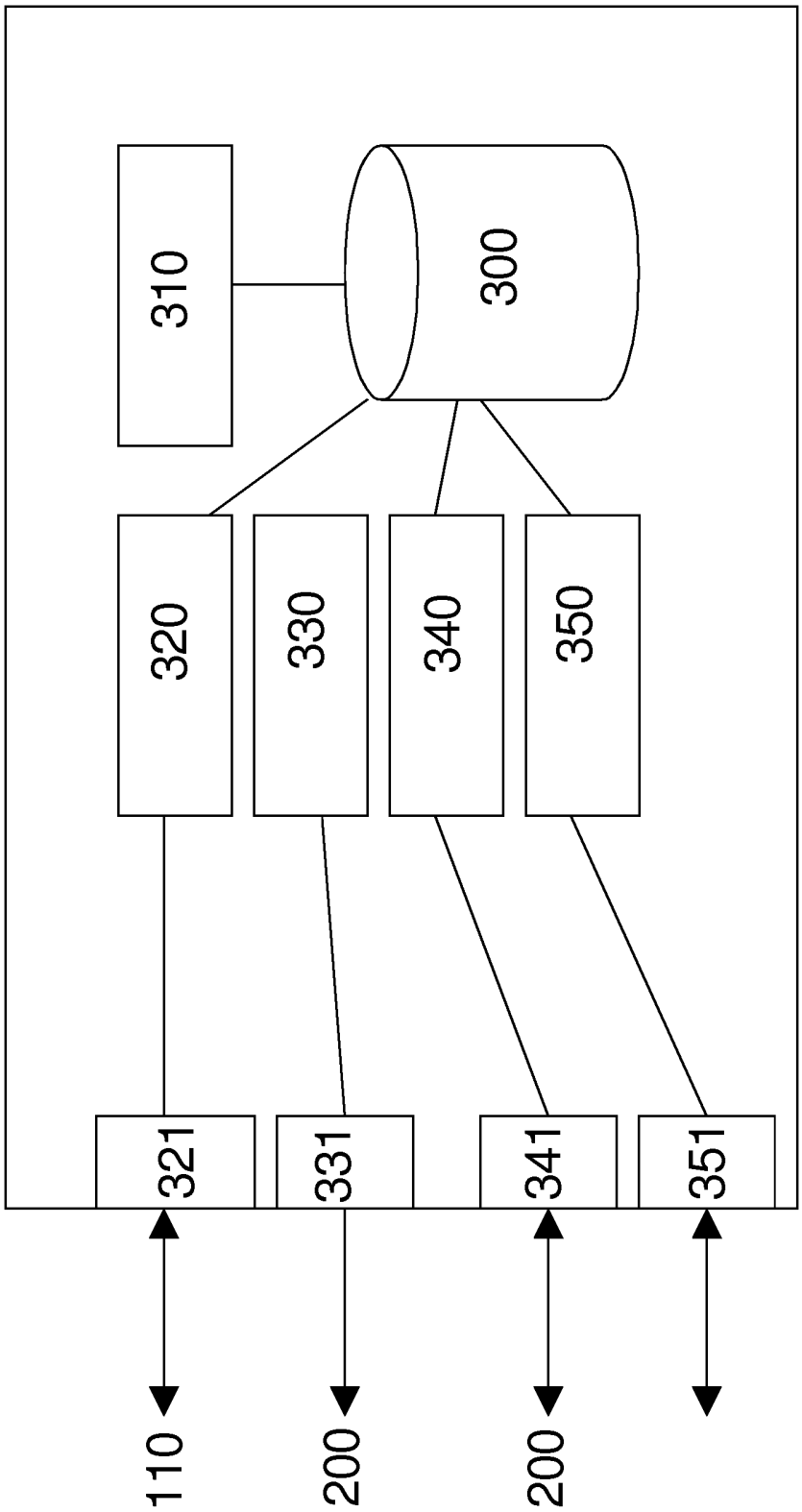


Fig. 3

Fig. 4

