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(54) Title: ENHANCED READABILITY WITH FLOWED BITMAPS

302 — OBTAIN IMAGE IN DIGITIZED FORM

304 — IMAGE CLEANUP

306 — LINES OF TEXT DISTINGUISHED

308 — INDIVIDUAL CHARACTERS DISTINGUISHED

310 — WORDS DISTINGUISHED

312 — ITEMS THAT ARE NOT WORDS OR CHARACTERS DISTINGUISHED

314 — SELECT DISPLAY SIZE

316 — REFLOW THE TEXT/IMAGES

(57) Abstract: A system and method of displaying
content on a computer screen, wherein text (or
other content) is formatted as multiple bitmaps, for
example, each bitmap corresponding to a word. The
bitmaps are resized so that they can be easily seen
by someone with impaired vision, for example. If the
resizing of the text causes some of it to extend beyond
the horizontal boundaries of the display, the text is
automatically wrapped to the next line.

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ENHANCED READABILITY WITH FLOWED BITMAPS

BACKGROUND OF THE INVENTION

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1. Technical Field:

The present invention is directed to a system and method for aiding the visually impaired in reading.

10 ### 2. Description of Related Art:

Many people lack perfect vision. There are many tools and technologies designed to help the visually impaired read displayed text, such as that on a computer screen. Traditional methods include Optical Character Recognition (OCR) and simple

15 scan-and-magnify (SAM) systems.

OCR (optical character recognition) is the recognition of printed or written text characters by a computer. Though there are different methods of implementing OCR, the process generally involves photoscanning of the text or image,

20 analyzing the scanned image, and then translating the character image into character codes, such as ASCII, commonly used in data processing.

In OCR processing, the scanned-in image or bitmap is analyzed for light and dark areas in order to identify each

25 alphabetic letter or numeric digit. When a character is recognized, it is converted into an ASCII code. Special circuit boards and computer chips designed expressly for OCR are used to speed up the recognition process. This recognition process is computationally

30 expensive, since various fonts or scripts can make matching characters difficult, especially if the font is new or atypical

Existing systems for aiding the visually impaired have several disadvantages. In conventional SAM systems, once a

35 page is magnified larger than the final display area, the user must slide the image back and forth to see all of each

line, a tedious, hands on and disorienting process. Some tools use formats such as HTML that permit resizing the font and reflowing the page as necessary to fit the display area. However, not all formats allow reflowing, and not all display

5   programs are capable of performing reflowing or allowing resizing by a user. For example, in a typical Internet browser, HTML text can be reflowed. However, if the text displayed on the browser is part of a .gif, .jpg, or .pdf file, for example, the browser is unable to reflow the text.

10   Furthermore, in OCR systems, problems arise because of poor character recognition and inability to handle diverse fonts and languages.

Therefore, there is a need in the art for an improved system and method of displaying text in electronic media.

SUMMARY OF THE INVENTION

The present invention creates a tool that takes images
(scanned, video captured, screen captured, etc.) and applies
several OCR-like functions to them to define and extract
bitmaps of text. A bitmap is a general term referring to any
representation of a graphics image in computer memory. In one
example embodiment, a text page is scanned and mapped. The
text on a page is broken into word sized images, and these
images are magnified and then reflowed, for example, to fit
the display device.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the
5 invention are set forth in the appended claims. The invention
itself, however, as well as a preferred mode of use, further
objectives and advantages thereof, will best be understood by
reference to the following detailed description of an
illustrative embodiment when read in conjunction with the
10 accompanying drawings, wherein:

Figure 1 shows a representation of a computer system
consistent with a preferred embodiment.

Figure 2 shows a block diagram of relevant parts of a
computer system capable of implementing the present invention.

15   **Figure 3** shows a flowchart of the process steps in a
preferred embodiment.

Figure 4A shows a computer screen before implementation of
the present invention.

Figure 4B shows a computer screen displaying magnified
20 text without benefit of the present invention.

