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United States Patent [19]

Mitchell et al.

[11] **Patent Number: 5,857,099**

[45] **Date of Patent: Jan. 5, 1999**

[54] **SPEECH-TO-TEXT DICTATION SYSTEM WITH AUDIO MESSAGE CAPABILITY**

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[73] Assignee: **AllVoice Computing Plc**, Devon, England

[21] Appl. No.: **896,105**

[22] Filed: **Jul. 17, 1997**

Related U.S. Application Data

[62] Division of Ser. No. 720,373, Sep. 27, 1996.

[51] **Int. Cl.**[6] **G10L 9/06**; G06F 7/21

[52] **U.S. Cl.** **704/235**; 704/270; 707/530

[58] **Field of Search** 704/235, 270; 707/530

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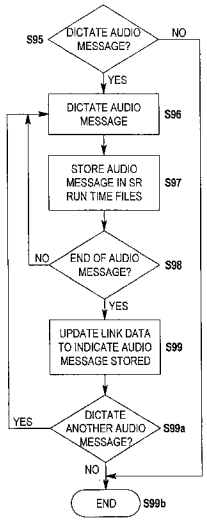
Assistant Examiner—Tālivaldis Ivars Šmits
Attorney, Agent, or Firm—Schwegman, Lundberg, Woessner & Kluth, P.A.

[57] **ABSTRACT**

Data processing apparatus is disclosed for receiving recognition data from a speech recognition engine and its corresponding dictated audio data where the recognition data includes recognised words or characters. A display displays the recognised words or characters and the recognised words or characters are stored as a file together with the corresponding audio data. Link data is formed to link the position of the words or characters in the file and the position of the corresponding audio component in the audio data. The recognised words or characters can be processed without loosing the audio data.

