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Fleizach et al.

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(54) **INTELLIGENT TEXT-TO-SPEECH CONVERSION**

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CPC ***G10L 13/027*** (2013.01); ***G06F 17/2705*** (2013.01); ***G10L 13/00*** (2013.01); ***G10L 13/043*** (2013.01); ***G10L 19/018*** (2013.01)

(58) **Field of Classification Search**
CPC G10L 13/043; G10L 15/22; G10L 13/033; G10L 13/08; G10L 13/10;

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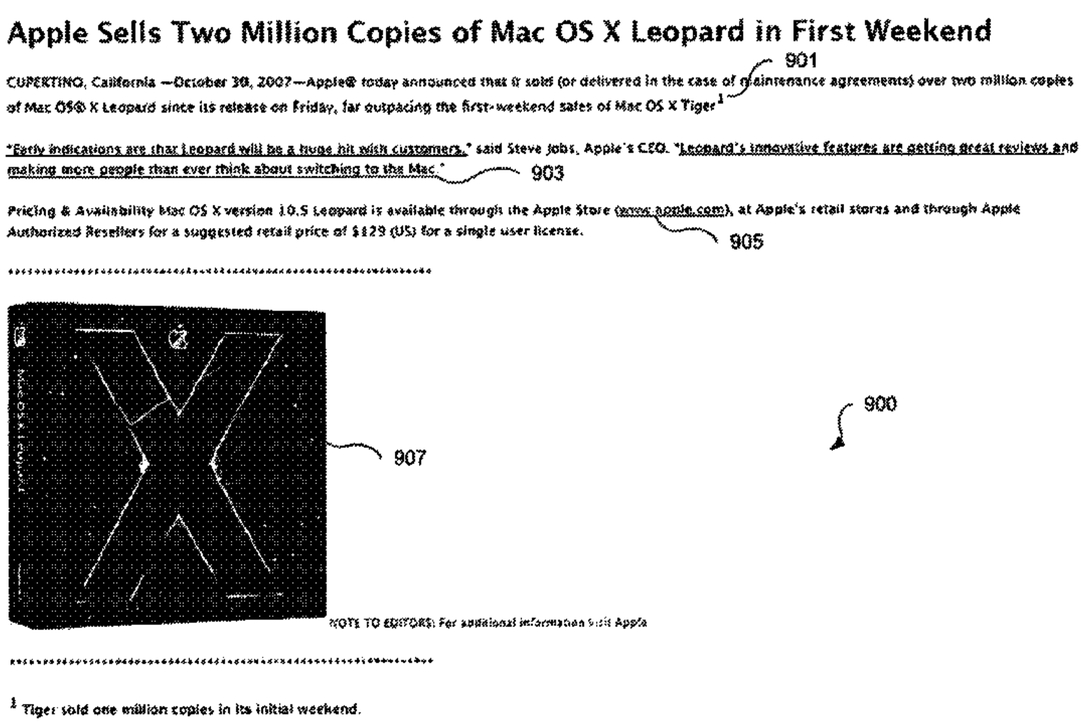
(57) **ABSTRACT**

Techniques for improved text-to-speech processing are disclosed. The improved text-to-speech processing can convert text from an electronic document into an audio output that includes speech associated with the text as well as audio contextual cues. One aspect provides audio contextual cues to the listener when outputting speech (spoken text) pertaining to a document. The audio contextual cues can be based on an analysis of a document prior to a text-to-speech conversion. Another aspect can produce an audio summary for a file. The audio summary for a document can thereafter be presented to a user so that the user can hear a summary of the document without having to process the document to produce its spoken text via text-to-speech conversion.

25 Claims, 12 Drawing Sheets



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See application file for complete search history.

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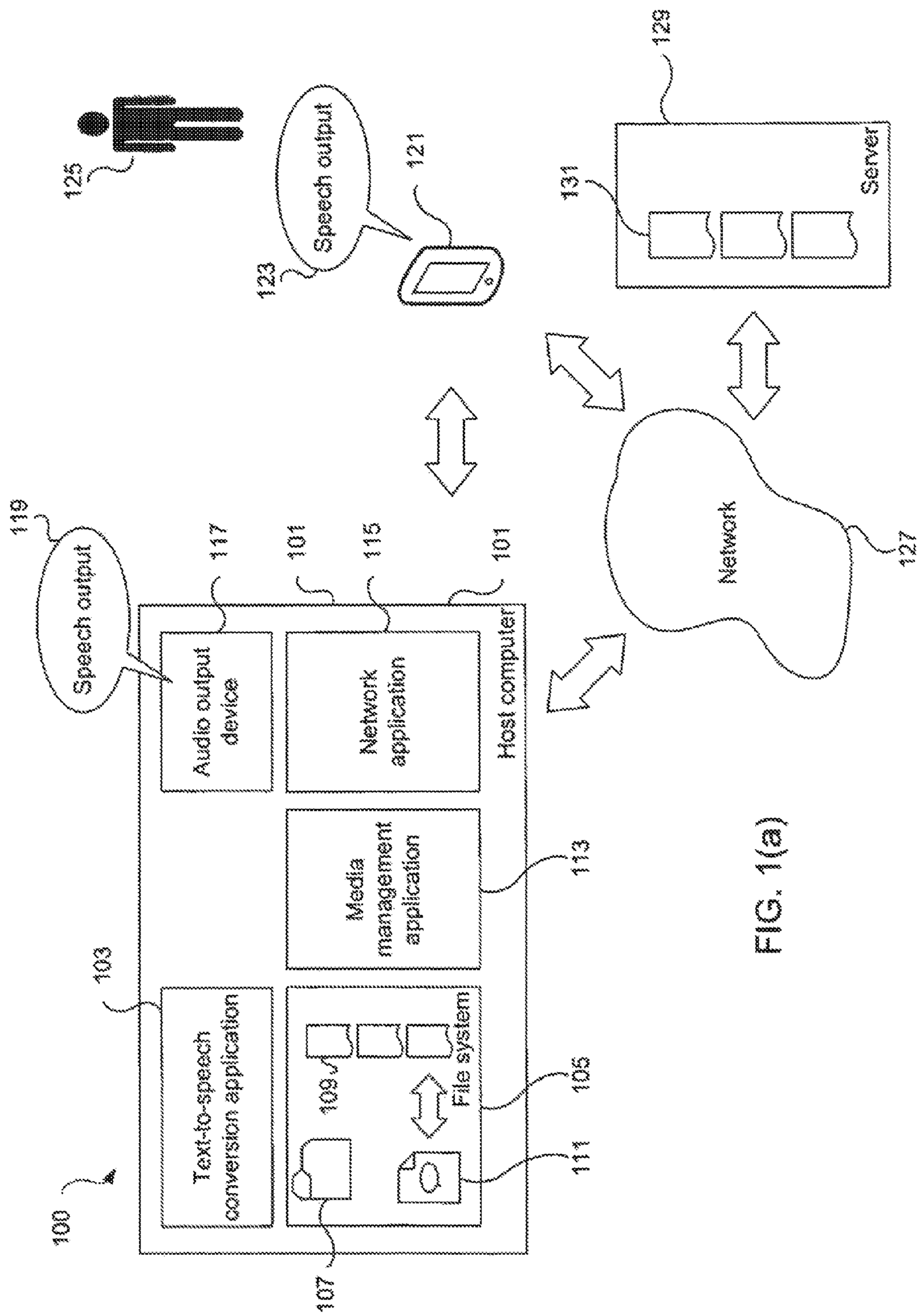

125
Speech output
123
121
129
131
Server
Network
127
119
Speech output
117
101
115
101
Audio output device
Network application
Host computer
Media management application
113
103
Text-to-speech conversion application
109
File system
105
111
100
107

FIG. 1(a)

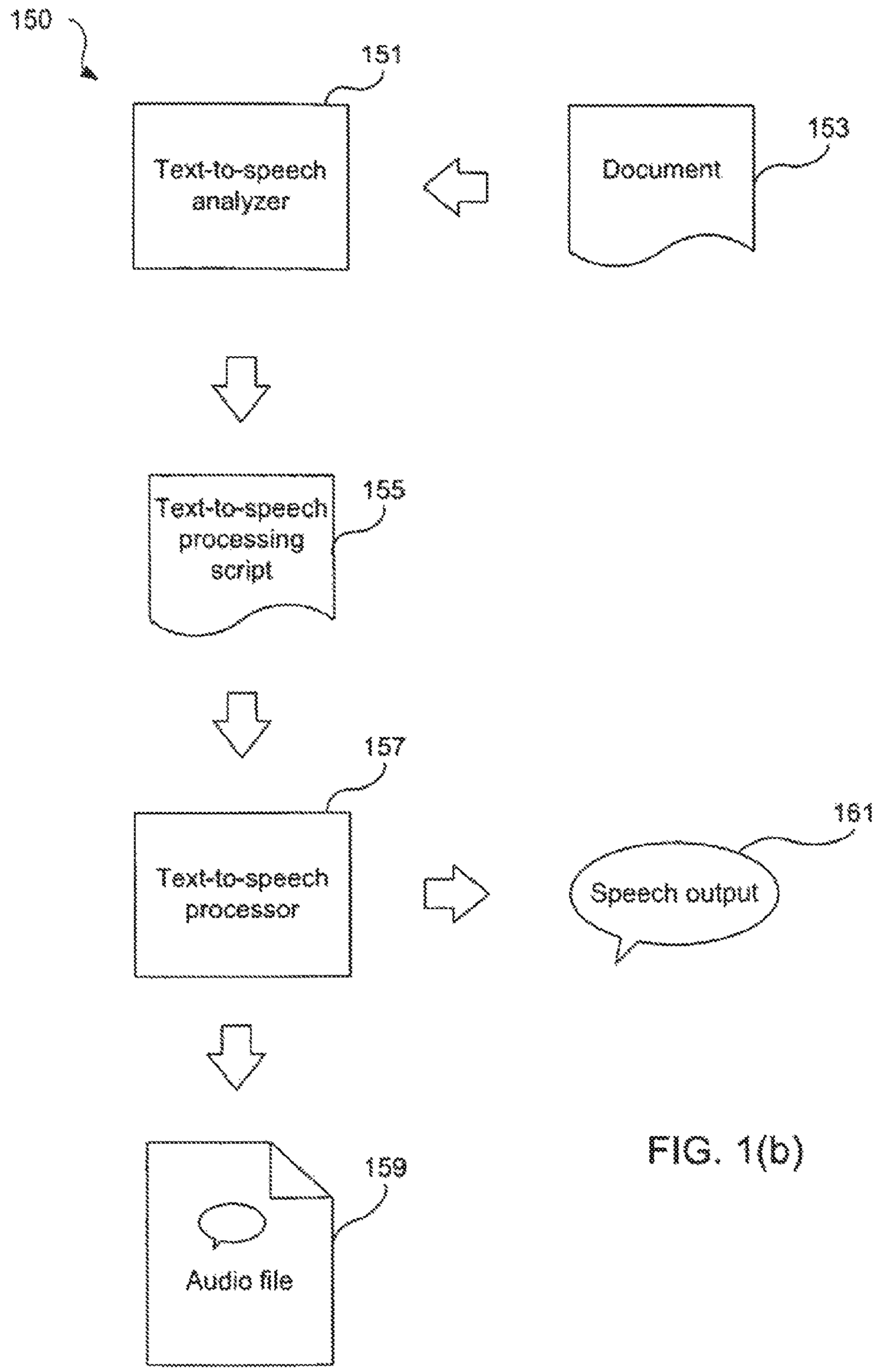

150
151
Text-to-speech analyzer
Document
153
Text-to-speech processing script
155
157
Text-to-speech processor
Speech output
161
Audio file
159