Figure 4C shows a computer screen displaying text
consistent with a preferred embodiment of the present
invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present innovations are described with reference to
5 the figures. To provide context, a sample computer system is
described consistent with implementing a preferred embodiment
of the present innovations.

With reference now to the figures and in particular with
reference to **FIG. 1**, a pictorial representation of a data
10 processing system in which the present invention may be
implemented is depicted in accordance with a preferred
embodiment of the present invention. A computer **100** is
depicted which includes a system unit **110**, a video display
terminal **102**, a keyboard **104**, storage devices **108**, which may
15 include floppy drives and other types of permanent and
removable storage media, and mouse **106**. Additional input
devices may be included with personal computer **100**, such as,
for example, a joystick, touchpad, touch screen, trackball,
microphone, and the like. Computer **100** can be implemented
20 using any suitable computer, such as an IBM RS/6000 computer
or IntelliStation computer, which are products of
International Business Machines Corporation, located in
Armonk, New York. Although the depicted representation shows a
computer, other embodiments of the present invention may be
25 implemented in other types of data processing systems, such as
a network computer. Computer **100** also preferably includes a
graphical user interface that may be implemented by means of
systems software
residing in computer readable media in operation within
30 computer **100**.

With reference now to **FIG. 2**, a block diagram of a data
processing system is shown in which the present invention may
be implemented. Data processing system **200** is an example of a
computer, such as computer **100** in **FIG. 1**, in which code or
35 instructions implementing the processes of the

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present invention may be located. Data processing system **200**
employs a peripheral component interconnect (PCI) local bus
architecture. Although the depicted example employs a PCI
bus, other bus architectures such as Accelerated Graphics Port

5   (AGP) and Industry Standard Architecture (ISA) may be used.
Processor **202** and main memory **204** are connected to PCI local
bus **206** through PCI bridge **208**. PCI bridge **208** also may
include an integrated memory controller and cache memory for
processor **202**. Additional connections to PCI local bus **206**

10 may be made through direct component interconnection or
through add-in boards. In the depicted example, local area
network (LAN) adapter **210**, small computer system interface
SCSI host bus adapter **212**, and expansion bus interface **214** are
connected to PCI local bus **206** by direct component connection.

15 In contrast, audio adapter **216**, graphics adapter **218**, and
audio/video adapter **219** are connected to PCI local bus **206** by
add-in boards inserted into expansion slots. Expansion bus
interface **214** provides a connection for a keyboard and mouse
adapter **220**, modem **222**, and additional memory **224**. SCSI host

20 bus adapter **212** provides a connection for hard disk drive **226**,
tape drive **228**, and CD-ROM drive **230**. Typical PCI local
bus implementations will support three or four PCI expansion
slots or add-in connectors.

         An operating system runs on processor **202** and is used to
25 coordinate and provide control of various components within
data processing system **200** in **FIG. 2**. The operating system
may be a commercially available operating system such as
Windows 2000, which is available from Microsoft Corporation.
An object oriented programming system such as Java may run in

30 conjunction with the operating system and provides calls to
the operating system from Java programs or applications
executing on data processing system **200**. "Java" is a
trademark of Sun Microsystems, Inc. Instructions for the
operating system, the object-oriented programming system, and

35 applications or programs are located on storage devices, such

as hard disk drive **226**, and may be loaded into main memory **204**
for execution by processor **202.**

Those of ordinary skill in the art will appreciate that
the hardware in **FIG. 2** may vary depending on the

5   implementation. Other internal hardware or peripheral
devices, such as flash ROM (or equivalent nonvolatile memory)
or optical disk drives and the like, may be used in addition
to or in place of the hardware depicted in **FIG. 2.** Also, the
processes of the present invention may be applied to a

10 multiprocessor data processing system.