22 Claims, 17 Drawing Sheets



GOOGLE EXHIBIT 1017

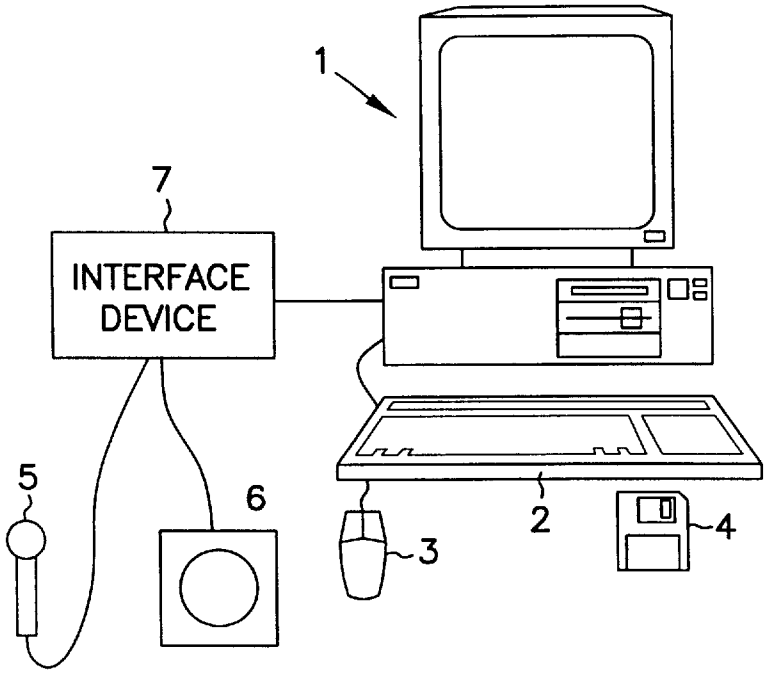


FIG. 1

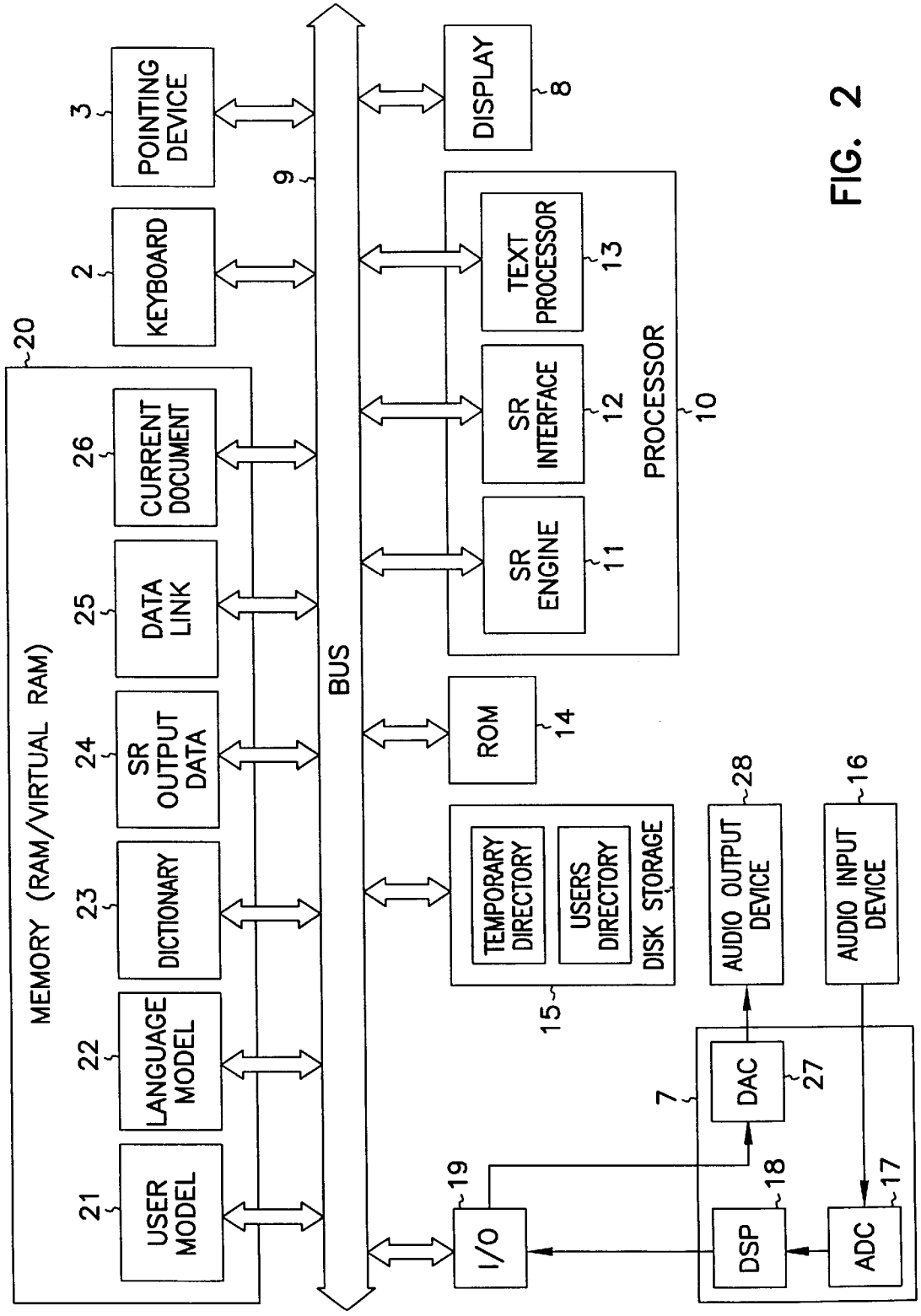

MEMORY (RAM/VIRTUAL RAM)
20
USER MODEL
21
LANGUAGE MODEL
22
DICTIONARY
23
SR OUTPUT DATA
24
DATA LINK
25
CURRENT DOCUMENT
26
KEYBOARD
2
POINTING DEVICE
3
BUS
9
DISPLAY
8
PROCESSOR
10
SR ENGINE
11
SR INTERFACE
12
TEXT PROCESSOR
13
ROM
14
DISK STORAGE
15
TEMPORARY DIRECTORY
USERS DIRECTORY
I/O
19
7
DSP
18
DAC
27
ADC
17
AUDIO OUTPUT DEVICE
28
AUDIO INPUT DEVICE
16

FIG. 2

IDENTIFIER TAG	AUDIO START	AUDIO END	ALTERNATIVE WORDS AND SCORES
1	0	199	$n_{1a}W_{1a}$ $n_{1b}W_{1b}$ $n_{1c}W_{1c}$ ...
2	199	324	$n_{2a}W_{2a}$ $n_{2b}W_{2b}$ $n_{2c}W_{2c}$ ...
3	324	361	...
4	361	...	
5	...		
...			