FIG. 1(b)

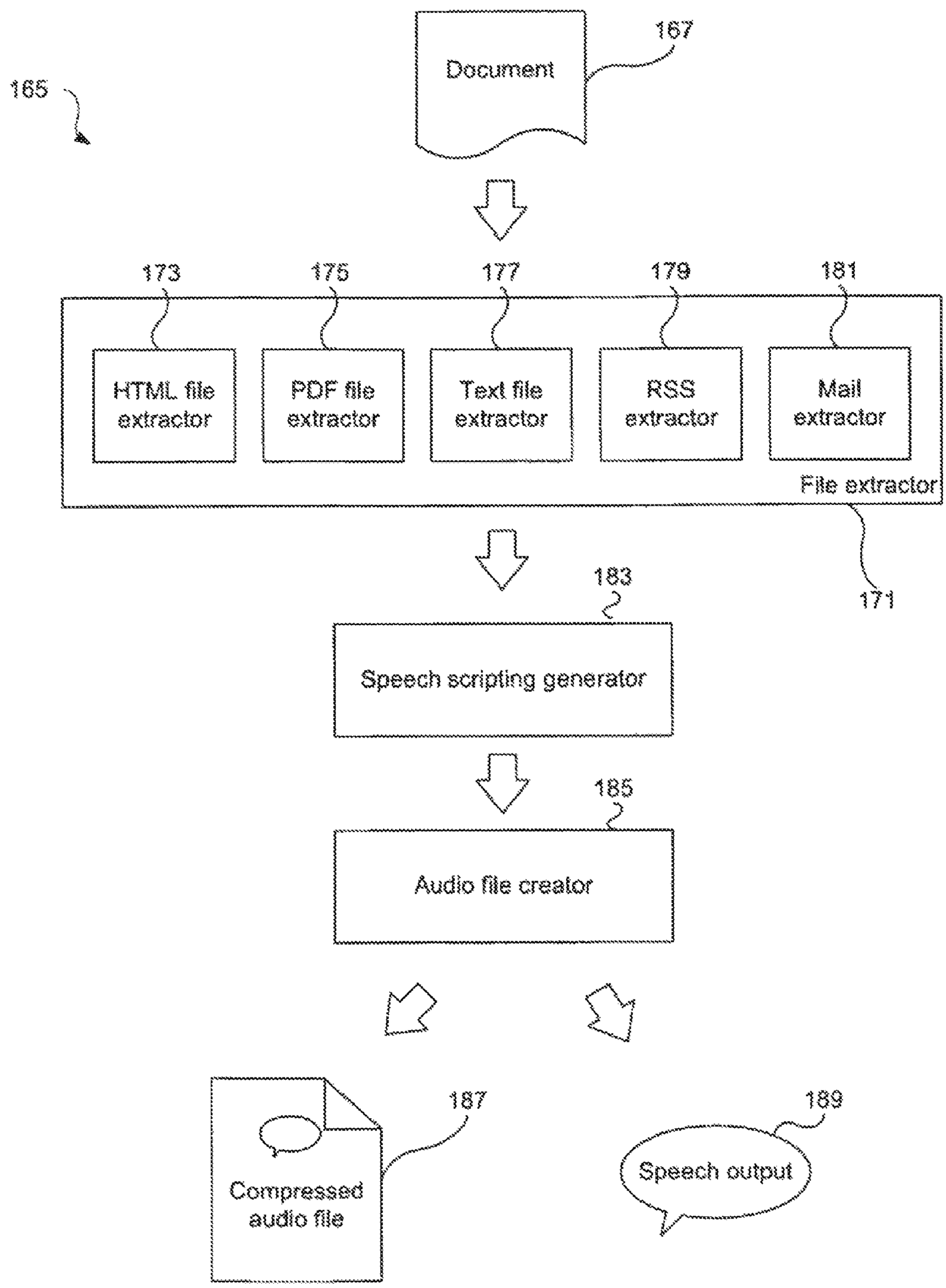

165
Document
167
173
175
177
179
181
HTML file extractor
PDF file extractor
Text file extractor
RSS extractor
Mail extractor
File extractor
171
183
Speech scripting generator
185
Audio file creator
187
Compressed audio file
189
Speech output

FIG. 1(c)

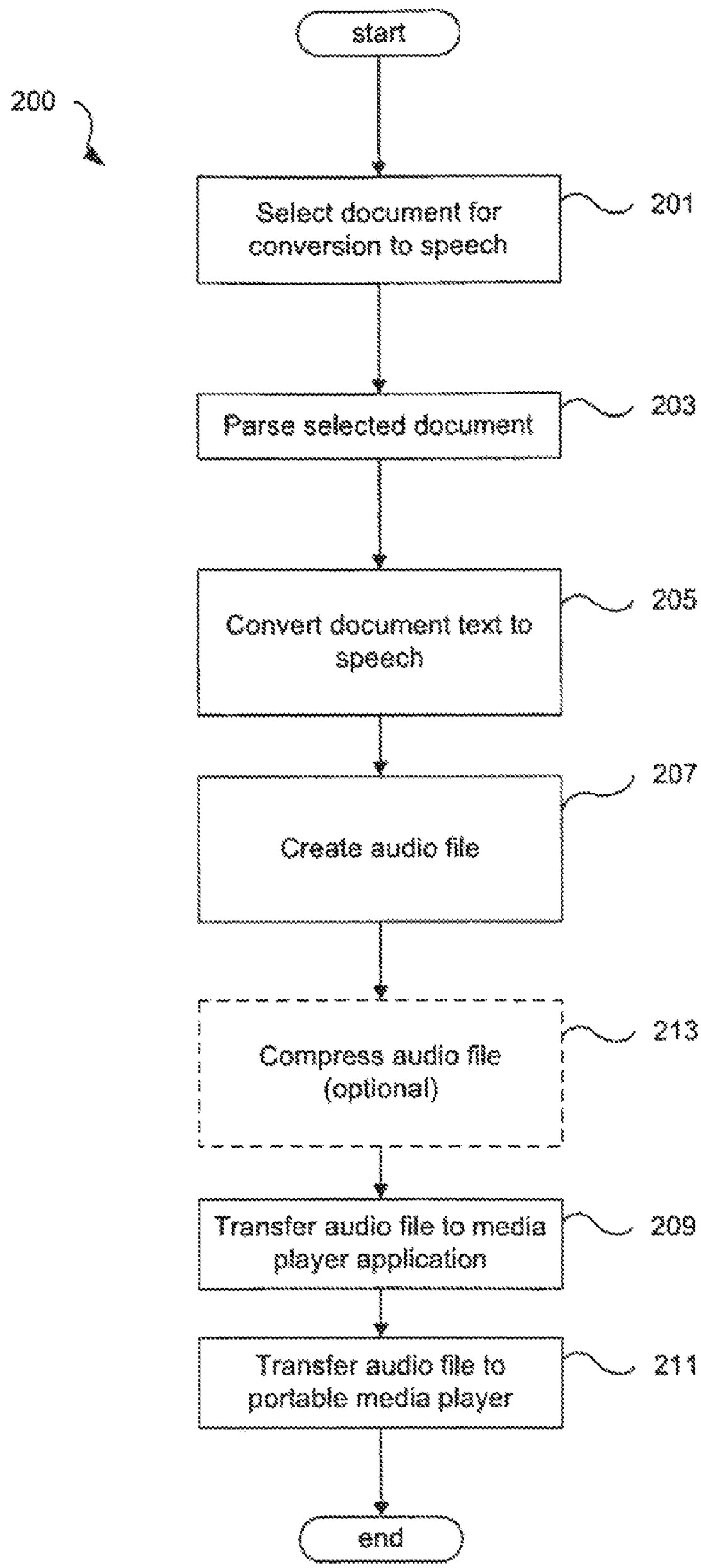

start
200
Select document for conversion to speech
201
Parse selected document
203
Convert document text to speech
205
Create audio file
207
Compress audio file (optional)
213
Transfer audio file to media player application
209
Transfer audio file to portable media player
211
end

FIG. 2

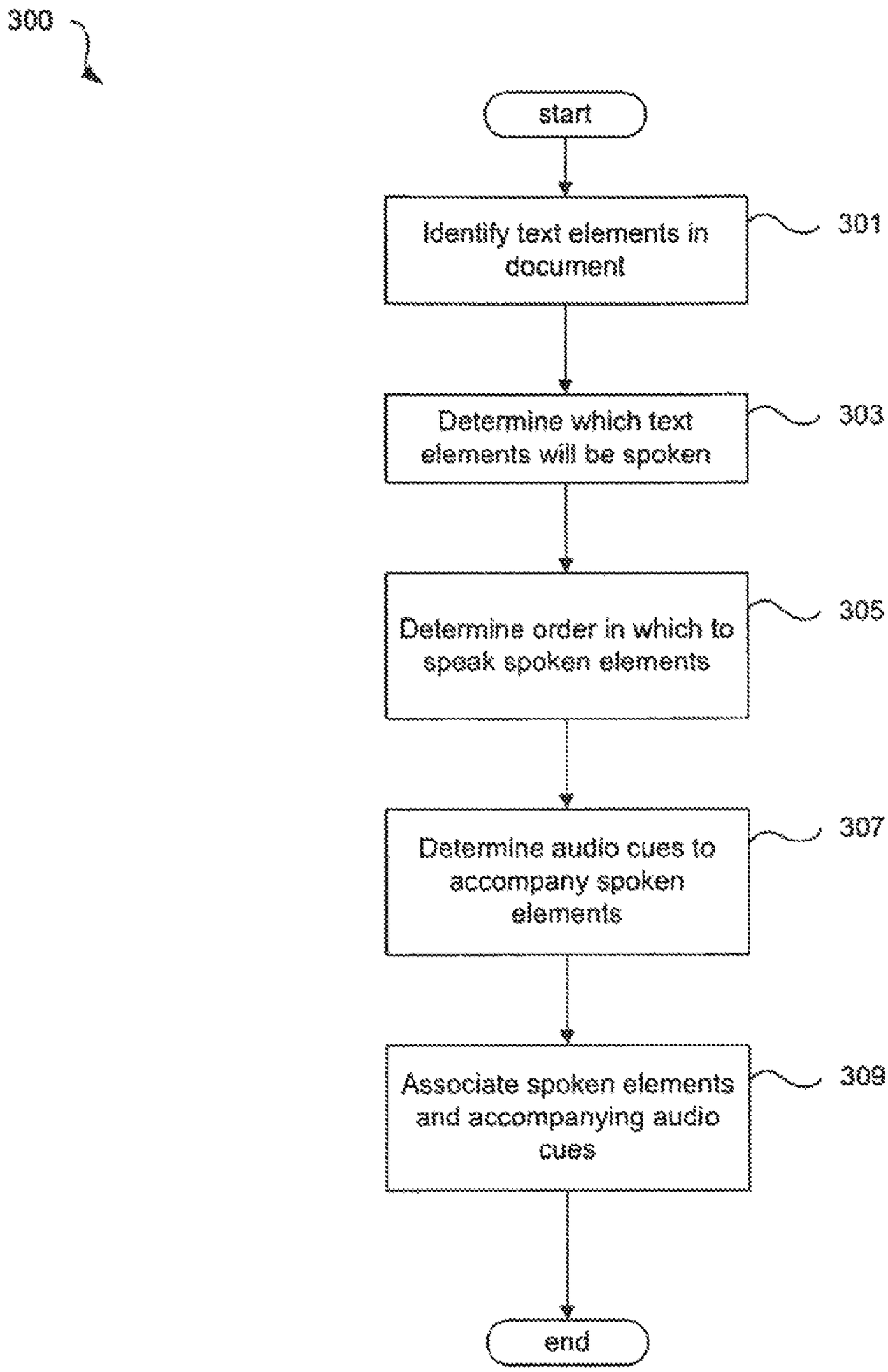

300
start
Identify text elements in document
301
Determine which text elements will be spoken
303
Determine order in which to speak spoken elements
305
Determine audio cues to accompany spoken elements
307
Associate spoken elements and accompanying audio cues
309
end

