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(54) Title: METHOD AND SYSTEM FOR CONDUCTING IMAGE PROCESSING FROM A MOBILE CLIENT DEVICE
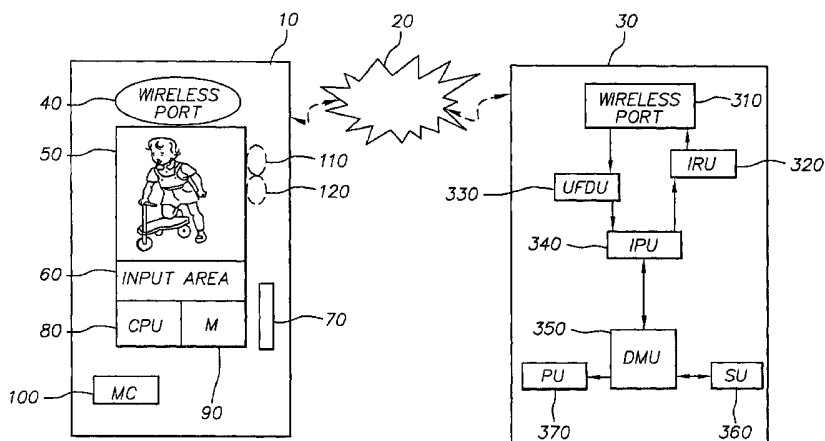
(57) Abstract: An image processing system includes a client device including a limited display having a resolution less than VGA
and a bit depth less than 24 bits for displaying a low resolution digital image and image processing operation indicators, an operator
interface for user input, a CPU and a memory, the CPU being capable of running a limited client image processing program, and
a first communication port; an image processing server for performing an image processing operation on a high definition image
stored at the image processing server, for producing a low resolution version of the image for display on the limited display of the
client device, and for producing image processing operation indicators indicating a particular image processing operation, the image
processing server including a second communication port and being responsive to remote user inputs to produce a processed digital
image; and a limited bandwidth mobile communication network connectable with the first and second communication ports for
transmitting the low resolution image and the image processing operation indicators from the image processing server to the client
device and transmitting remote user inputs from the client device to the image processing server.

METHOD AND SYSTEM FOR CONDUCTING IMAGE PROCESSING FROM A MOBILE CLIENT DEVICE

The present invention is related to image processing, and in

5   particular to the use of a mobile client device with limited display and computing capabilities to conduct the image processing.

The advances in mobile devices such as PDAs (e.g., Palm and Pocket PCs) and cell phones usher in a variety of new mobile computing applications. Given today's hectic lifestyle, people are increasingly attracted to

10   the appeal and benefit of mobile computing – accessing and manipulating your data from anywhere at anytime. From the early killer applications of address book and schedule keeping, mobile computing is rapidly moving into territories unimaginable just a couple of years ago. While laptop computers are becoming closer matches to their desktop counterparts in computing power, their size,

15   weight and power consumption are still a great hindrance to mobile computing – not everyone is willing to carry a laptop around. The computing power of PDAs has reached a point that can enable people to start thinking about more computationally intensive mobile computing tasks such as image processing.

Image processing typically involves high-performance image

20   processing on high definition images. It is, by far, among the most computationally intensive tasks in terms of CPU and memory, even for the most powerful desktop computer systems. A high definition image has at least 1 million pixels. A 1-mega pixel color digital image takes 3 mega bytes to store in the uncompressed format needed for image processing. Counting the intermediate

25   results typically needed to be stored in memory for subsequent processing, the amount of memory and the kind of CPU needed to process such a large amount of data becomes enormous.

The PDAs of today have very limited computing power, limited memory, and limited display capabilities. The CPU is not capable of handling

30   intensive computation, and the total memory on board is typically between 1MB to 32MB. In addition, PDAs have very limited display capabilities, both in terms of screen size and color bit depth. At the low end, a Palm 100 can only display

100 x 100 x 1bit (two colors), and at high end, a SONY Clie can display 320 x
240 x 16bit (64,000 colors), albeit for a very high price that may rival a middle-of-
the-line laptop. Cellular phones are even more limited in terms of computation
power and memory.