FIG. 3

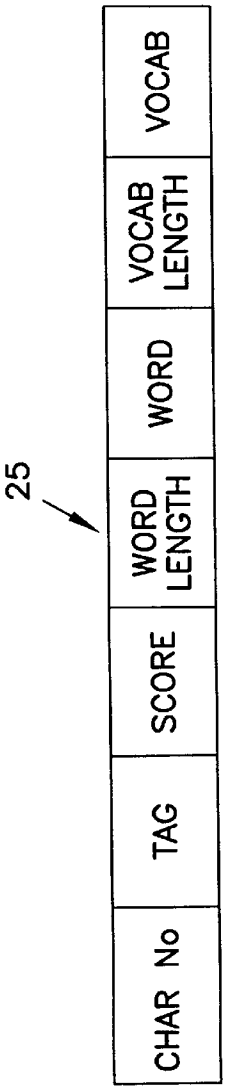


FIG. 4

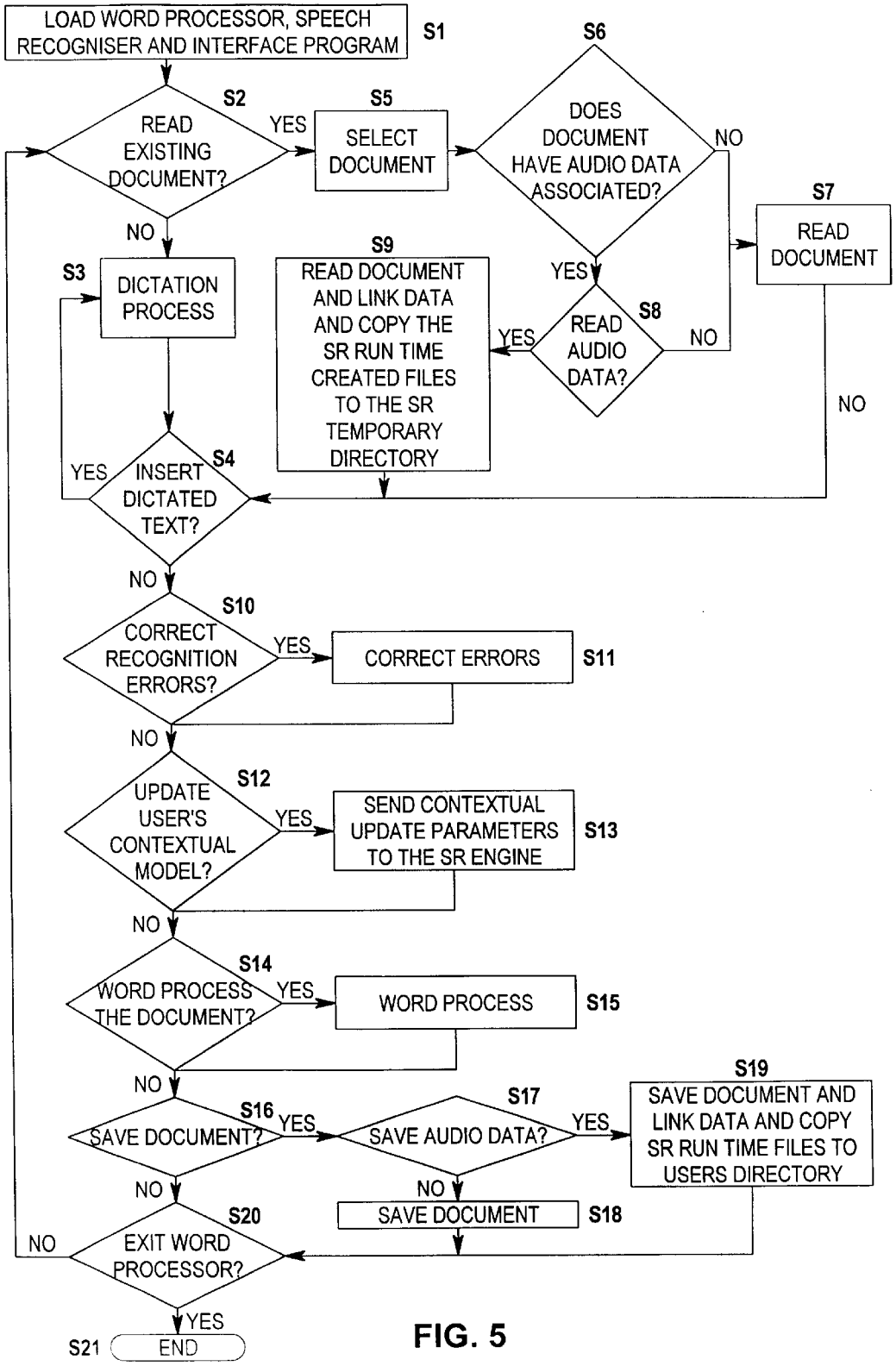

LOAD WORD PROCESSOR, SPEECH RECOGNISER AND INTERFACE PROGRAM
S1
S2
READ EXISTING DOCUMENT?
YES
NO
S5
SELECT DOCUMENT
S6
DOES DOCUMENT HAVE AUDIO DATA ASSOCIATED?
NO
YES
S7
READ DOCUMENT
S3
DICTATION PROCESS
S9
READ DOCUMENT AND LINK DATA AND COPY THE SR RUN TIME CREATED FILES TO THE SR TEMPORARY DIRECTORY
S8
READ AUDIO DATA?
YES
NO
NO
S4
INSERT DICTATED TEXT?
YES
NO
S10
CORRECT RECOGNITION ERRORS?
YES
CORRECT ERRORS
S11
NO
S12
UPDATE USER'S CONTEXTUAL MODEL?
YES
SEND CONTEXTUAL UPDATE PARAMETERS TO THE SR ENGINE
S13
NO
S14
WORD PROCESS THE DOCUMENT?
YES
WORD PROCESS
S15
NO
S16
SAVE DOCUMENT?
YES
S17
SAVE AUDIO DATA?
YES
S19
SAVE DOCUMENT AND LINK DATA AND COPY SR RUN TIME FILES TO USERS DIRECTORY
NO
NO
SAVE DOCUMENT
S18
S20
EXIT WORD PROCESSOR?
NO
YES
S21
END