FIG. 3

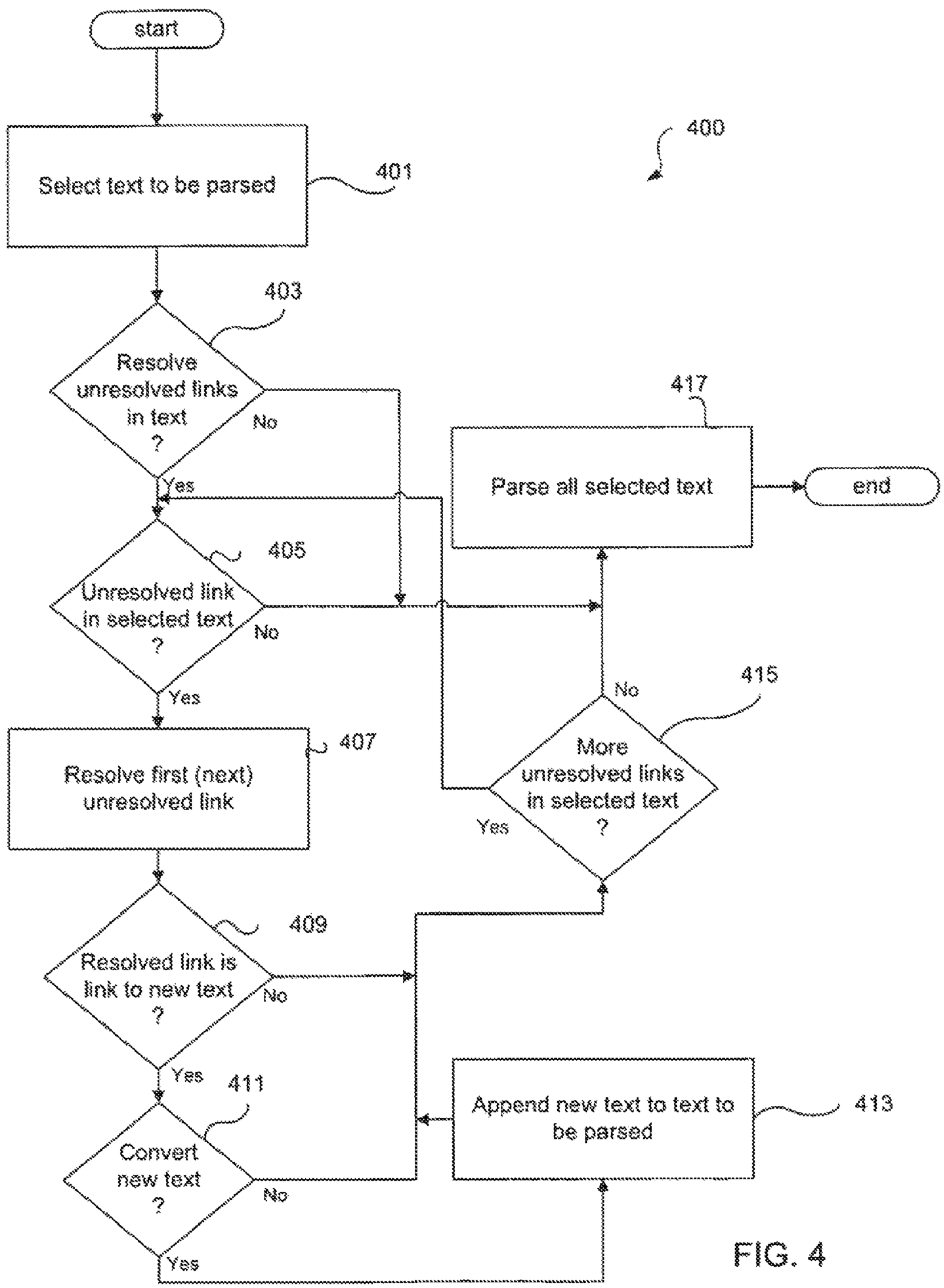

start
Select text to be parsed
401
400
Resolve unresolved links in text ?
403
No
Yes
Parse all selected text
417
end
Unresolved link in selected text ?
405
No
Yes
More unresolved links in selected text ?
415
No
Yes
Resolve first (next) unresolved link
407
Resolved link is link to new text ?
409
No
Yes
Convert new text ?
411
No
Yes
Append new text to text to be parsed
413

FIG. 4

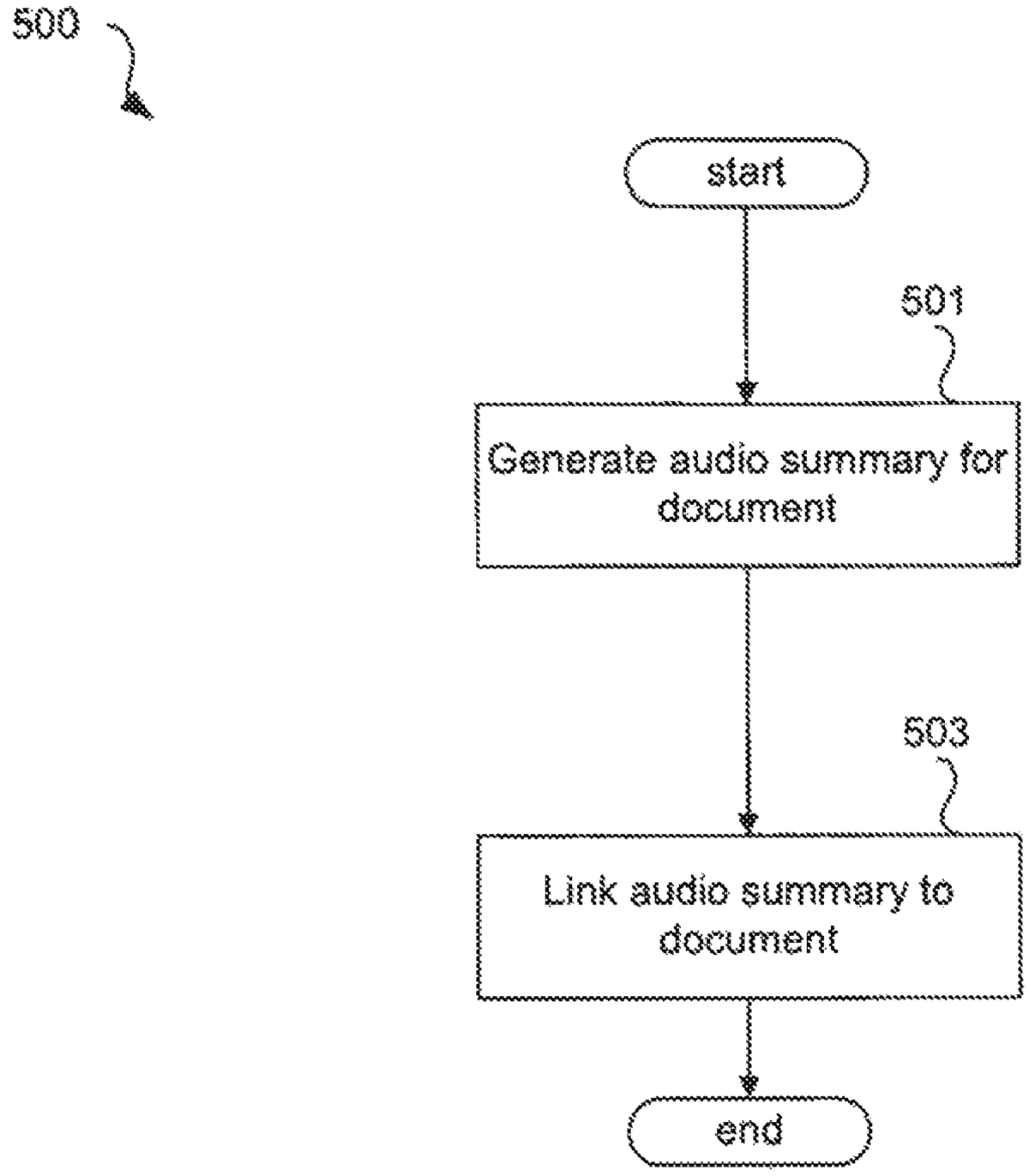

500
start
501
Generate audio summary for document
503
Link audio summary to document
end

FIG. 5

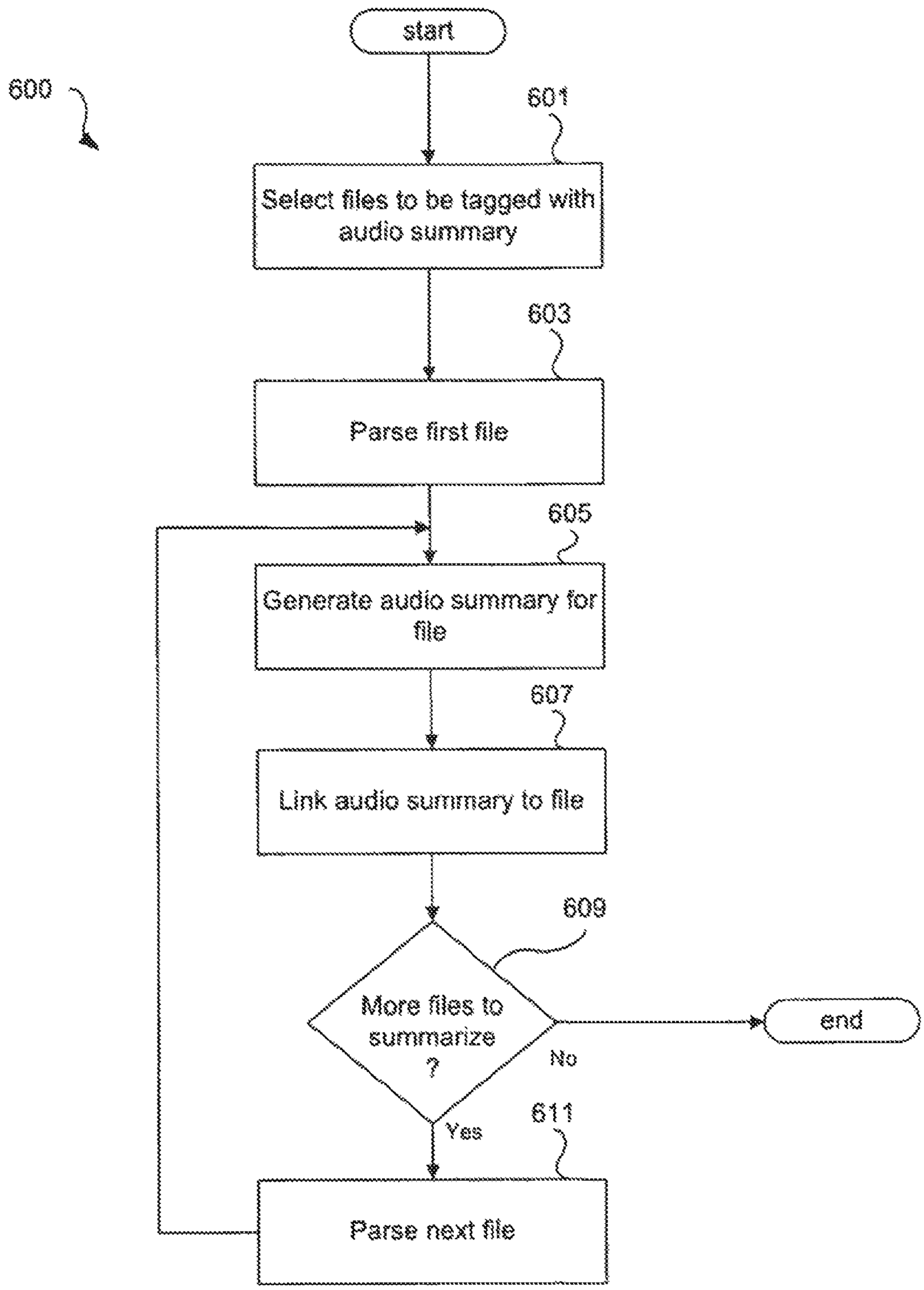

start
600
601
Select files to be tagged with audio summary
603
Parse first file
605
Generate audio summary for file
607
Link audio summary to file
609
More files to summarize ?
No
end
Yes
611
Parse next file