For example, data processing system **200**, if optionally
configured as a network computer, may not include SCSI host
bus adapter **212**, hard disk drive **226**, tape drive **228**, and
CD-ROM **230**, as noted by dotted line **232** in **FIG. 2** denoting

15 optional inclusion. In that case,
the computer, to be properly called a client computer, must
include some type of network communication interface, such as
LAN adapter **210**, modem **222**, or the like. As another example,
data processing system **200** may be a stand-alone system

20 configured to be bootable without relying on some type of
network communication interface, whether or not data
processing system **200** comprises some type of network
communication interface. As a further example, data
processing system **200** may be a personal digital assistant

25 (PDA), which is configured with ROM and/or flash ROM to
provide non-volatile memory for storing operating system files
and/or user-generated data.

The depicted example in **FIG. 2** and above-described
examples are not meant to imply architectural limitations. For

30 example, data processing system **200** also may be a notebook
computer or hand held computer in addition to taking the form
of a PDA. Data processing system **200** also may be a kiosk or a
Web appliance.

The processes of the present invention are performed by

35 processor **202** using computer implemented instructions, which

may be located in a memory such as, for example, main memory
204, memory **224**, or in one or more peripheral devices **226-230**.

In one preferred embodiment, the present innovations are
implemented as part of an Internet browser or other program
5   capable of displaying images to a user. **FIG. 3** shows a
flowchart for implementing the process steps for a preferred
embodiment. First, the image or document which the user
desires to display is digitized, if it is
not already in digitized form (**step 302**). This step is to
10 create a bitmap of the document or "image." In this context,
the term "image" refers to displayed information, including
but not limited to text, graphics or pictures, or a
combination of the two. Such a bitmap can be created, for
example, by photoscanning of the image or by capturing a
15 screenshot of the image. Alternately, the contents of the file
could be rendered to disk. Regardless of the method used, the
content to be displayed to the user is captured as a bitmap.

In some embodiments, after a bitmap of the document or
image is obtained, some clean up steps are performed (step
20 **304**). For example, contrast processing and/or realignment of
text may be performed. It should be noted that cleaning up the
image is not necessary for practice of the present invention,
since individual characters are not necessarily identified as
what they are.

25 Next, in the case of text, the different lines of text
are distinguished by the program (**step 306**). Individual
characters are then distinguished (though preferably not
identified, *i.e.*, OCR is not yet applied) (**step 308**). (It
should be noted that the term "distinguish" as used herein
30 refers to merely telling where one item ends and another
begins, or telling where the boundary of one object or
character or word ends and another's begins, while the term
"identify" is meant to refer to actual identification of a
character, *i.e.*, matching it to a known character. Hence,
35 lines of text and words and even characters may be

Alternately, the contents of the file could be rendered to disk. Regardless of the method used, the content to be displayed to the user is captured as a bitmap.

In some embodiments, after a bitmap of the document or image is obtained, some clean up steps are performed (**step 304**). For example, contrast processing and/or realignment of text may be performed. It should be noted that cleaning up the image is not necessary for practice of the present invention, since individual characters are not necessarily identified as what they are.

Next, in the case of text, the different lines of text are distinguished by the program (**step 306**). Individual characters are then distinguished (though preferably not identified, *i.e.*, OCR is not yet applied) (**step 308**). (It should be noted that the term "distinguish" as used herein refers to merely telling where one item ends and another begins, or telling where the boundary of one object or character or word ends and another's begins, while the term "identify" is meant to refer to actual identification of a character, *i.e.*, matching it to a known character. Hence, lines of text and words and even characters may be "distinguished" but not "identified." If a word were distinguished but not identified, the beginning and end of the word would be known, but not the meaning or spelling or other content of the word.)

After characters are distinguished, groupings of
characters that form words are distinguished (**step 310**
). Once words are distinguished, items that are neither
words nor characters are distinguished, such as
graphics images (**step 312**). Note that individual
characters need not be matched or identified in the
preceding steps. Note also that the innovative system
could also simply seek out spaces consistent with
spacing between words to distinguish individual words,
or to define "word areas," or areas of the document
corresponding to a single word, or even groups of
words.