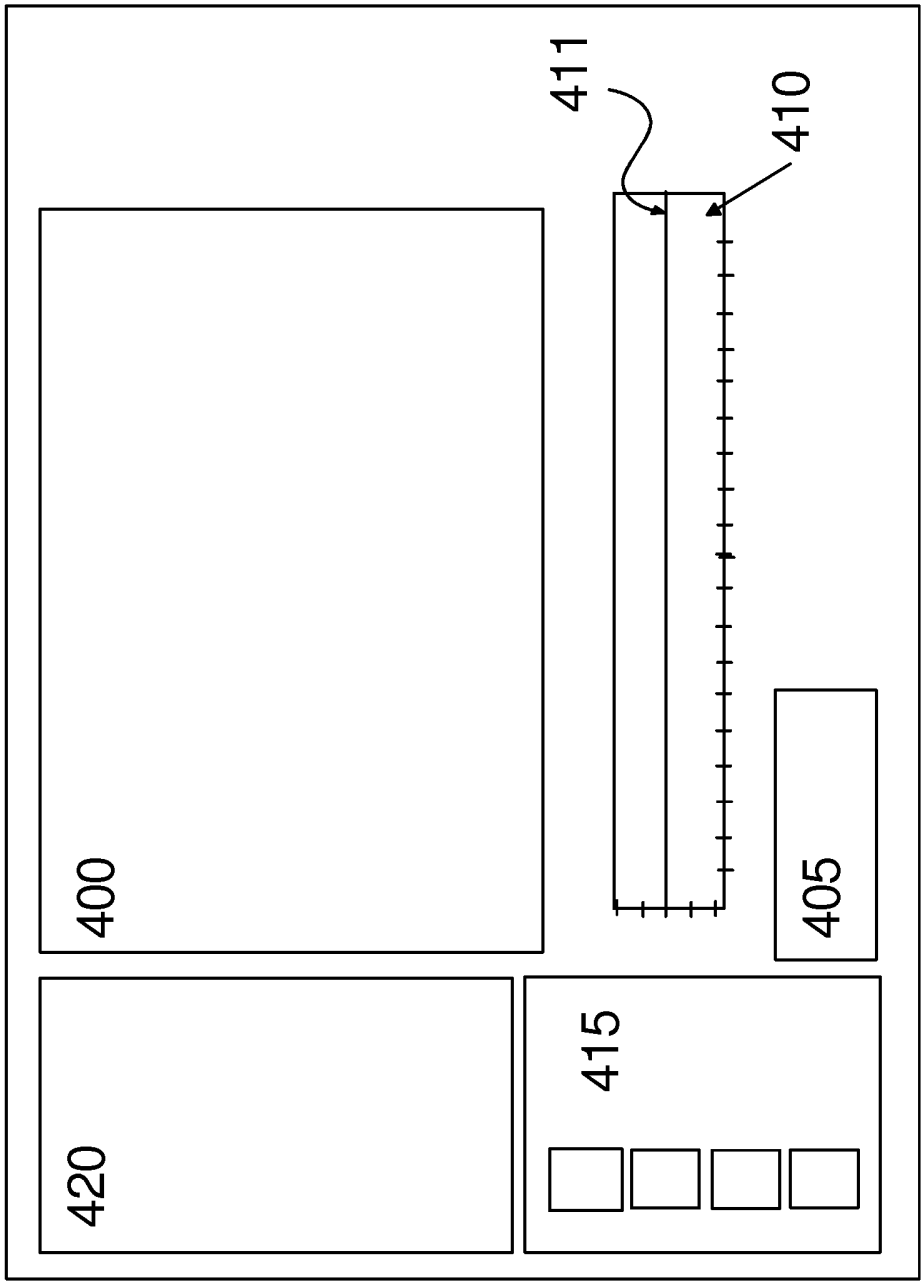


Fig. 5