FIG. 6

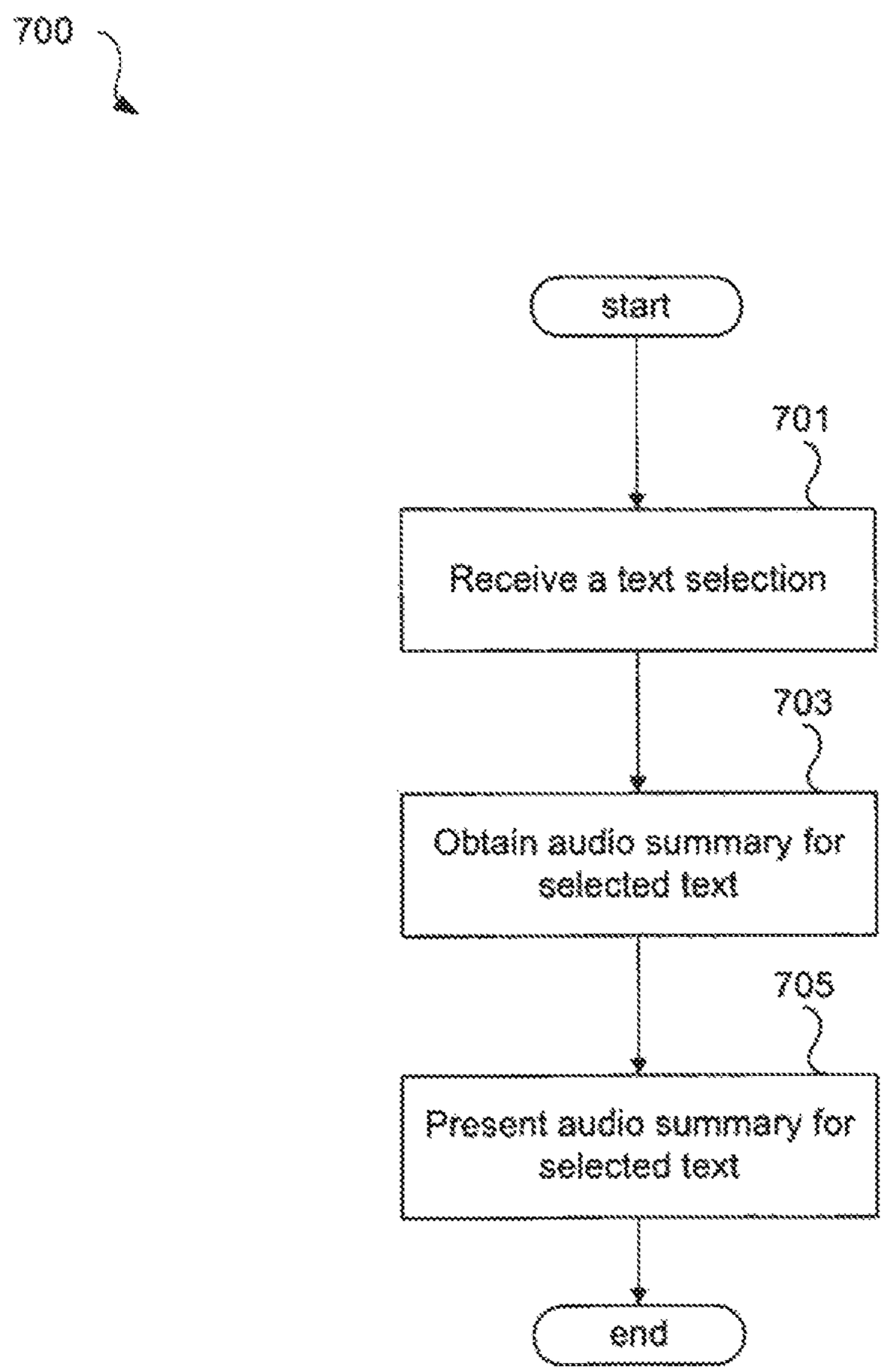

700
start
701
Receive a text selection
703
Obtain audio summary for selected text
705
Present audio summary for selected text
end

FIG. 7

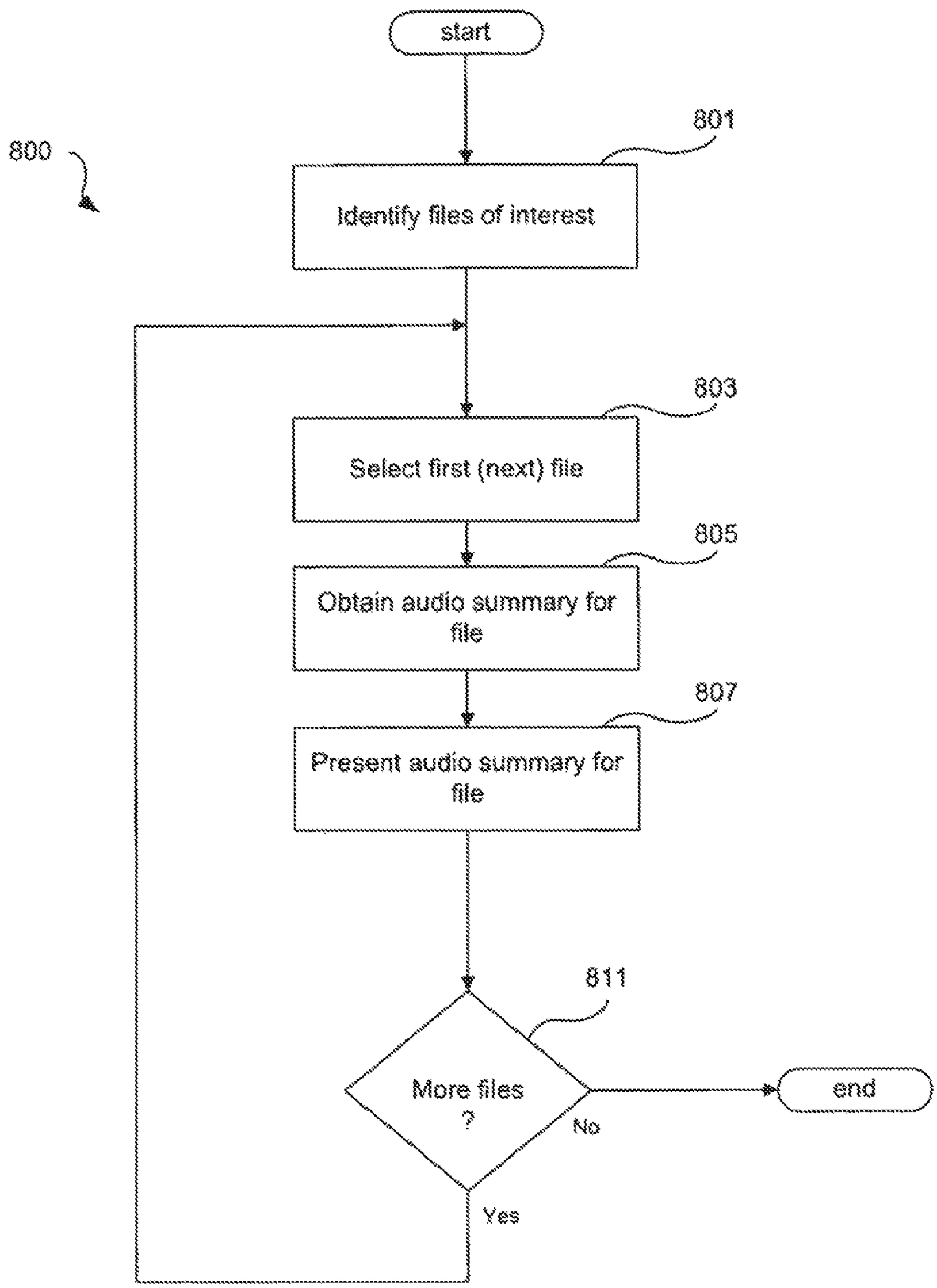

start
800
801
Identify files of interest
803
Select first (next) file
805
Obtain audio summary for file
807
Present audio summary for file
811
More files ?
No
end
Yes

FIG. 8

Apple Sells Two Million Copies of Mac OS X Leopard in First Weekend

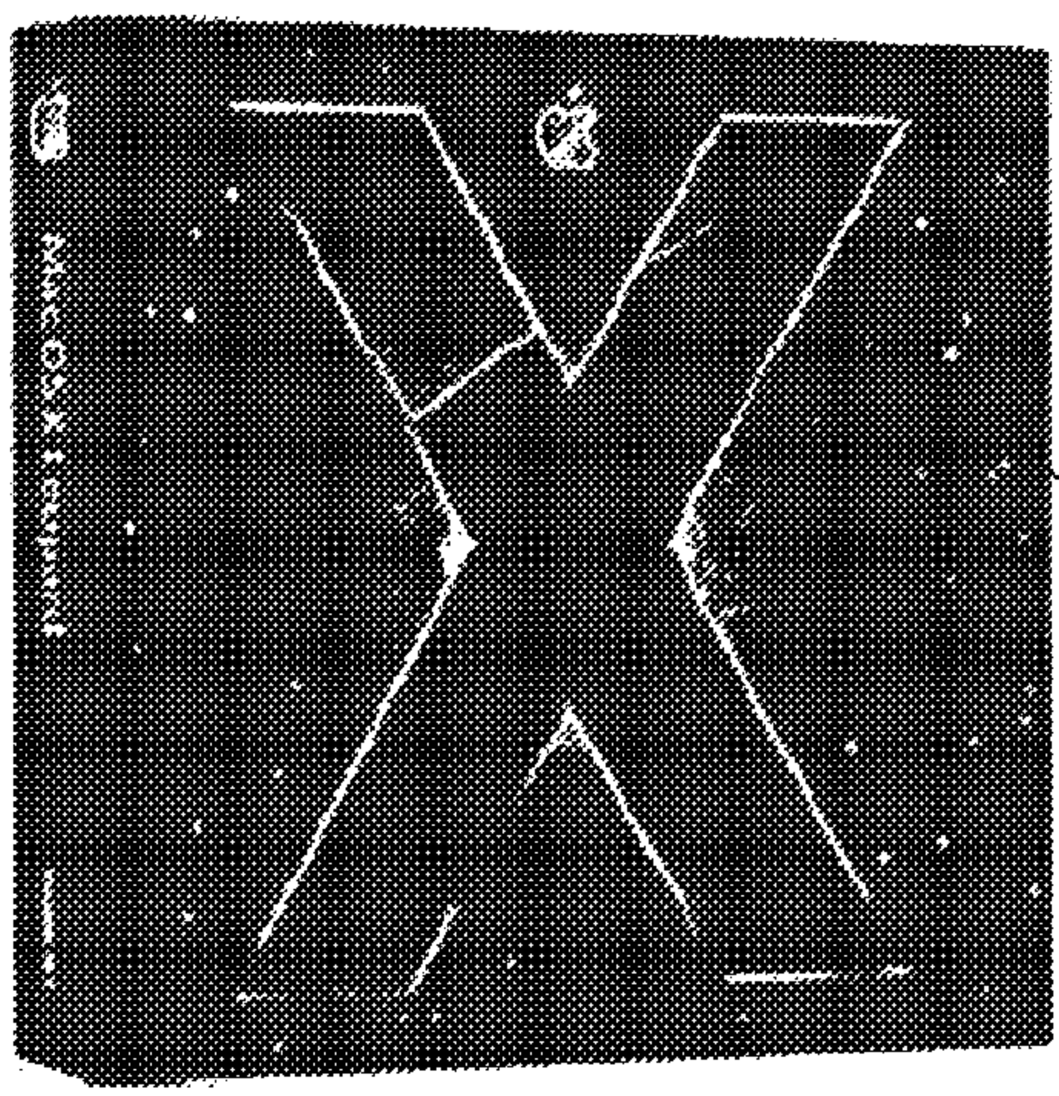
901

CUPERTINO, California —October 30, 2007—Apple® today announced that it sold (or delivered in the case of maintenance agreements) over two million copies of Mac OS® X Leopard since its release on Friday, far outpacing the first-weekend sales of Mac OS X Tiger[1]