After individual words have been distinguished,
the preferred display size of the content is indicated,
preferably by a user of the innovative system (**step 314**
). This can be implemented in many ways. For example,
in a browser display, the individual words can be
formatted as image files such as .gif or .jpg. These
image files can be resized by a browser by using HTML
image tags. For example, a typical image tag can
include a note indicating the display size:

<img src=word001.gif width=50>

In this example, the individual word has been made into
a .gif file named "word001.gif." The displayed width of
this individual image is indicated by the tag
"width=50"
which means the image (i.e., the word) will be 50
pixels wide.

"distinguished" but not "identified." If a word were
distinguished but not
identified, the beginning and end of the word would be known,
but not the meaning or spelling or other content of the word.)

5   After characters are distinguished, groupings of
characters that form words are distinguished (**step 310**). Once
words are distinguished, items that are neither words nor
characters are distinguished, such as graphics images (**step
312**). Note that individual characters need not be matched or
10 identified in the preceding steps. Note also that the
innovative system could also simply seek out spaces consistent
with spacing between words to distinguish individual words, or
to define "word areas," or areas of the document corresponding
to a single word, or even groups of words.
15   After individual words have been distinguished, the
preferred display size of the content is indicated, preferably
by a user of the innovative system (**step 314**). This can be
implemented in many ways. For example, in a browser display,
the individual words can be formatted as image files such as
20 .gif or .jpg. These image files can be resized by a browser by
using HTML image tags. For example, a typical image tag can
include a note indicating the display size:

                <img src=word001.gif width=50>

25

In this example, the individual word has been made into a .gif
file named "word001.gif." The displayed width of this
individual image is indicated by the tag "width=50"
which means the image (i.e., the word) will be 50 pixels wide.
30   Consistent with this example implementation, the size of
the individual word image "word001.gif" can be enlarged by
altering the "width" tag to a larger number.Alternately, the
images could be magnified before they are broken into
individual images. For example, the image of each word could
35 be enlarged using known software that expands an image. The

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enlarged individual word images can then be arranged on the
page to fit the width of the viewable are of the display.

Some images are scanned at higher resolution than that at
which they are displayed. Such an image could be subdivided
5   into words and those individual words, instead of being
magnified, would be demagnified before being displayed, or
could be displayed at their original size if appropriate.
Another alternative includes magnifying the entire image to
the desired magnification before parsing it into individual
10 words, then parsing and reflowing the document at the
preferred magnification.

After magnification, the image is reflowed (**step 316**)
according to the preferred display size and the available
display area. This step preferably comprises situating the
15 individual images/words into lines of text such that a single
line of text spans no more than the available display area.
Reflowing is preferably done at the level of individual words,
which were distinguished previously in the process. The words
are preferably reflowed according to their new size such that
20 the text only spans the available display area and does not go
beyond. Hence, after resizing and reflowing, a line of text
would begin at one side of the display area, and when the
words displayed on that line reach the other side of the
display area, the next word is wrapped to the next line
25 automatically. This prevents the user from having to scroll
across to read the entire line of text.

FIGs. 4A-C show potential arrangements for text on a
page. In **FIG. 4A**, the sentence is in a small font, and the
entire sentence fits the viewable display area **400**. In a
30 preferred embodiment, the sentence is parsed and each word **402**
is separated and made into an individual bitmap. Any format
for the bitmap is consistent with the present innovations.

In **FIG. 4B** the text has been enlarged according to
typical OCR or SAM systems. The sentence runs off the viewable
35 display area **400** so that a user who wishes to view all the

text must use the scroll bar **404** to scan the entire page
width.

In **FIG. 4C** the present innovations are employed. The
individual words **402** have been arranged so they wrap to the
next line when there is no more viewable area **400** to the
display.

One embodiment of the present innovations is implemented
as part of a browser program. The innovative aspects can be
implemented as part of the browser program itself, or as a
separate program working in combination with the browser
program. In either case, the text or images displayed by the
browser can be resized and reflowed according to the commands
of the user. Reflowing is implemented (in this example) by
creating graphics images of the individual words (for example,
as described
in the process of **FIG. 3**), and reflowing the images using
autogenerated HTML coding and the "width" tag.

The present innovative concepts can also be implemented
as a stand-alone computer program capable of working in
combination with a non-browser program, such as Adobe's
Acrobat Reader™, for example.