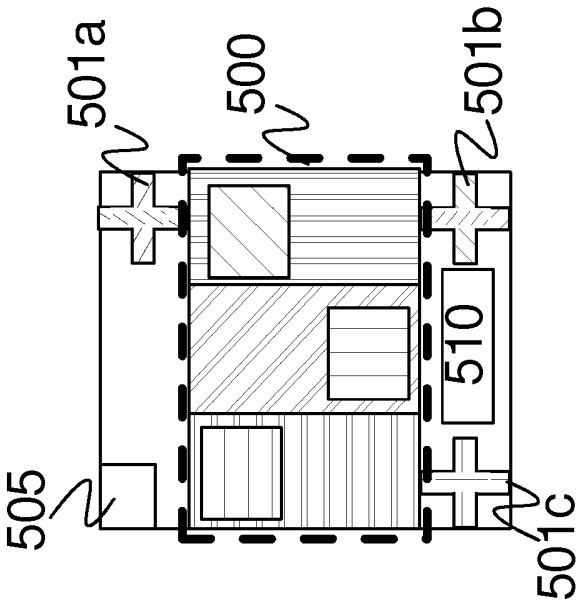
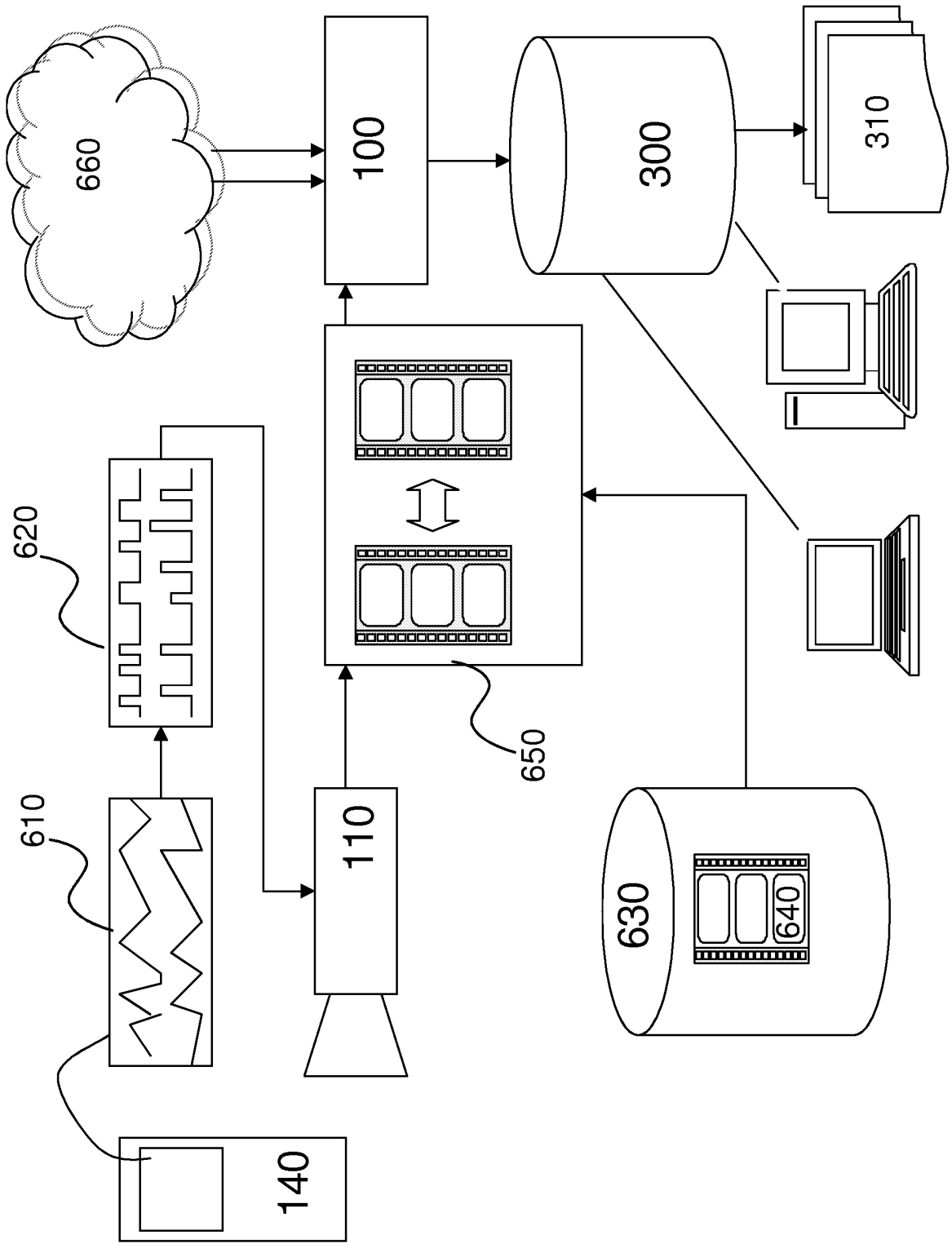