"Early indications are that Leopard will be a huge hit with customers," said Steve Jobs, Apple's CEO. "Leopard's innovative features are getting great reviews and making more people than ever think about switching to the Mac." 903

Pricing & Availability Mac OS X version 10.5 Leopard is available through the Apple Store (www.apple.com), at Apple's retail stores and through Apple Authorized Resellers for a suggested retail price of $129 (US) for a single user license. 905

****



907

900

NOTE TO EDITORS: For additional information visit Apple

****

[1] Tiger sold one million copies in its initial weekend.

FIG. 9(a)

950

Apple Sells Two Million Copies of Mac OS X Leopard in First Weekend

951 953

{long pause}{two new lines}CUPERTINO, California {short pause (punctuation)}—October 30, 2007{short pause (punctuation)}—Apple® today announced that it sold {rate increase (parenthesis)}(or delivered in the case of maintenance agreements) over two million copies of Mac OS® X Leopard since its release on Friday, 955 far outpacing the first-weekend sales of Mac OS X Tiger{short pause, speak text for footnote in faster rate}[1].

959 957 961

{switch to male voice (speaker name is Steve)}"Early indications are that Leopard will be a huge hit with customers." {switch to narrator voice}said Steve Jobs, Apple's CEO. {switch to male voice (speaker name is Steve)}"Leopard's innovative features are getting great reviews and making more people than ever think about switching to the Mac."

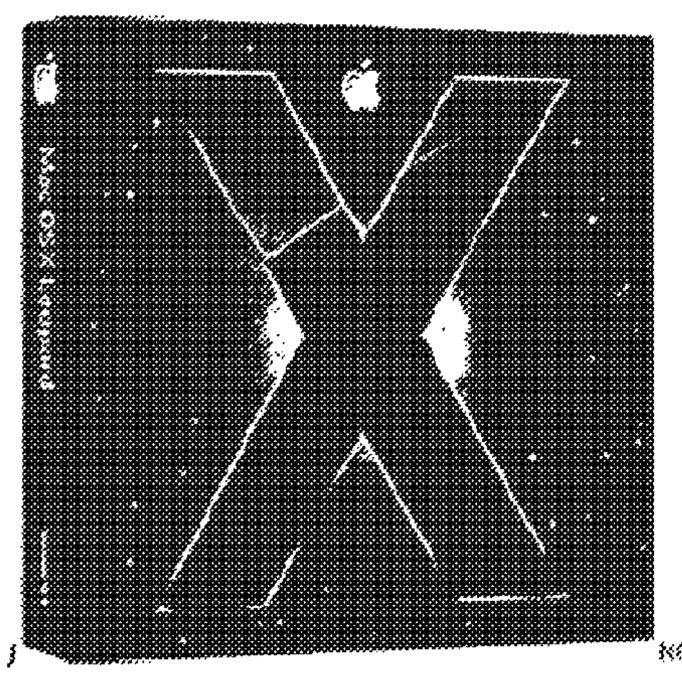
963

{switch to narrator voice}Pricing & Availability {short pause}{font style change}{Mac OS X version 10.5 Leopard is available through the Apple Store {slow speech rate, play sound (link)}(www.apple.com), at Apple's retail stores and through Apple Authorized Resellers for a suggested retail price of $129 (US) for a single user license.

965 973

{long pause (extended punctuation)}**********

967



{play sound (image)} NOTE TO EDITORS: For additional information visit Apple

969

{long pause (extended punctuation)}**********

{not spoken (already spoken inline)}[1] Tiger sold one million copies in its initial weekend.

971

FIG. 9(b)

INTELLIGENT TEXT-TO-SPEECH CONVERSION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/631,526, filed on Feb. 25, 2015, entitled INTELLIGENT TEXT-TO-SPEECH CONVERSION, which is a continuation of U.S. patent application Ser. No. 12/098,417, filed Apr. 5, 2008, now U.S. Pat. No. 8,996,376, issued Mar. 31, 2015, entitled INTELLIGENT TEXT-TO-SPEECH CONVERSION, both of which are hereby incorporated by reference in their entirety for all purposes.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention pertains to text-to-speech processing and, more particularly, to enhanced text-to-speech processing for improved document review.

Description of the Related Art

For various reasons, documents have been converted to speech (spoken text) using conventional text-to-speech processing. A user desiring to review a document can then listen to the resulting speech instead of having to read through the document. For users with impaired vision, listening to the resulting speech for a document is particularly important. Regardless of the reasons for listening to speech associated with a document, conventional text-to-speech processing is often not able to impart to the user (listener) contextual information about the text that is being spoken. Further, in recent years, documents have become more complex and more diversified. As a result, today's documents can have many different formats and contain various different document elements, including links, images, headings, tables, captions, footnotes, etc., which makes text-to-speech processing more challenging. Thus, there is a need to provide improved text-to-speech processing that can present contextual information to listeners.

For users desiring to listen to documents while on-the-go, text-to-speech processing can generate audio output that can be listened to while on-the-go. However, text-to-speech processing is processor-intensive, making it impractical for many portable devices that have limited processing power. Hence, there is also a need to manage creation, delivery and consumption of audio outputs that provide speech associated with documents.

SUMMARY OF THE INVENTION

The invention pertains for techniques for improved text-to-speech processing. The improved text-to-speech processing can convert text from an electronic document into an audio output that includes speech associated with the text as well as audio contextual cues.

The invention can be implemented in numerous ways, including as a method, system, device, or apparatus (including a computer readable medium or a graphical user interface). Several embodiments of the invention are discussed below.

As a computer-implemented method for converting text to speech, one embodiment of the invention can, for example, include at least: selecting a document to be converted to speech; parsing the selected document; converting text in the selected document to speech; and creating an audio file based on the converted text.

As a computer-implemented method for converting text to speech, another embodiment of the invention can, for example, include at least: identifying text elements in a document; determining which of the identified text elements will be spoken; determining an order in which the identified text elements will be spoken; determining at least one audio cue that will accompany the at least one of the spoken text elements; and associating the at least one determined audio cue with the at least one of the spoken text elements corresponding thereto.

As a computer implemented method for generating an audio summary for a document, one embodiment of the invention can, for example, include at least: parsing a document; generating an audio summary for the parsed document; and associating the audio summary to the parsed document.

As a method for presenting a text-based document in an audio fashion, one embodiment of the invention can, for example, include at least: providing a text document having at plurality of embedded text-to-speech markup tags; and converting the text document to an audio file using text-to-speech conversion and using the embedded text-to-speech tags.

As a text-to-speech conversion system, one embodiment of the invention can, for example, include at least: a text document having at plurality of embedded text-to-speech markup tags; and a text-to-speech converter configured to convert the text document to an audio file in accordance with the embedded text-to-speech tags.

As a computer readable storage medium including at least computer program code for converting text to speech tangibly embodied therein, one embodiment can, for example, include at least: computer program code for selecting a document to be converted to speech; computer program code for parsing the selected document; computer program code for converting text in the selected document to speech; and computer program code for creating an audio file based on the converted text, where the audio file includes at least one audio cue.

Other aspects and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. **1**(*a*) is a block diagram of a text-to-speech processing system according to one embodiment of the invention.

FIG. **1**(*b*) is a block diagram of a text-to-speech processing system according to another embodiment of the invention.

FIG. **1**(*c*) is a block diagram of a text-to-speech processing system according to another embodiment of the invention.

FIG. **2** is a flow diagram of a document to audio file conversion process according to one embodiment of the invention.

FIG. **3** is a flow diagram of a text-to-speech processing process according to one embodiment of the invention.

FIG. **4** is a flow diagram of a text-parsing process according to one embodiment of the invention.

FIG. **5** is a flow diagram of an audio summary generating process according to one embodiment of the invention.

FIG. **6** is a flow diagram of an audio summary file-tagging process according to one embodiment of the invention.

FIG. **7** is a flow diagram of an audio summary presentation process according to one embodiment of the invention.

FIG. **8** is a flow diagram of an audio summary presentation process according to one embodiment of the invention.

FIG. **9**(*a*) is a screenshot of an exemplary text document.

FIG. **9**(*b*) is a screenshot of an exemplary marked up text document that has been prepared for conversion to speech.

DETAILED DESCRIPTION OF THE INVENTION

The invention pertains for techniques for improved text-to-speech processing. The improved text-to-speech processing can convert text from an electronic document into an audio output that includes speech associated with the text as well as audio contextual cues.

One aspect of the invention provides audio contextual cues to the listener when outputting speech (spoken text) pertaining to a document. The audio contextual cues can be based on an analysis of a document prior to a text-to-speech conversion. In one embodiment, audio contextual cues can announce the context of a particular block of text, for example by saying "this is a title", "this is a footnote", etc. In other embodiment, audio contextual cues for the content of a document can also be imparted, for example, by any of: altering speed of the text as it is read, changing a voice used by the text-to-speech processor, playing a sound to announce a contextual change, speaking text while a background noise is played, changing the pitch of the voice speaking the text, playing a sound to indicate italicized or bolded text, playing a sound to indicate a misspelling or grammatical mistake, or altering volume of the voice speaking the text.

In one embodiment, the invention can process hyperlinks in a document in an intelligent manner. In one implementation, when a block of text includes a hyperlink, a text-to-speech processor can indicate (e.g., by auditory cue) to the user that a string of text (possibly a word or phrase) is a hyperlink. As one example, a low tone in the background can be played while a text-to-speech processor speaks the hyperlink. As another example, a tone or click can be played before and/or after the hyperlink. As still another example, a text-to-speech processor can use a distinct voice to let the user know that text being read is a hyperlink.

In one embodiment, audio contextual clues can be influenced by user preferences. Audio contextual cues can be, for example, set as user preferences in a software control panel associated with a text-to-speech processor.

According to another aspect of the invention, an audio summary can be generated for a file. The audio summary for a document can thereafter be presented to a user so that the user can hear a summary of the document without having to process the document to produce its spoken text via text-to-speech conversion.