5   The solution to the computing power problem seems to lie in
wireless communication, where a server with enormous CPU power and massive
memory and storage can perform the heavy-duty part of the mobile computing. A
client such as a PDA or a cell phone can get away with performing a minimum
portion of the overall computing if it is connected to the server through wireless

10   links. The mobility is preserved and in some aspect improved over using a laptop
computer. At the same time, a mobile device user can take advantage of image
processing software residing on a server in order to obtain a high quality print
from an image that has been subjected to high accuracy and high definition image
processing using dedicated expensive hardware and software in the laboratory.

15   Furthermore, a certain level of user input or feedback can be obtained via
interaction through a mobile device and transmitted to the server to correct errors
made by the software on the server, guaranteeing satisfactory results from image
processing.

           Home printing has also been a challenge due to the limitations on

20   computing hardware and software at home and consumer know-how. After
requesting and previewing image processing on a mobile device, high quality
prints from the high definition images can be ordered via the mobile device and
printed by high-quality, high-throughput printers networked to the image
processing server. The prints can be mailed to the user afterwards.

25   However, due to limited bandwidth of wireless links associated
with mobile devices, as well as the cost for airtime during transmission of
information between the server and the client, significant effort needs to be
devoted to minimizing the amount of such traffic of information (or the amount of
communicated information).

30   Conventional systems for client-server image processing use wired
communication links such as the Internet. US Patent Application 20020019859

by Watanabe, published February 14, 2002, describes a method and system for contents data processing service that transfers contents data from a terminal of an orderer to a processing apparatus of an order receiver via a communication line, processes the transferred contents data in the processing apparatus of the order

5 receiver and transfers processed contents data from the processing apparatus of the order receiver to the terminal of the orderer via the communication line and/or stores and manages the processed contents data in a storage area of a data managing unit that is accessible from at least one of the terminal of the orderer and a terminal of a third party via the communication line. Said contents data is

10 digital image data, said processing performed in said processing apparatus of the order receiver is high definition image processing, and said processed contents data is digital image data that has been subjected to image processing. Said high definition image processing includes at least one of red-eye correction processing, defect erasing processing, dodging processing, lens aberration correction

15 processing, fading correction processing, granulation restraining processing, sharpening processing, gradation correction processing, back light correction processing, RP style finish processing, cloth filter finish processing, soft focus finish processing, monotone finish processing, slender body finish processing, fair complexion finish processing, and under/over correction processing. This system

20 can take advantage of server image processing engines for computers at homes linked to the Internet. However, this system cannot be used for mobile image processing. With this system, all the image processing happens on the server, and there are no limitations in bandwidth and display.

There is, therefore, a need to provide a mobile image processing

25 system that is capable of: (1) minimizing computational load on a mobile device; (2) maximizing the benefit of user feedback from limited input means of a mobile device; (3) minimizing the amount of information needed to be transmitted between the server and a mobile device; and (4) optimizing the rendering of the result of image processing for display on a mobile device.

30 The need is met by the present invention by providing an image processing system that includes a client device including a limited display having

a resolution less than VGA and a bit depth less than 24 bits for displaying a low

resolution digital image and image processing operation indicators, an operator

interface for user input, a CPU and a memory, the CPU being capable of running a

limited client image processing program, and a first communication port ; an

5   image processing server for performing an image processing operation on a high

definition image stored at the image processing server, for producing a low

resolution version of the image for display on the limited display of the client

device, and for producing image processing operation indicators indicating a

particular image processing operation, the image processing server including a

10   second communication port and being responsive to remote user inputs to produce

a processed digital image; and a limited bandwidth mobile communication

network connectable with the first and second communication ports for

transmitting the low resolution image and the image processing operation

indicators from the image processing server to the client device and transmitting

15   remote user inputs from the client device to the image processing server.