It should be noted that the present invention avoids many
of the disadvantages of existing OCR systems. First, the text
of a page can be displayed in enlarged or magnified form while
the words are wrapped to the area available for display. The
present innovations also avoid the need for converting an
image imperfectly into text and then converting the text back
into magnified characters. The present invention also allows
virtually any printed document to be viewable as a single
top-to-bottom document of any size, with words wrapped to the
width of whatever area is available for display.

Another advantage of the present invention stems from the
fact that at no point is the individual character matched to a
particular known character. For example, in OCR systems, when
the program detects the image of an individual letter, the
image must be compared to known letters until a match is

found. This complicates OCR systems and makes them less
effective for recognizing text of documents in new or unknown
fonts or languages. The present invention, since it only
parses the text into words but need not necessarily recognize
5   the individual characters of the words, can be used to enlarge
the displayed text of various language.

The present invention can therefore be used to reflow
languages of different fonts or scripts, languages not
amenable to character recognition (such as handwritten text or
10 script), and languages with different primary and secondary
directions. In the context of the present invention, the
primary direction of text flow in an English language document
would be left to right. The secondary direction would be from
top to bottom. In other languages, the primary flow direction
15 may be right to left (as in some Arabic writing) or top to
bottom (as in Japanese writing). Secondary directions can
change as well, and are not limited by the present inventive
concept. The present invention can also be used to enlarge and
reposition non-text symbols or pictures.
20   Likewise, the primary boundaries of an English text
document are the left and right margins, while the secondary
boundaries are the top and bottom margins, corresponding to
the primary and secondary directions described above.

It is important to note that while the present invention
25 has been described in the context of a fully functioning data
processing system, those of ordinary skill in the art will
appreciate that the processes of the present invention are
capable of being distributed in the form of a computer
readable medium of instructions and a variety of forms and
30 that the present invention applies equally regardless of the
particular type of signal bearing media actually used to carry
out the distribution. Examples of computer readable media
include recordable-type media such a floppy disc, a hard disk
drive, a RAM, and CD-ROMs and transmission-type media such as
35 digital and analog communications links.

The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be
5   apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various
10 modifications as are suited to the particular use contemplated.

CLAIMS:

1.   A method for displaying text in a viewable area of a display device, comprising the steps of:

determining breaks between words of the text;

creating individual bitmaps of at least some of the individual words;

displaying the bitmaps within the primary boundaries of the viewable area of the display device.

2.   The method of Claim 1, wherein the bitmaps are enlarged before they are displayed.

3.   The method of Claim 1, wherein the bitmaps are reduced in size before they are displayed.

4.   The method of Claim 1, wherein the step of displaying the bitmaps within the primary boundaries of the viewable area of the display device is performed by wrapping some of the bitmaps to a new line when the width of the displayed bitmaps would be greater than the width of the viewable area of the display device.

5.   The method of Claim 1, wherein the primary boundaries are the left and right edges of the viewable display area.

6.   A method of displaying information on a display device, comprising the steps of:

defining and extracting a plurality of bitmaps from a document;

controlling magnification of the bitmaps; and

reflowing the bitmaps.

7.   The method of Claim 6, wherein at least some of the bitmaps comprise individual words of text.

8.   The method of Claim 6, wherein at least some of the bitmaps comprise symbols.

9.   The method of Claim 6, wherein the magnification of the bitmaps is controlled by a user.

10.   The method of Claim 6, wherein the magnification of the bitmaps is stored as a user preference.

11.   The method of Claim 6, wherein the bitmaps are reflowed such that no bitmaps extend beyond primary boundaries of the display device.

12.   A system for displaying content, comprising:
       a display device having a viewable display area, the viewable area having left and right boundaries;
       a document including displayable information;
       wherein individual parts of the displayable information are formatted as bitmaps; and
       wherein the individual parts are reflowed within primary boundaries of the viewable area.