Documents as used herein pertain to electronic documents. The electronic documents are electrically stored in an electronic file on a computer readable medium. For example, a document used herein can be of various different types and formats, including documents concerning text, word processing, presentation, webpage, electronic mail (e-mail), markup language, syndication, page description language, portable document format, etc.

Embodiments of the invention are discussed below with reference to FIGS. **1**-**9**(*b*). However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes as the invention extends beyond these limited embodiments.

FIG. **1**(*a*) is a block diagram of a text-to-speech processing system **100** according to one embodiment of the invention. The text-to-speech processing system **100** includes a host computer **101**, a portable media player **121**, and a server computer **129**. The host computer **101** can be connected to the portable media player **121**, for example, by using a USB cable or other cable, or by using a wireless network connection such as WiFi or Bluetooth. The host computer **101** can connect to the server computer **129** over a network **127**, for example the Internet. The host computer **101** can be connected to the network either by a cable, for example an Ethernet cable, or by using a wireless network connection. The host computer **101** can include a file system **105**, which is used to access files **109** and directories **107** on the host computer **101**.

The host computer **101** can also include one or more software applications, for example a media management application **113**, a network application **115**, and a text-to-speech conversion application **103** (or text-to-speech converter). The media management application **113** can be, for example iTunes™ software program, produced by Apple Inc. of Cupertino, Calif. The media management application **113** can be used to organize and present (e.g., play) media files **111**. Media files **111** can include audio files such as MP3s, AACs or RSS feeds, video files, and any other media content file. The media management application **113** can also be used to manage the transfer of audio files **111** between the host computer **101** and the portable media player **121**, for example by performing a synching operation between the host computer **101** and the portable media player **121**. For ease of use on the portable media player **121**, the audio files **111** can be stored in a predetermined organization. The predetermined organization can facilitate searching, navigation and/or playback of the audio files **111** on the portable media player **121**. For example, like types of documents (e.g., emails, webpages, etc.) can be separately grouped. The network application **115** can include any of a wide variety of network capable applications including, but not limited to, Web browsers, e-mail applications, and terminal applications. Also, the network application **115** can be implemented as a module or part of the media management application **113**.

The text-to-speech conversion application **103** can be used to convert electronic documents (e.g., text files) into audio files **111**. Alternately, the text-to-speech conversion application **103** can be used generate speech output **119** (e.g., by using a speech synthesizer). The generated speech output **119** can be presented to a user **125** using an audio output device **117**. The audio output device **117** can be a sound card, for example, or other built-in sound hardware such as an audio output device built into a motherboard. Speech output **119** can be presented to the user **125** by way of a speaker or headphones, for example. The text-to-speech conversion application **103** can interact with a network application to present a webpage or the contents of an e-mail mailbox to the user **125**. In one embodiment, the text-to-speech conversion application **103** can be used to convert documents, including webpages, RSS feeds, e-mails, text files, PDFs, or other documents having text into audio files **111** at the host computer **101**. The text-to-speech conversion application **103** can also be used to produce files **131** that reside on the server computer **129**. The files **131** that reside on the server computer can include audio files as well as any of the documents mentioned above. The audio files **111** can,

in one embodiment, be copied from the host computer **101** to the portable media player **121**. Further, the portable media player **121** can be capable of presenting speech output **123** to the user **125**.

FIG. **1**(*b*) is a block diagram of a text-to-speech processing system **150** according to one embodiment of the invention. The text-to-speech processing system **150** can be, for example, implemented by the text-to-speech conversion application **103** of FIG. **1**(*a*).

The text-to-speech processing system **150** can include a text-to-speech analyzer **151**. The text-to-speech analyzer **151** can analyze a document **153** and output a text-to-speech processing script **155**. The document text-to-speech analyzer **151** can, for example, identify different elements of the document **153**, such as the table of contents, publishing information, footnotes, endnotes, tables, figures, embedded video or audio, document abstract, hyperlinks, proprietary elements (e.g., such as Adobe Flash content or Apple QuickTime™ content), and document meta-information. The text-to-speech processing script **155** can then be created by the text-to-speech analyzer **151** with embedded audio context cues to be interpreted by a text-to-speech processor **157**.

In one embodiment, the content of a document **153** to be converted to speech can be rearranged in the text-to-speech processing script **155** according to user preferences. For example, footnotes in the document **153** can be marked to be read in-line rather than at the bottom of the page, page numbers can be announced at the start of the page rather than at the end, a table of contents can be moved or omitted entirely, etc. The text-to-speech processor **157** can output an audio file **159** or can output speech **161** directly.

In one embodiment, in the case where the text-to-speech processor **157** output is converted into an audio file **159**, audio chapter information can be inserted into the text-to-speech processing script **155** for conversion into chapter or track markers within the audio file (e.g., so a user can navigate within the audio file by skipping forward or backward by chapter).

The document text-to-speech processing script **155** can be stored for later use. For example, the document text-to-speech script **155** can be stored in a header of a file, in the directory that contains the file, or in some other linked file. In one embodiment, the document text-to-speech analyzer **151** can resolve hyperlinks, either for immediate processing or for later use. In this case, a user can set a preference instructing the document text-to-speech analyzer **151** how to resolve hyperlinks (e.g., how many levels of hyperlinks to resolve). Thus, references cited to within a document, for example in footnotes or endnotes, can be processed as well and inserted into the audio file **159** by the text-to-speech processor **157**.

In one embodiment, a text-to-speech processing script **155** can be embedded in a document upon creation of the document, with the assumption that some users will want to have the document read to them rather than reading it themselves. Alternatively, a standardized markup language (e.g., a "text-to-speech markup language") can be used during creation of a document, in order to allow the creator of the document to exercise creative control over future text-to-speech conversions. For example, a creator (author) of a document can, in advance, pick the voice that a text-to-speech processor will use to read a document. In another example, a creator can pre-select voices for the dialogue of characters in a document, such as a book. In a third example, a webmaster seeking to design a webpage accessible to the visually impaired can incorporate commands to be processed by a text-to-speech processor, rather than relying on a document text-to-speech analyzer to correctly interpret his webpage design.

In the above description, such as illustrated in FIG. **1**(*b*), the document text-to-speech analyzer **151** and the text-to-speech processor **157** are shown as separate from each other. However, the text-to-speech analyzer **151** and text-to-speech processor **157** need not be separate. Further, the text-to-speech processing script **153** is also not required in other embodiments. Thus, in one embodiment, a single software application combining the functions of the text-to-speech analyzer **151** and the text-to-speech processor **157** can process a document **153** and output audio, either as speech output **161** (e.g., reading the document to the user on demand) or as an audio file **159** for later playback.

FIG. **1**(*c*) is a block diagram of a text-to-speech processing system **165** according to one embodiment of the invention. The text-to-speech processing system **165** can receive a document **167** at a file extractor **171** that can be used to retrieve and/or examine (i.e., open) the document **167**. The file extractor **171** can include a variety of modules capable of processing different types of documents **167**. For example, a file extractor **171** can include an HTML file extractor **173**, a PDF file extractor **175**, a text file extractor **177**, and RSS extractor **179**, and an e-mail extractor **181**, as well as other modules for extracting other types of documents (Microsoft Word files, RTF files, etc.) The file extractor **171** can output the contents (including at least text) of an extracted file to a speech scripting generator **183**. The speech scripting generator **183** can take text that has been extracted by a file extractor **171** and apply heuristics (e.g., rules) to markup the text with speech markup tags. The speech markup tags can indicate when different speech attributes (e.g., the speed to read text, the voice used, or the pitch of the voice used) are to be applied.

The speech scripting generator **183** can output instructions (i.e., a script) to an audio file creator **185** which can be used to create an audio file based on the script supplied by the speech scripting generator **183** as well as the speech of the extracted text. For example, the audio file creator **185** can incorporate a text-to-speech processor and a sound recording application, where the output of the text-to-speech processor is recorded and stored as an audio file. The audio file creator **185** can output a compressed audio file **187**, for example an MP3 or AAC file. Alternately, the audio file creator **185** can output an uncompressed audio file, for example an AIFF or WAV file. In an alternate embodiment, the audio file creator **185** can output speech to present to a listener, for example by using an audio output device **117** as described above in reference to FIG. **1**(*a*), instead of generating a compressed audio file **187**.

FIG. **2** is a flow diagram of an audio file creation process **200** according to one embodiment of the invention. The audio file creation process **200** can be implemented using, for example, the text-to-speech processing system **100** of FIG. **1**(*a*), the text-to-speech processing system **150** of FIG. **1**(*b*), or the text-to-speech processing system **165** of FIG. **1**(*c*).

The audio file creation process **200** begins by selecting **201** a document for conversion into an audio file. A document can be any electronic file or link that contains text. For example, the document can be a text file, a PDF file, a webpage, a hyperlink, an RSS feed, or an e-mail. Text files can be of any format, for example: plain text. RTF or other proprietary file formats generated by common word processing software; files formatted using a page description language such as a PostScript or PDF; files formatted using a markup language such as HTML or XML; or files format-

ted using a typesetting program such as TeX. The audio file creation process **200** continues by parsing **203** the selected document. Parsing **203** can involve examining, interpreting and/or identifying all the various elements of the selected document. For example, parsing **203** can be used to identify the various text elements in the selected document, including, but not limited to, author information, document title, header text, footer text, body text, table captions, picture captions, abstract text, footnotes, endnotes, table of contents, hyperlinks, and copyright information. In addition, parsing **203** can involve identifying supplemental elements that may be present in the selected document. Examples of supplemental elements are markup tags, typesetting information, binary code, embedded video, pictures, proprietary content such as Flash or QuickTime, and metadata. In one embodiment, when hyperlinks are present, one or more hyperlinks can be opened and resolved during the parsing **203** of the selected document. For example, if the selected document is an RSS feed, the parsing **203** can resolve a RSS URL for the RSS feed, and examine the text or webpage associated with the RSS URL. As another example, if the selected document pertains to e-mail, parsing **203** can include retrieving e-mails from a server.

Once the document has been parsed **203**, the document text is converted **205** to speech consistent with the document parsing **203** using a text-to-speech processor, for example the text-to-speech processor **107** of FIG. **1**(*b*). Different types of text elements can be converted to speech differently, using different speech cadence, inflection, or tone, or by indicating different types of text using auditory cues. The audio file creation process **200** continues by creating **207** an audio file using the speech created by the text-to-speech conversion of step **205**, for example, by recording (i.e., storing) the output of the text-to-speech processor. Alternately, a text-to-speech processor can create **207** an audio file directly.

Next, the audio file can be transferred **209** to a media player application. In the case where the audio file is transferred to a media player application, the media player application can be a media management application for example iTunes™ software program, produced by Apple Inc. of Cupertino, Calif. Finally, the audio file can be transferred **211** to a portable media player, for example by performing a synching operation between the portable media player, (e.g., an iPod™ or other portable media player), and a personal computer. The transfer **211** of the audio file to the portable media player can be managed using the media management application. Alternately, the audio file can be transferred **211** to a media player application directly, without first performing step **209**.

In one embodiment, the audio file can be compressed **213** before being transferred **209** to the media player application. Compression may be necessary because many standard audio files are created using "lossless" recording algorithms, which typically produce files that require a large amount of memory storage space. For example, in the audio interchange file format (.aiff), one minute of audio can require 10 MB or more of storage space. Thus, it is common to compress audio, for example, into a "lossy" file format, such as MP3 or AAC, which take up much less memory storage space. Alternately, in one embodiment, a compressed audio file can be created in step **207**, thus eliminating the need for compression step **213**.