        The present invention provides a system that is capable of mobile

image processing by: (1) minimizing computational load on a mobile device; (2)

maximizing the benefit of user feedback from limited input means of a mobile

device; (3) minimizing the amount of information needed to be transmitted

20   between the server and a mobile device; and (4) optimizing the rendering of the

result of image processing for display on a mobile device.

        Fig. 1 is a schematic view showing a preferred embodiment of the

present invention;

        Fig. 2 is a figurative view of an example of a GUI of a mobile

25   device for selecting an image processing operation of the present invention;

        Fig. 3 is a figurative view of an example of a GUI of a mobile

device for previewing an image processing operation of the present invention;

        Fig. 4 is a figurative view of an example of a GUI of a mobile

device for previewing redeye correction of the present invention; and

30   Fig. 5 is a flow chart showing the steps of the method of the

present invention.

Referring to Fig. 1, there is shown a complete end-to-end mobile
image processing system according to a preferred embodiment of the present
invention. This system includes a mobile device 10, a wireless communication
network 20, and an image processing server 30. A typical mobile device 10 can

5   include a wireless communication port 40 for transmitting and receiving
information, a display 50, an operator interface 60 (for example a touch screen, a
keypad or a stylus 70) for collecting user input, a CPU 80 for running a limited
client image processing program, a memory 90 for storing programs (including
the client image processing program) and intermediate data, a memory card 100

10   for expanded memory and data storage, a microphone 110 for voice acquisition
and a digital camera 120 for capturing images.

A mobile device does not necessarily include all of the above
components (for example, a particular cell phone might not have a touch screen
input area or a particular PDA might not have a microphone). In general, a

15   mobile device that fits the above definitions can be a PDA with wireless
capability, a cellular phone, a cellular phone with a digital camera, a hybrid
PDA/cellular phone combination, or a digital camera with wireless capability.

Still referring to Fig. 1, the image processing server 30 is shown in
more detail. A typical image processing server 30 consists of a wireless

20   communication port 310 for transmitting and receiving data, an image rendering
unit 320 for preparing images for optimal display on the limited display of a
mobile device, a user feedback processing unit 330 for interpreting user feedback
and sending control signals to other units, an image processing unit 340 for
performing image processing on high definition images, a database management

25   unit 350 for managing the high definition images stored in a storage unit 360. In
addition, the image processing server may also contain a printing unit 370 for
fulfilling user request of making high quality prints out of either processed or
unprocessed high definition images. The phrases "high definition" and "high
resolution" can be used interchangeably.

30   Still referring to Fig. 1, a limited bandwidth wireless
communication network 20 connects the communication port of the mobile device

10 to that of the image processing server **30**. The entire network may be the commercial wireless network for cellular telephones or it may also include the Internet for relaying information.

5   An image processing operation can be initiated by a user request from a mobile device **10**. Referring to Fig. 2, there is shown a figurative view of an example of a GUI (graphical user interface) of a mobile device for selecting an image processing operation of the present invention. A resized, rendered but unprocessed digital image **410** is received and displayed in the display area **50** of the mobile device **10**. At the same time, an image processing menu **420** is

10   presented to the user. Typically, the menu contains image processing operations such as redeye reduction, image rotation, image cropping, auto fix, text/voice annotation, and image deleting, as shown by the icons at the bottom of the display area in Fig. 2. Auto fix refers to, collectively, brightness adjustment, color adjustment, and contrast adjustment, as in many image processing software

15   packages (e.g., Adobe Photoshop, Microsoft Picture It!). A user can use a stylus **70** to select an icon representing an image processing operation, or speak into a microphone **110** a word corresponding to an icon and the image processing operation it represents, or use the keypad (input area **60**) to select the corresponding image processing operation. For example, a user can request that

20   redeye reduction be performed by selecting the corresponding icon. Furthermore, the user input may include an indication of the general region of the image where the redeye reduction needs to be performed. The request for the selected image processing operation is then sent to the image processing server **30**. High definition images are then processed by the requested image processing operation

25   by the image processing unit **340**.