13.   The system of Claim 12, wherein the bitmaps are resized according to a user input.

14.   The system of Claim 12, wherein the bitmaps are resized according to a stored value.

15.   The system of Claim 12, wherein the displayable information is text.

16.   A system for displaying text, comprising:

means for determining breaks between words of the text ;

means for creating individual bitmaps of at least some of the individual words;

means for displaying the bitmaps within the primary

5   boundaries of the viewable area of the display device.

17.   The system of Claim 16, wherein displaying the bitmaps within the primary boundaries of the viewable area of the display device is performed by wrapping some of the bitmaps to

10   a new line when the width of the displayed bitmaps would be greater than the width of the viewable area of the display device.

18.   The system of Claim 16, wherein the primary boundaries

15   are the left and right edges of the viewable display area.

19.   A method of displaying content on a display device, comprising the steps of:

formatting the content as a plurality of bitmaps;

20   resizing the bitmaps of the plurality;

reflowing the bitmaps of the plurality such that no content extends beyond the primary boundary of a viewable area on the display device.

25   20.   The method of Claim 19, wherein each bitmap of the plurality is an individual word.

21.   The method of Claim 19, wherein the bitmaps are resized by manipulating HTML tags associated with the bitmaps.

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22.   The method of Claim 19, wherein the content comprises text.

23.   A system for magnifying text on a display device,

35   comprising the steps of:

means for reformatting the text as a plurality of bitmaps;

means for reflowing the bitmaps.

5   24. The system of Claim 23, wherein the bitmaps are enlarged before they are reflowed.

25. The system of Claim 24, wherein the bitmaps are enlarged according to a user input.

10

26. The system of Claim 23, wherein individual words of the text are formatted as individual bitmaps.

27. The system of Claim 23, wherein the bitmaps are reflowed
15   to fit within primary boundaries of the display device.

28. A method of displaying content on a display device, comprising the steps of:

formatting the content as a plurality of bitmaps;
20   responsive to a user input, resizing the bitmaps of the plurality;

reflowing the bitmaps of the plurality based on a width of the display device and size of the bitmaps of the plurality after the step of resizing.

25

29. The method of Claim 28, wherein the bitmaps of the plurality are resized such that no content extends beyond a primary boundary of a viewable area on the display device.

30   30. The method of Claim 28, wherein the bitmaps of the plurality are resized by manipulating HTML tags associated with the plurality of bitmaps.

31. A system for displaying content on a display device,
35   comprising:

a document having displayable content, wherein the

displayable content is formatted as a plurality of bitmaps;

means for resizing the bitmaps of the plurality responsive to user input;

wherein the bitmaps of the plurality are reflowed based
5   on a width of the display device and size of the bitmaps of the plurality after the bitmaps of the plurality are resized.

32.   The system of Claim 31, wherein the bitmaps of the plurality are resized such that no content extends beyond a
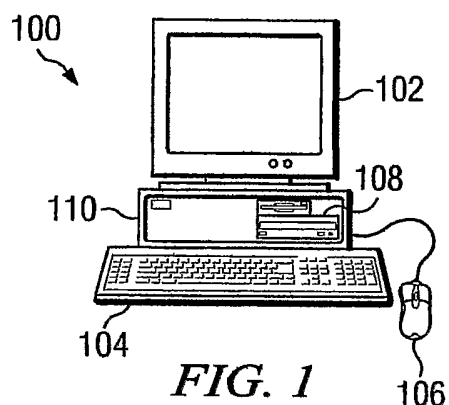10 primary boundary of a viewable area on the display device.