Fig. 6



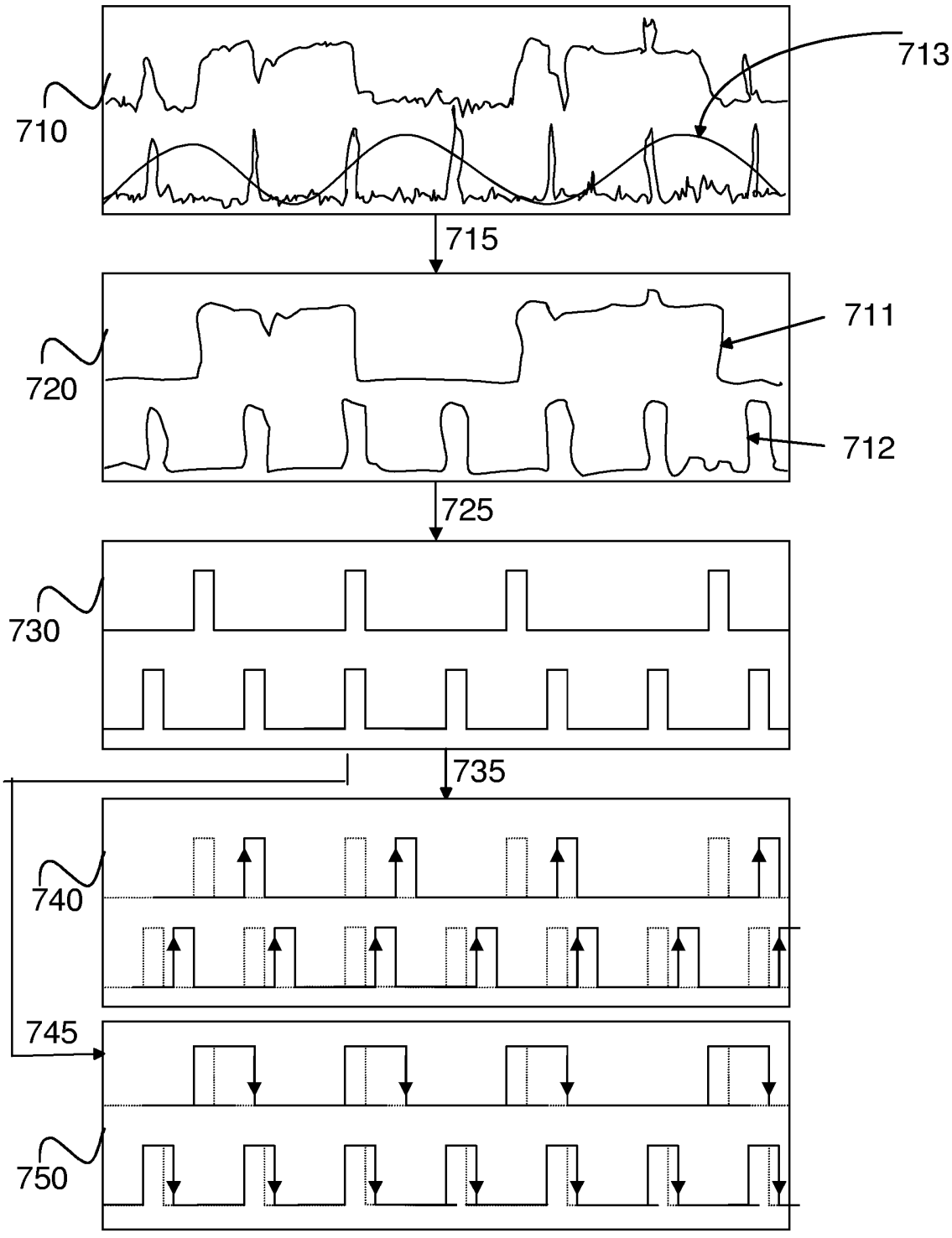


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2005/050304

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 : G09G, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5572444 A (LENTZ LOUIS F et al.) 05 November 1996 (05.11.1996) column 3 line 58 - column 4 line 6, column 7 lines 49-51, column 8 lines 28-67, column 9 lines 20-63, column 12 lines 6-12, column 12 lines 55-63, column 13 line 59 - column 14 line 7, column 16 lines 55-61; claim 6; figures 4E, 14, 17	1, 2, 3, 5, 6, 12, 13, 14, 16, 17, 18, 20, 21, 22, 24
Y		7, 8, 11
Y	EP 1377080 A1 (ROHDE & SCHWARZ) 02 January 2004 (02.01.2004), paragraph [0012]; claims 1, 2, 5 and 6	7, 8
Y	US 2002/0157033 A1 (COX ANDREW) 24 October 2002 (24.10.2002), paragraphs [0001] and [0061]; claims 1 and 9	11
Y	US 5175772 A (KAHN PETER A et al.) 29 December 1992 (29.12.1992), column 2 lines 51-55, column 3 lines 48-58	11
X	US 5032769 A (KAWAKAMI YUICHI) 16 July 1991 (16.07.1991), column 1 line 66 - column 2 line 56, column 4 lines 37-45, column 6 lines 26-34 column 8 lines 24-58, column 9 lines 5-27	19

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search	Date of mailing of the international search report
22 November 2005 (22.11.2005)	07 December 2005 (07.12.2005)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2005/050304

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5122651 A (FURUKAWA HIROSHI et al.) 16 June 1992 (16.06.1992), column 2 lines 18-54, column 11 lines 10-57, column 12 lines 24-59	19

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2005/050304

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
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US 5175772 A	29/12/1992	None	
US 5032769 A	16/07/1991	JP 2174491 A	05/07/1990
US 5122651 A	16/06/1992	JP 3044524 A	26/02/1991

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2005/050304

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
G09G 3/00 (2006.01)
H04N 17/04 (2006.01)