Referring to Fig. 5, the steps of mobile image processing are shown for a preferred embodiment of the present invention. Assuming that high definition images have been uploaded to the image processing server **30**, the image processing unit **340** first performs **710** image processing on all the high

30   definition images off-line. At the request of a mobile device **10**, the image processing server **30** sends **712** the image, the result of image processing (after

proper resizing and rendering), and an image processing operation indicator to the mobile device. The mobile device then displays 714 the image and the result of image processing. Next, a user provides feedback 716 regarding the result of image processing and the mobile device sends user feedback inputs to the image

5   processing server. Finally, the image processing server 30 revises the image processing 718 in response to the user feedback and generates 720 a final processed high definition image.

Typically, the default image processing operations performed by default on the image processing server may include redeye reduction, automatic

10 image cropping, and auto fix. Again, auto fix refers to brightness adjustment, color adjustment, and contrast adjustment, collectively. Referring now to Fig. 3, there is shown a figurative view of an example of a GUI of a mobile device for previewing the result of an image processing operation of the present invention. Information about the types of image processing operation performed on a high

15 definition image, in the form of an image processing operation indicator, is sent to the client mobile device 10 upon a request for previewing an image, along with a rendered and resized version of the unprocessed high definition digital image.

The version of the unprocessed image 410 is displayed in the display area 50 of the mobile device 10, with image processing indicators 520, in

20 the form of icons, indicating the availability of the result of the automatically performed image processing operation. The user can select what image processing result to preview by using a stylus 70 to tap on an icon corresponding to the image processing operation indicator, or by speaking into a microphone 110 a word corresponding to an icon representing an image processing operation, or

25 using the keypad (input area 60) to select the icon. If an image processing result is requested by a user, a resized, rendered version of the processed high definition digital image 510 is transmitted and displayed in the display 50 of the mobile device 10. Note that an image processing operation does not necessarily always have any effect, i.e. generating a new image. For example, redeye correction

30 would have no effect on an image if no red eyes are present or detected. Only if

the result of the image processing is different from the original, a corresponding icon will be shown.

Also the effect of image processing operation may not show on the mobile device limited display, therefore rendering may be performed to boost

5   image change perception on the target display: increased contrast, stretched color balance, increased magnification, and so on.

One particularly valuable image processing operation is redeye reduction. US 6,292,574 issued September 18, 2001 to Schildkraut et al., describes a computer program product for detecting eye color defects of a subject

10   in an image due to flash illumination comprises: a computer readable storage medium having a computer program stored thereon for performing the steps of detecting skin colored regions in a digital image; searching the skin colored regions for groups of pixels with color characteristic of redeye defect; and correcting color of the pixels based on a location of redeye defect found. Such a

15   computer program is computationally intensive and should only be run on an image processing server with high computing power and large memory. However, the automatic redeye reduction program can make mistakes, including false alarms (e.g., red light bulbs on a Christmas tree) and misses (e.g., missing objectionable red eyes). Therefore, there is a need for user previewing in order to

20   reject or correct such mistakes.

Fig. 4 is a figurative view of an example of a GUI of a mobile device for previewing redeye reduction of the present invention. Because redeye is localized in a human face, it makes sense to only display an area around the face that has red eyes. Therefore, upon the user request for previewing, a

25   zoomed-in or magnified area of the processed digital image is rendered by the image processing server 30 and sent to the mobile device 10. This zoomed processed image 610 is presented to the user in the display area 50 of the mobile device. At the same time, a user feedback/correction menu 620 is also presented. A user can choose to "reject" a false alarm correction, or "accept" a satisfactory

30   correction, or even "correct" the location of "left eye" or "right eye". If a correction action is selected, a cross-hair is shown to indicate the automatically

determined redeye location and a user can use the stylus **70** or the keypad (input area **60**) to move the cross-hair in order to revise the redeye location.