33.   A computer program product for displaying content on a display device, comprising:

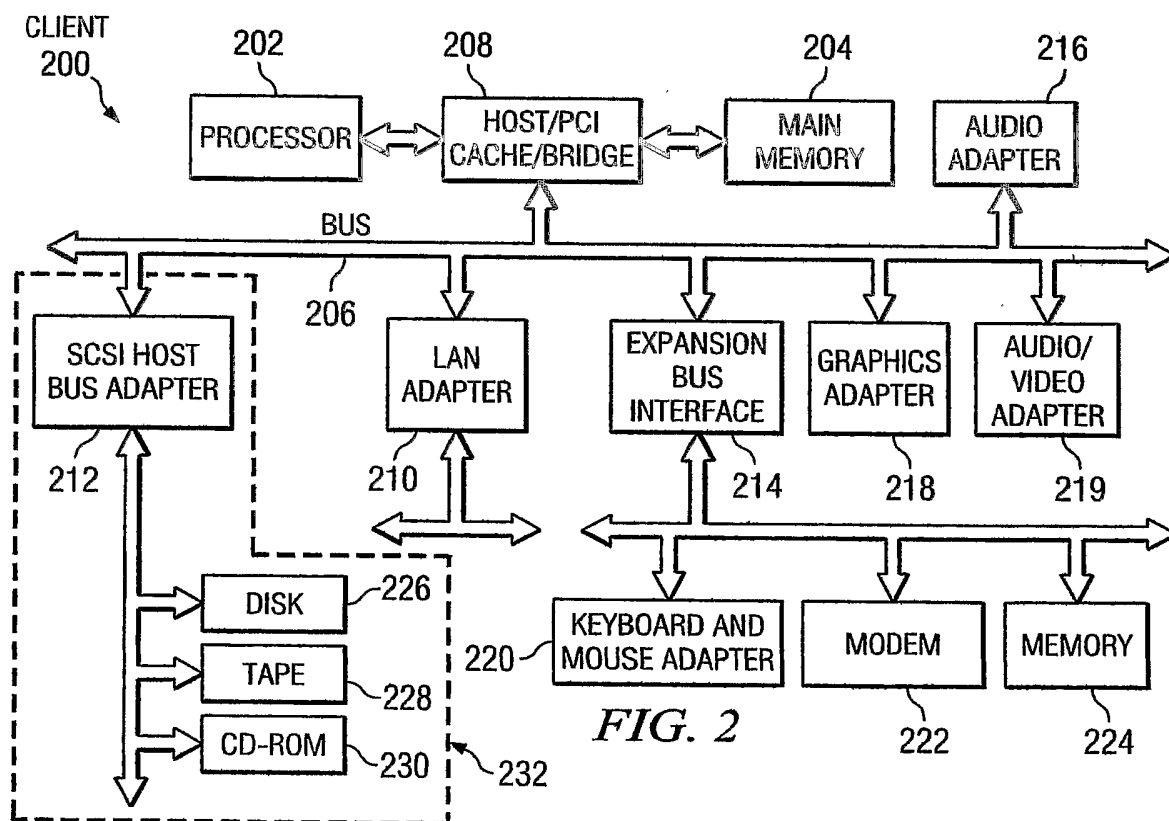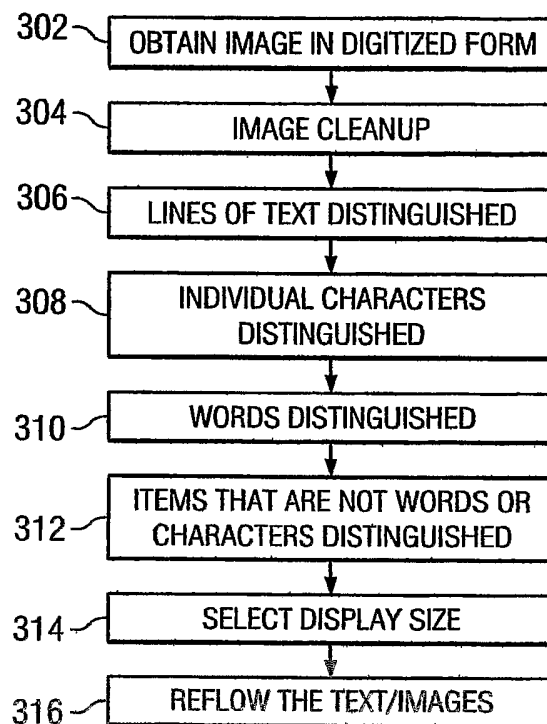first instructions for formatting the content as a
15 plurality of bitmaps;