FIG. 5

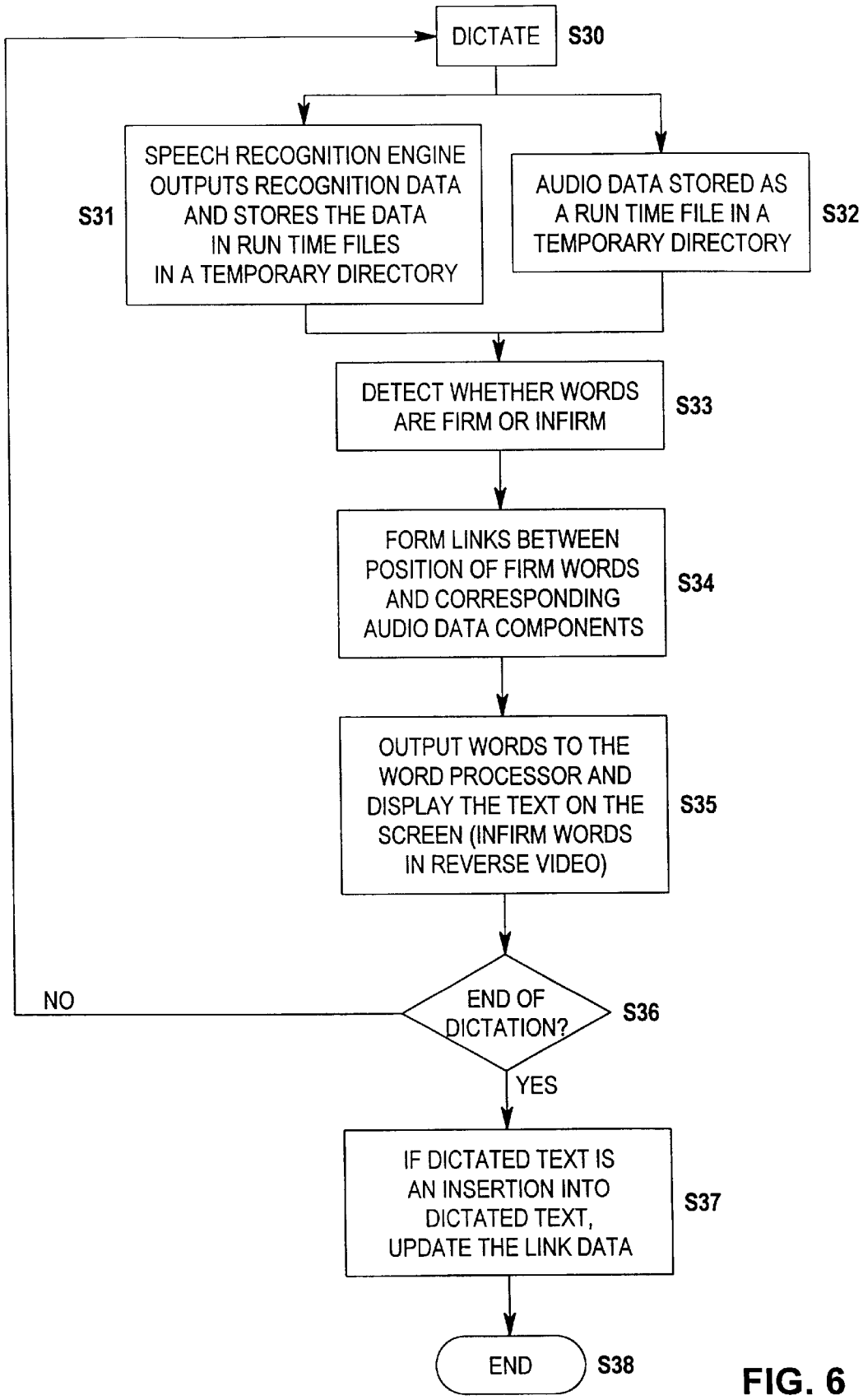

DICTATE
S30
SPEECH RECOGNITION ENGINE OUTPUTS RECOGNITION DATA AND STORES THE DATA IN RUN TIME FILES IN A TEMPORARY DIRECTORY
S31
AUDIO DATA STORED AS A RUN TIME FILE IN A TEMPORARY DIRECTORY
S32
DETECT WHETHER WORDS ARE FIRM OR INFIRM
S33
FORM LINKS BETWEEN POSITION OF FIRM WORDS AND CORRESPONDING AUDIO DATA COMPONENTS
S34
OUTPUT WORDS TO THE WORD PROCESSOR AND DISPLAY THE TEXT ON THE SCREEN (INFIRM WORDS IN REVERSE VIDEO)
S35
NO
END OF DICTATION?
S36
YES
IF DICTATED TEXT IS AN INSERTION INTO DICTATED TEXT, UPDATE THE LINK DATA
S37
END
S38

FIG. 6

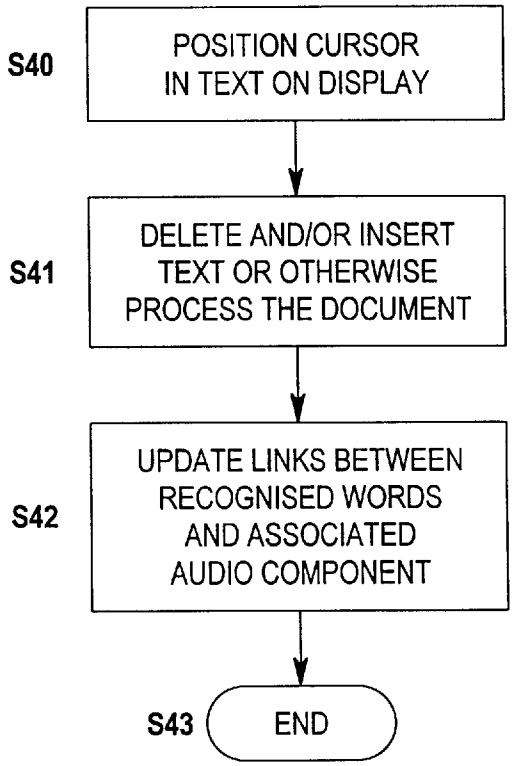

S40
POSITION CURSOR IN TEXT ON DISPLAY
S41
DELETE AND/OR INSERT TEXT OR OTHERWISE PROCESS THE DOCUMENT
S42
UPDATE LINKS BETWEEN RECOGNISED WORDS AND ASSOCIATED AUDIO COMPONENT
S43
END