FIG. **3** is a flow diagram of a text-to-speech processing process **300** according to one embodiment of the invention. The text-to-speech processing process **300** can replace and/or supplement the parsing step **203** and the text-to-speech conversion step **205** of FIG. **2**.

The text to speech processing process **300** begins by identifying **301** text elements in a given document. The identifying **301** of text elements in a document can include, for example, parsing the document as described in block **203** of FIG. **2**. Other elements in the document, such as supplemental elements, including pictures, embedded video, markup language tags, and metadata, can also be identified **301**. The supplemental elements may also include text that is not normally presented to a reader when the document is displayed, such as copyright information or document revision information.

Next, the text-to-speech processing process **300** determines **303** which text elements will be spoken. Examples of text elements that can be spoken include, but are not limited to, titles, body text, footnotes, picture captions, table captions, and page numbers. Examples of text elements that might not be spoken include markup tags, tables of contents, and other text elements that may be difficult to convert to speech. Those particular text elements that are not to be spoken can be designated as non-spoken text elements during the determination **303**. FIG. **4**, as discussed below, is a flow diagram of a text-parsing process **400** according to one embodiment of the invention.

The text to speech processing process **300** continues by determining **305** the order in which to speak spoken elements. For example, the text-to-speech processing process **300** can determine **305** that footnotes contained in a document are to be spoken in line (i.e., spoken as they occur in the document). Other examples of text elements that may be spoken in a different order than they occur in the text document include page numbers, which can be spoken at the beginning of the page rather than at the end, author information, and endnotes. Next, audio cues that will accompany spoken elements can be determined **307**. Audio cues include audio contextual cues that are presented to the listener in order to better convey the content of a particular document. As noted above, audio contextual cues can be as simple as announcing the context of a particular block of text, for example by saying "this is a title", "this is a footnote", etc. Audio contextual cues for the content of a document can also be imparted, for example, by altering the speed of the text as it is read, changing the voice used by the text-to-speech processor, playing a sound to announce a contextual change, speaking the text while a background noise is played, or altering the volume of the voice speaking the text.

Next, the spoken elements as determined in step **303** are associated **309** with the audio cues that were determined in step **307**. The association **309** of the spoken elements and the audio clues can produce a tagged document or a speech script for use with a document.

In one embodiment, the invention can process hyperlinks in a document in an intelligent manner. In one implementation, when a block of text includes a hyperlink, a text-to-speech processor can indicate (e.g., by auditory cue) to the user that a string of text (possibly a word or phrase) is a hyperlink. As one example, a low tone in the background can be played while a text-to-speech processor speaks the hyperlink. As another example, a tone or click can be played before and/or after the hyperlink. As still another example, a text-to-speech processor can use a distinct voice to let the user know that text being read is a hyperlink. Besides auditory cues for denoting hyperlinks, hyperlinks can point to other documents and such other documents can be processed for text-to-speech and/or audio cues.

FIG. **4** is a flow diagram of a text-parsing process **400** according to one embodiment of the invention. The text-parsing process **490** can be used to resolve links (e.g., hyperlinks) in a document. For example, the text-parsing process **400** can be performed by the text-to-speech analyzer **151** of FIG. **1**(*b*).

The text-parsing process **400** begins by selecting **401** text within an electronic document to be parsed. Next, a determination **403** determines if links (e.g., hyperlinks) in the selected text are to be resolved. For example, if a user can indicate (e.g., with a preference setting) whether links are to be resolved. Resolving a link can involve following the link to another document, following the link to another place on the same document, or simply determining where the link leads. In some cases, such as when the document being processed is a webpage, it may be undesirable to follow all links, since webpages sometimes contain numerous links. In other cases, it may be desirable to resolve one or more links in-line, such as when the webpage contains footnotes. Alternatively, the text-parsing process **400** may simply determine that a document contains one or more links without resolving any of the links. Thus the determination **403** can be used to determine which, if any, links are to be resolved in a particular document or block of text.

If the decision **403** determines that unresolved links are not to be resolved, the selected text is parsed **417** and the parsing process **400** ends. Parsing **417** can be, for example, the parsing **203** as described in reference to FIG. **2**. On the other hand, if determination **403** determines that one or more unresolved links are to be resolved, then the text-parsing process **400** continues to decision **405** which determines if there are unresolved links in the selected text. If decision **405** determines that there are no unresolved links in the selected block of text, then the selected text is parsed **417** and the text-parsing process **400** ends. Alternatively, if decision **405** determines that there are unresolved links in the selected text, then the first unresolved link is resolved **407**. Next, a decision **409** determines if the link that has been resolved **407** is a link to new text, such as a link to a footnote or a new document. If decision **409** determines that the resolved link is not a link to new text, for example if the link is a link (e.g., a bookmark) to a different section of the same document, then the text-parsing process **400** proceeds to decision **415**. On the other hand, if decision **409** determines that the resolved link is a link to new text, a decision **411** determines if the new text is to be converted. In the case wherein the new link is a link to a new document, for example a different webpage, decision **411** can determine that the new text is not to be converted. Alternatively, in the case where the new link is a link to a footnote, decision **411** can determine that the text is to be converted. The decision of whether to convert a particular block of text can be, for example, predetermined by a user (i.e., by setting a preference setting) or predetermined by the designer of the program used to parse the document (i.e., set by default in a program). If decision **411** determines that the new text is to be converted, the new text is appended **413** to the text that was previously selected **401** to be parsed. At this point in the text-parsing process **400**, the text that will eventually be parsed in step **417** includes the original text selected **401** and the new text appended **413**.

Following block **413**, following the decision **409** if the resolved link is not a link to new test, or following the decision **411** if the new text is not to be converted, a decision **415** determines if there are more unresolved links in the selected text. If decision **415** determines that there are more unresolved links, the text-parsing process **400** continues to decision **405** and subsequent blocks. If decision **415** determines that there are no more unresolved links, the text-parsing process **400** continues to block **417** where the selected text together with any appended new test can be parsed. Following block **417**, the text-parsing process **400** can end.

In one embodiment of the invention, in the case where the new link is a link to a new document, the new document can be converted and stored as a separate audio file. Furthermore, links between one or more audio files created by, for example, the text-to-speech processing system of FIG. **1**(*b*) can be inserted as chapter or section markers in the audio files. Later, when a user listening to an audio file created by a text-to-speech processor is notified (e.g., by an audio cue) that a hyperlink or link to another document has been reached, that user could, if desired, skip forward to that document.

FIG. **5** is a flow diagram of an audio summary generating process **500** according to one embodiment of the invention. The audio summary generating process **500** can be used to create an audio summary for a file. The resulting audio summary can be accessed without opening the file. In one embodiment, the audio summary is implemented as "audio metadata", whereby metadata that is incorporated into a file is converted into speech. For example, many audio files, such as MP3 files or AAC files, contain metadata (i.e., data and that describes the data contained in the file). The audio summary generating process **500** can be used to convert the metadata contained in the MP3 or AAC file into an audio format (i.e., audio metadata) using a text-to-speech processor. One advantage of converting metadata into audio metadata is that a user can determine the contents of a file without having to look at or open that file.

The audio summary generating process **500** can begin by generating **501** an audio summary for a document. As examples, the document can be a music file, a text document, or a webpage. In the case of a music file, the generating of an audio summary can involve examining the metadata of the music file (typically contained in the file headers) and converting some or all of the metadata to audio. In the case of a text file, the generating **501** of the audio summary can include parsing the document to determine the author and title of the document. Further, in the case of the text file, the generating **501** of the audio summary can include identifying abstract or summary text and including audio for such text in the audio summary. In the case of a webpage, a generating **501** of the audio summary can include parsing the webpage for metadata, identifying title, author and/or abstract information for the webpage.

E-mail and RSS feeds typically include text and thus can also be considered documents. In the case of e-mail, the generating of the audio summary can include summarizing the contents of an e-mail inbox. For example, if an e-mail inbox contains five messages, the audio summary generating process can parse the headers of the five e-mails and compose a summary of the authors and subjects of the e-mails. Similarly, in the case of an RSS feed, the audio summary generating process can generate **501** a summary of the sources and subjects of new or updated RSS feeds.

In any event, after the audio summary is generated **501**, the audio summary generating process **500** can link **503** the audio summary to the document. The linking **503** of the audio summary to the document can include, for example, embedding the audio summary into a header of a file containing the document. Alternately, the linking **503** of the audio summary to the document can store the audio sum-

mary in a directory associated with the document and provide a pointer (i.e., a software pointer) to the document.

FIG. **6** is a flow diagram of an audio summary file tagging process **600** according to one embodiment of the invention. The audio summary file tagging process **600** can be used to tag or more files with audio summary data. The audio summary file tagging process **600** can be performed as a batch operation, for example, on a folder of files, an e-mail inbox, a collection of RSS feeds, or on an entire directory tree. In one implementation, the audio summary file tagging process **600** can occur during, for example, the generation **501** of an audio summary for a document as described above in reference to FIG. **5**.

The audio summary file tagging process **600** begins by selecting **601** one or more files to be tagged with an audio summary. As mentioned above, the selection **601** of one or more files can include files within a folder or directory. Next, a first file is parsed **603**. The file can be parsed **603**, for example, using a text-to-speech analyzer **151** as described in FIG. **1**(*b*). After the file is parsed **603**, an audio summary for the file is generated **605**. The audio summary can be generated **605**, for example, as described above with reference to FIG. **5**. After generating **605** the audio summary for the file, the audio summary file tagging process **600** continues by linking **607** the audio summary to the file. The linking **607** can be accomplished, for example as described above in reference to FIG. **5**. Next, a decision **609** that determines if more files have been selected to summarize, such as in the case where multiple files have been selected to be tagged with audio summaries. If decision **609** determines that there are more files to summarize, then the audio summary file tagging process **600** continues to parse **611** a next selected file. After the next selected file is parsed **611**, the audio summary file tagging process returns to repeat block **605** and subsequent blocks to produce the audio summary for the selected file. On the other hand, if decision **609** determines that there are no more files to summarize, then the audio summary file tagging process **600** ends.

In one embodiment, when a user selects a file (i.e., clicks on the file using a mouse) that contains an audio summary, a text-to-speech processor, for example the text-to-speech conversion application **103** of FIG. **1**(*a*), presents an audio summary of the selected file. In another embodiment, when a user mouses over (i.e., manipulates a mouse to place a cursor over) a file, a text-to-speech processor presents the audio summary of the file that has been moused over. In a third embodiment, selecting or mousing over a file or document causes a media player application to play an audio summary associated with the selected document or file. In still another embodiment, a portable media player incorporates the capability to present an audio summary of a file when a user selects the file, for example, by using the user interface of the portable media player. In one embodiment, the audio summary can be generated on a personal computer and transferred to a portable media player for later presentation by the portable media player. In another embodiment, the audio summary can be presented using a text-to-speech processor operating on the portable media player.

FIG. **7** is a flow diagram of an audio summary presentation process **700** according to one embodiment of the invention. The audio summary presentation process **700** can be implemented by, for example, the host computer **101** of FIG. **1**(*a*). Alternately, or in addition, the audio summary presentation process **700** can be implemented by the portable media player **121** of FIG. **1**(*a*).

The audio summary presentation process **700** begins by receiving **701** a selection of text (e.g., document) to be summarized. In the case of a webpage, entering the webpage URL into a network browser can operate to select text to be summarized. In the case of a document or file, clicking or mousing over a file can operate to select text from an associated document. In the case of an e-mail application, opening an e-mail inbox can operate to select text of e-mails in the e-mail inbox. Similarly, in the case of an RSS reader, navigating to or opening a RSS reader application can operate to select text from one or more of the RSS feeds available to the RSS reader. Next, the audio summary presentation process obtains **703** an audio summary for the selected text. The audio summary can be created or, if already created and stored, the audio summary can be retrieved. Finally, the audio summary for the selected text is presented **705** to the user. For example, the host computer **101** or the portable media player **121** can play the audio summary for a user.