second instructions for resizing the bitmaps of the plurality responsive to a user input;

third instructions for reflowing the bitmaps of the plurality based on a width of the display device and size of
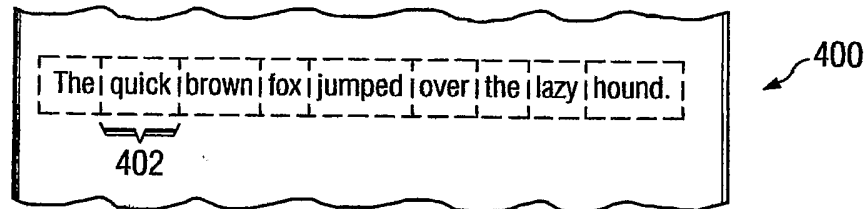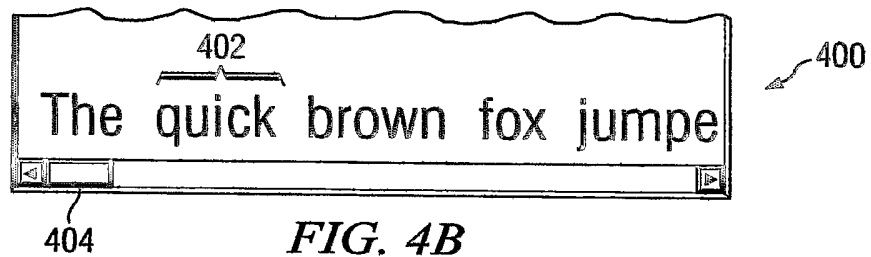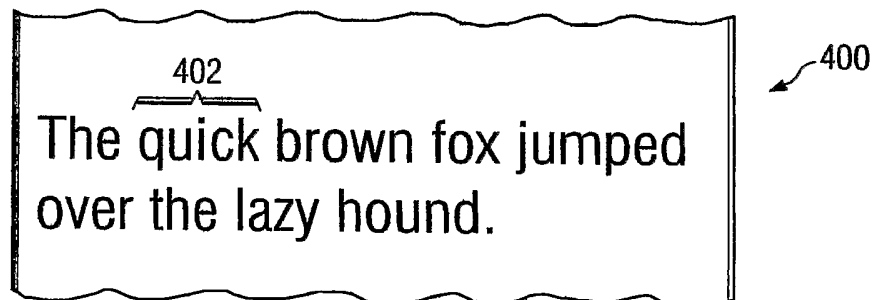20 the bitmaps of the plurality after the step of resizing.

34.   The computer program product of Claim 33, wherein the bitmaps of the plurality are resized such that no content extends beyond a primary boundary of a viewable area on the
25 display device.

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FIG. 1

302 — OBTAIN IMAGE IN DIGITIZED FORM

304 — IMAGE CLEANUP

306 — LINES OF TEXT DISTINGUISHED

308 — INDIVIDUAL CHARACTERS DISTINGUISHED

310 — WORDS DISTINGUISHED

312 — ITEMS THAT ARE NOT WORDS OR CHARACTERS DISTINGUISHED

314 — SELECT DISPLAY SIZE

316 — REFLOW THE TEXT/IMAGES

FIG. 3

CLIENT 200

PROCESSOR 202

HOST/PCI CACHE/BRIDGE 208

MAIN MEMORY 204

AUDIO ADAPTER 216

BUS 206

SCSI HOST BUS ADAPTER 212

LAN ADAPTER 210

EXPANSION BUS INTERFACE 214

GRAPHICS ADAPTER 218

AUDIO/ VIDEO ADAPTER 219

DISK 226

TAPE 228

CD-ROM 230

232

KEYBOARD AND MOUSE ADAPTER 220

MODEM 222

MEMORY 224

FIG. 2

The quick brown fox jumped over the lazy hound.

402

400

FIG. 4A

402

The quick brown fox jumpe

404

400

FIG. 4B

402

The quick brown fox jumped over the lazy hound.

400

FIG. 4C