The function of the image processing program on the client device can be limited to what is minimally needed for the main purpose of facilitating user input and feedback. Typically, a client image processing program should be capable of displaying a low-resolution image (which may have been rendered in advance on the image processing server), rotating a low-resolution image, indicating user feedback (e.g., indicating which icon is selected by user input, adding a cross-hair for user correction of redeye location), etc. For more capable client devices, part of the image rendering operations, e.g., color quantization and error diffusion, can be shifted from the image processing server **30** to the mobile device **10**.

CLAIMS:

    1. An image processing system comprising:

    (a) a client device including a limited display having a resolution less than VGA and a bit depth less than 24 bits for displaying a low resolution digital image and image processing operation indicators , an operator interface for user input, a CPU and a memory, the CPU being capable of running a limited client image processing program, and a first communication port;

    (b) an image processing server for performing an image processing operation on a high definition image stored at the image processing server, for producing a low resolution version of the image for display on the limited display of the client device, and for producing image processing operation indicators indicating a particular image processing operation, the image processing server including a second communication port and being responsive to remote user inputs to produce a processed digital image; and

    (c) a limited bandwidth mobile communication network connectable with the first and second communication ports for transmitting the low resolution image and the image processing operation indicators from the image processing server to the client device and transmitting remote user inputs from the client device to the image processing server.

    2. A method of conducting image processing from a client device having a limited display and limited image processing power, comprising the steps of:

    (a) providing a client device including a limited display having a resolution less than VGA and a bit depth less than 24 bits for displaying a low resolution digital image and image processing operation indicators, an operator interface for user input, a CPU and a memory, the CPU being capable of running a limited client image processing application, and a first communication port;

    (b) providing an image processing server for performing an image processing operation on a high resolution image stored at the image processing

server, for producing a low resolution version of the image for display on the limited display of the client device, and for producing image processing operation indicators indicating a particular image processing operation, the image processing server including a second communication port and being responsive to remote user inputs to produce a processed digital image;

(c) producing a low resolution version of the image, a processed high resolution digital image, and a low-resolution preview image representing the effect of the image processing operation in the image processing server;

(d) transmitting the low resolution version of the image along with image processing operation indicators to the client device over a limited bandwidth mobile communication network and displaying the low resolution version of the image and the image processing operation indicators on the client device;

(e) using the displayed image processing operation indicators and the operator interface to request a preview image and transmitting the preview image to the client device;

(f) displaying the preview image on the display of the client device;

(g) using the operator interface to obtain user feedback and transmitting the user feedback to the client device; and

(h) producing a final processed high resolution image on the image processing server in response to the user feedback.

3. The method claimed in claim 31, wherein the image processing operation is redeye reduction and the preview image is an enlarged portion of the image where redeye reduction was performed, with a graphic element in the image indicating the location of redeye reduction.

4. The method claimed in claim 31, wherein the user input includes an indication of a correction to the region of the image where the redeye   - reduction should be performed.