FIG. **8** is a flow diagram of an audio summary presentation process **800** according to one embodiment of the invention. The audio summary presentation process **800** can be used to apply the audio summary presentation process **700** of FIG. **7** to a group of files or documents. The audio summary presentation process **800** can be implemented by, for example, the host computer **101** of FIG. **1**(*a*). Alternatively, or in addition, the audio summary presentation process **800** can be implemented by the portable media player **121** of FIG. **1**(*a*).

The audio summary presentation process **800** begins by identifying **801** files of interest. The files of interest can pertain to text or documents of interest. For example, the identifying **801** can be initiated by selecting a folder or directory of files or navigating to a website. Next, a first file of interest is selected **803**. After selecting **803** the file, an audio summary is obtained **805** for the selected file. The audio summary can be obtained **805** from memory or can be generated. Next, the audio summary is presented **807** for the selected file.

After presenting **807** the audio summary for the selected file, a decision **811** determines if more files to be processed to provide audio summaries are. Here, the decision **811** can be based on the files of interest identified in step **801**. If there are more files to be processed, the audio summary presentation process **800** returns to block **803** where a next file can be selected and then similarly processed. On the other hand, if there are no more files to be processed, then the audio summary presentation process **800** ends.

In one embodiment, when a user selects a file (i.e., clicks on a file using a mouse) a directory that contains one or more audio summaries, a text-to-speech processor, for example the text-to-speech conversion application **103** of FIG. **1**(*a*), presents an audio summary of the selected file. In another embodiment, the audio summary presentation process **800** can be used to create an audio summary of one or more files, e-mails, RSS feeds, etc., create an audio file of the audio summary, and later transfer the audio file of the audio summary to a portable media player for playback at the user's convenience. In this embodiment, the audio summary of the one or more files can be a separate audio file from the audio files that it summarizes. For example, in the case of an e-mail inbox, an audio summary can be made describing the contents of the user's inbox. In addition, each individual e-mail can be converted to audio and stored in one or more separate files. Alternatively, a single audio file can be created containing chapters, wherein one chapter contains an audio summary of the contents of the user's e-mail inbox and subsequent chapters contain text-to-speech conversions of the individual e-mails in the user's e-mail inbox.

It is noted that audio summaries can be embedded or linked to documents by any of the above processes at any stage of file creation or after files have been created. For example, an audio summary can be embedded into a webpage by the creator of the webpage. In another example, an audio summary can be embedded in a document (e.g., as metadata) upon creation of the document by the author of the document. Thus, in the case where a user purchases a media file on an online store, the producer of the media file may have already embedded an audio summary and/or audio metadata into the file.

FIG. **9**(*a*) is a screenshot of an exemplary document **900**. The exemplary document **900** is a document that contains not only text but also a footnote **901**, a quote **903**, a hyperlink **905** and an image **907**. The document also varies text sizes and has punctuation and formatting. The document **900** can be a webpage, a PDF document, or any other document type that can contain not only text but also specific components such as footnotes, quotes, hyperlinks and images.

FIG. **9**(*b*) is a screenshot of an exemplary marked up document **950** that has been prepared for conversion to speech. The exemplary marked up text document **950** can represent the exemplary document **900** of FIG. **9**(*a*) after it has been marked up with instructions for subsequent spoken presentation by a voice synthesizer (e.g., a computerized voice used by a text-to-speech program to speak text.) The instructions embedded in the exemplary marked up text document **950** can be regarded as instructions corresponding to one implementation of a text-to-speech markup language described above in reference to FIG. **1**(*b*) above. Further, exemplary text marked up document **950** can be regarded as an example of a text-to-speech processing script created by the text-to-speech analyzer **151** of FIG. **1**(*b*). In the exemplary marked up text document **950**, pauses can indicate punctuation, for example a voice synthesizer can insert long pause **951** to indicate two new lines, a short pause **953** to indicate a dash, a short pause **963** to indicate a font style change, and a long pause **967** to indicate extended punctuation, in this case a long string of asterisks. Long and short pauses can have different durations as set, for example, by a user preference. The exemplary marked up text document **950** also includes markup indicating changes in the speed at which the text-to-voice synthesizer will speak text. Rate increase **955** indicates parenthetical text. Rate increase **957** indicates a footnote. Rate decrease **965** indicates a link (e.g., hyperlink). The rate at which text is spoken can be set by the user as a user preference. The exemplary marked up text document **950** also includes voice synthesizer voice selections. Voice selection **959** indicates a male voice, designated Steve, will be used to speak the text contained in quotes. Voice selection **961** indicates that a voice, designated narrator, will be used to speak the text. Any number of different voices may be available, depending on the speech synthesizer. Alternatively, the parameters covering the voice produced by the text-to-speech synthesizer (e.g., pitch, speed, tone, accent, inflection, etc.) can be designated in the document, allowing for the creation of custom voices for a particular document. The exemplary marked up text document **950** also includes markup that directs text-to-speech processor to play sounds at particular times during the speaking of a document. In the exemplary marked up document **950**, a command to play a sound **973** is used to indicate a link in the document, while a command to play a sound **969** is used to indicate an image in the document. The exemplary marked up text document **950** also depicts that the footnote text **971** is spoken inline where it is first referenced in the document and is not re-spoken at the end of the page.

The advantages of the invention are numerous. Different aspects, embodiments or implementations may, but need not, yield one or more of the following advantages. One advantage of certain embodiments of the invention is that improved quality of text-to-speech processing and improved identification of documents can be provided through the use of audio metadata. Another advantage of certain embodiments of the invention is that pauses, voice changes, and other audio cues can be presented to a user, thus improving the user experience when listening to text-to-speech output. This improved user experience when listening to text-to-speech output can be especially beneficial to a visually impaired listener, who can gain a fuller and more comprehensive understanding of a document's structure, format and content. Another advantage of certain embodiments of the invention is that audio summaries can for documents can be produced and presented. Another advantage of certain embodiments of the invention is that use of text-to-speech processing scripts allows separation of text-to-speech presentation software from text-to-speech processing software, which can reduce the need for complex text-to-speech processing applications on device providing speech presentation. For example, a device with minimal processing power can run a simple text-to-speech engine that follows a text-to-speech script that has been prepared on a more powerful device rather than having to perform the text-to-speech processing itself.

The various aspects, features, embodiments or implementations of the invention described above can be used alone or in various combinations.

Embodiments of the invention can, for example, be implemented by software, hardware, or a combination of hardware and software. Embodiments of the invention can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data which can thereafter be read by a computer system. Examples of the computer readable medium generally include read-only memory and random-access memory. More specific examples of computer readable medium are tangible and include Flash memory, EEPROM memory, memory card, CD-ROM, DVD, hard drive, magnetic tape, and optical data storage device. The computer readable medium can also be distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

The many features and advantages of the present invention are apparent from the written description. Further, since numerous modifications and changes will readily occur to those skilled in the art, the invention should not be limited to the exact construction and operation as illustrated and described. Hence, all suitable modifications and equivalents may be resorted to as falling within the scope of the invention.

What is claimed is:

1. A method for converting text to speech, the method comprising:

at an electronic device with a processor and memory storing one or more programs for execution by the processor:

parsing a document to identify a plurality of text elements in the document to be converted to speech, the subset of text having a markup tag;

creating an announcement comprising a spoken description of a context related to the markup tag; and

generating audio that includes the spoken form of the subset of text and the announcement, wherein the announcement is spoken prior to the spoken form of the subset of text.

2. The method of claim **1**, wherein the context is a footnote.

3. The method of claim **1**, wherein the context is a title.

4. The method of claim **1**, further comprising:

identifying a second subset of text while parsing the document, the second subset of text having a second markup tag that is different from the markup tag; and

creating a second announcement comprising a spoken description of a second context; wherein the generated audio includes a spoken form of the second subset of text and the second announcement, wherein the second announcement is spoken prior to the spoken form of the second subset of text.

5. The method of claim **1**, wherein the document does not include text corresponding to the announcement.

6. The method of claim **1**, further comprising:

identifying a non-text element of the document while parsing the document; and

creating an audio cue that represents the non-text element in the document, wherein the generated audio includes the audio cue.

7. The method of claim **6**, wherein the non-text element is an image.

8. The method of claim **6**, wherein the non-text element is a hyperlink.

9. The method of claim **1**, further comprising:

generating a text-to-speech processing script that includes the subset of text and the announcement, wherein the text-to-speech processing script is processed to generate the audio.

10. A non-transitory computer-readable storage medium comprising instructions for causing one or more processors to:

parse a document to identify a plurality of text elements in the document to be converted to speech, the subset of text having a markup tag;

create an announcement comprising a spoken description of a context related to the markup tag; and

generate audio that includes the spoken form of the subset of text and the announcement, wherein the announcement is spoken prior to the spoken form of the subset of text.

11. The non-transitory computer-readable storage medium of claim **10**, wherein the context is a footnote.

12. The non-transitory computer-readable storage medium of claim **10**, wherein the context is a title.

13. The non-transitory computer-readable storage medium of claim **10**, further comprising instructions for:

identifying a second subset of text while parsing the document, the second subset of text having a second markup tag that is different from the markup tag; and

creating a second announcement comprising a spoken description of a second context; wherein the generated audio includes a spoken form of the second subset of text and the second announcement, wherein the second announcement is spoken prior to the spoken form of the second subset of text.

14. The non-transitory computer-readable storage medium of claim **10**, wherein the document does not include text corresponding to the announcement.

15. The non-transitory computer-readable storage medium of claim **10**, further comprising:

identifying a non-text element of the document while parsing the document; and

creating an audio cue that represents the non-text element in the document, wherein the generated audio includes the audio cue.

16. The non-transitory computer-readable storage medium of claim **15**, wherein the non-text element is an image.

17. The non-transitory computer-readable storage medium of claim **15**, wherein the non-text element is a hyperlink.

18. An electronic device comprising:

one or more processors;

memory;

one or more programs, wherein the one or more programs are stored in the memory and configured to be executed by the one or more processors, the one or more programs including instructions for:

parsing a document to identify a plurality of text elements in the document to be converted to speech, the subset of text having a markup tag;

creating an announcement comprising a spoken description of a context related to the markup tag; and

generating audio that includes the spoken form of the subset of text and the announcement, wherein the announcement is spoken prior to the spoken form of the subset of text.

19. The electronic device of claim **18**, wherein the context is a footnote.

20. The electronic device of claim **18**, wherein the context is a title.

21. The electronic device of claim **18**, wherein the one or more programs further comprise instructions for:

identifying a second subset of text while parsing the document, the second subset of text having a second markup tag that is different from the markup tag; and

creating a second announcement comprising a spoken description of a second context; wherein the generated audio includes a spoken form of the second subset of text and the second announcement, wherein the second announcement is spoken prior to the spoken form of the second subset of text.

22. The electronic device of claim **18**, wherein the document does not include text corresponding to the announcement.

23. The electronic device of claim **18**, wherein the one or more programs further comprise instructions for:

identifying a non-text element of the document while parsing the document; and

creating an audio cue that represents the non-text element in the document, wherein the generated audio includes the audio cue.

24. The electronic device of claim **23**, wherein the non-text element is an image.

25. The electronic device of claim **23**, wherein the non-text element is a hyperlink.

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