-12-

5. The method claimed in claim 31, wherein the image processing operation is auto fix (color, brightness, and contrast adjustment) and the preview image is a low resolution version of the auto fixed image.
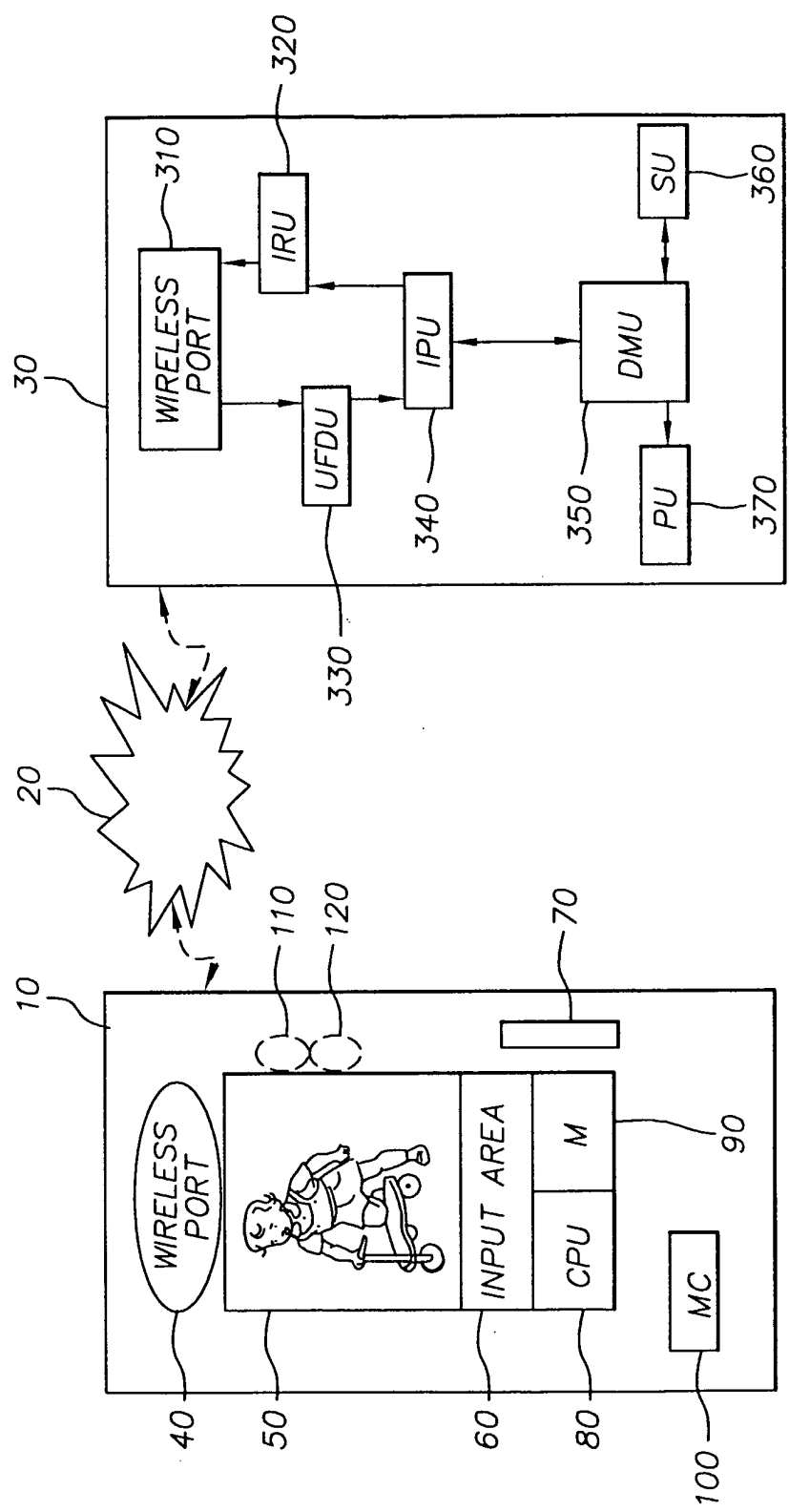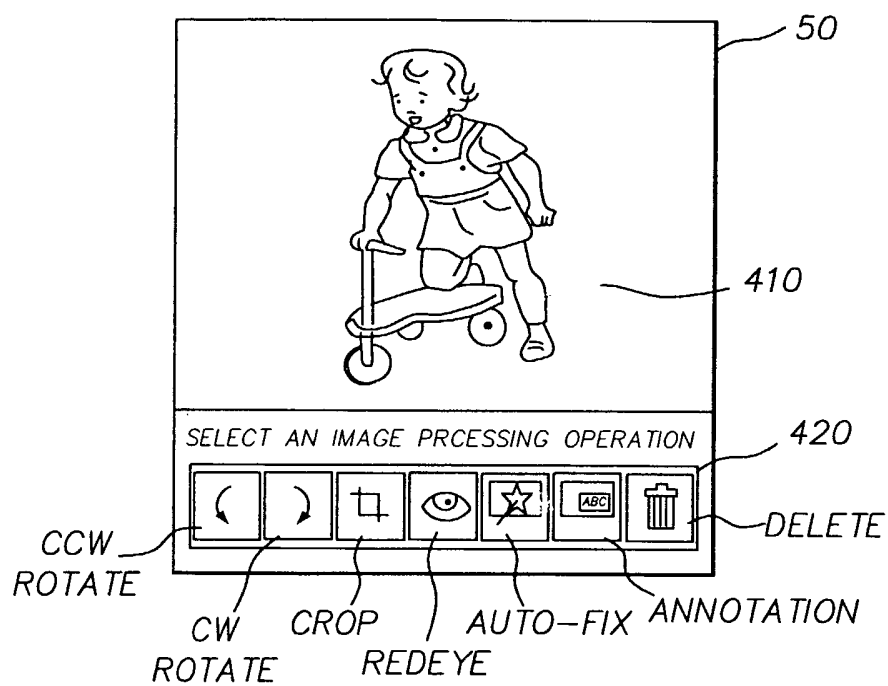
FIG. 1

FIG. 2
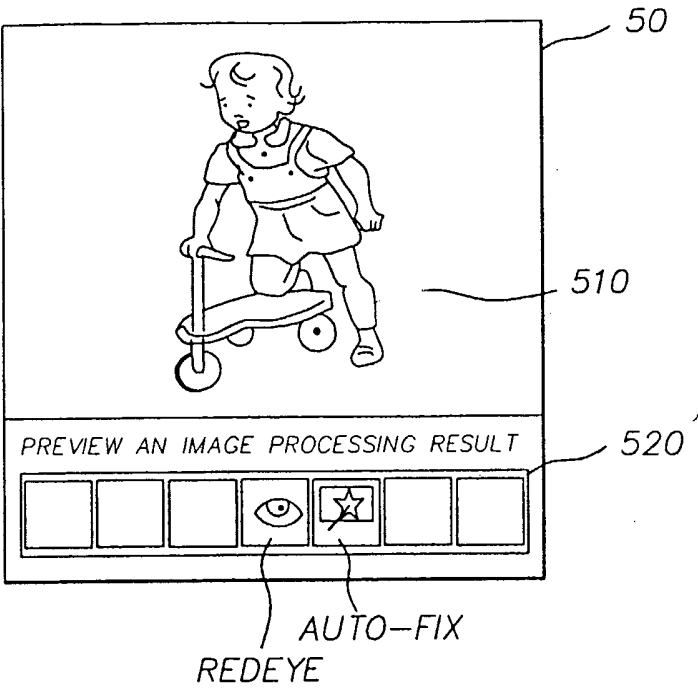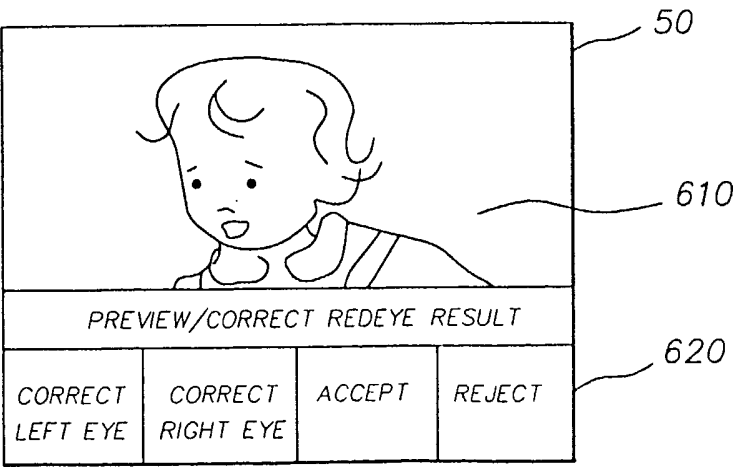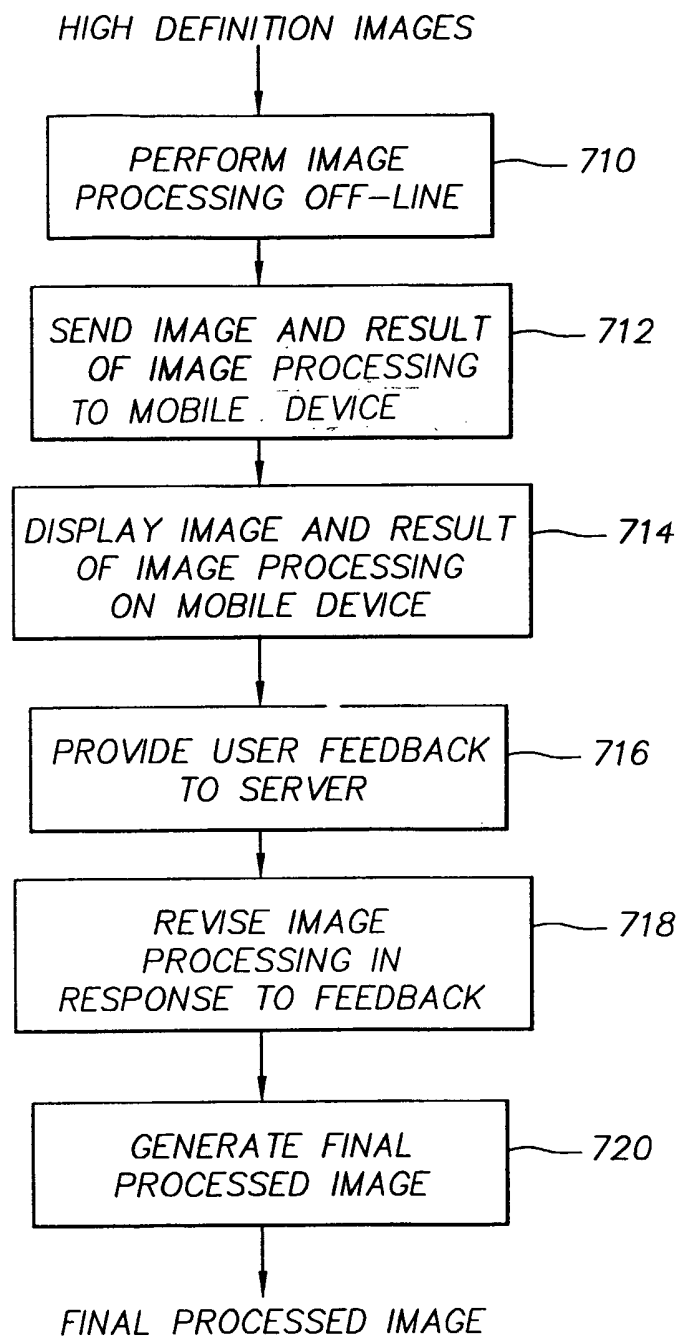
PREVIEW AN IMAGE PROCESSING RESULT

REDEYE   AUTO-FIX

FIG. 3

PREVIEW/CORRECT REDEYE RESULT

CORRECT LEFT EYE	CORRECT RIGHT EYE	ACCEPT	REJECT

FIG. 4

HIGH DEFINITION IMAGES

| PERFORM IMAGE PROCESSING OFF—LINE | — 710 |

| SEND IMAGE AND RESULT OF IMAGE PROCESSING TO MOBILE DEVICE | — 712 |

| DISPLAY IMAGE AND RESULT OF IMAGE PROCESSING ON MOBILE DEVICE | — 714 |

| PROVIDE USER FEEDBACK TO SERVER | — 716 |

| REVISE IMAGE PROCESSING IN RESPONSE TO FEEDBACK | — 718 |

| GENERATE FINAL PROCESSED IMAGE | — 720 |

FINAL PROCESSED IMAGE

FIG. 5

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04N1/00

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)
IPC 7   H04N   G06T

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

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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-/--

[X]	Further documents are listed in the continuation of box C.	[X]	Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2004	25/03/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Hazel, J

INTERNATIONAL SEARCH REPORT

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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