FIG. 7

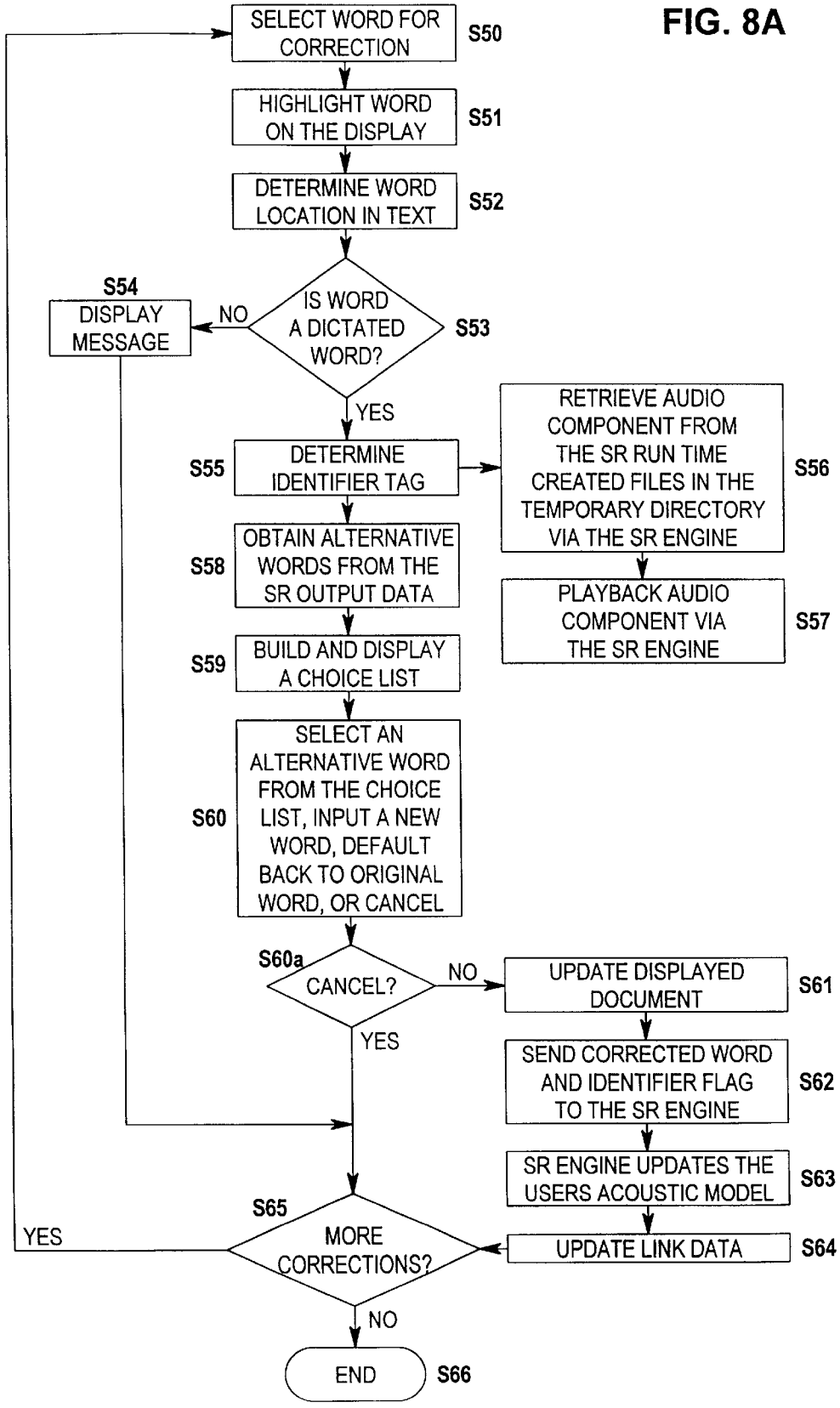


FIG. 8A
SELECT WORD FOR CORRECTION
S50
HIGHLIGHT WORD ON THE DISPLAY
S51
DETERMINE WORD LOCATION IN TEXT
S52
IS WORD A DICTATED WORD?
S53
NO
S54
DISPLAY MESSAGE
YES
S55
DETERMINE IDENTIFIER TAG
RETRIEVE AUDIO COMPONENT FROM THE SR RUN TIME CREATED FILES IN THE TEMPORARY DIRECTORY VIA THE SR ENGINE
S56
PLAYBACK AUDIO COMPONENT VIA THE SR ENGINE
S57
S58
OBTAIN ALTERNATIVE WORDS FROM THE SR OUTPUT DATA
S59
BUILD AND DISPLAY A CHOICE LIST
S60
SELECT AN ALTERNATIVE WORD FROM THE CHOICE LIST, INPUT A NEW WORD, DEFAULT BACK TO ORIGINAL WORD, OR CANCEL
S60a
CANCEL?
NO
UPDATE DISPLAYED DOCUMENT
S61
YES
SEND CORRECTED WORD AND IDENTIFIER FLAG TO THE SR ENGINE
S62
SR ENGINE UPDATES THE USERS ACOUSTIC MODEL
S63
UPDATE LINK DATA
S64
S65
MORE CORRECTIONS?
YES
NO
END
S66

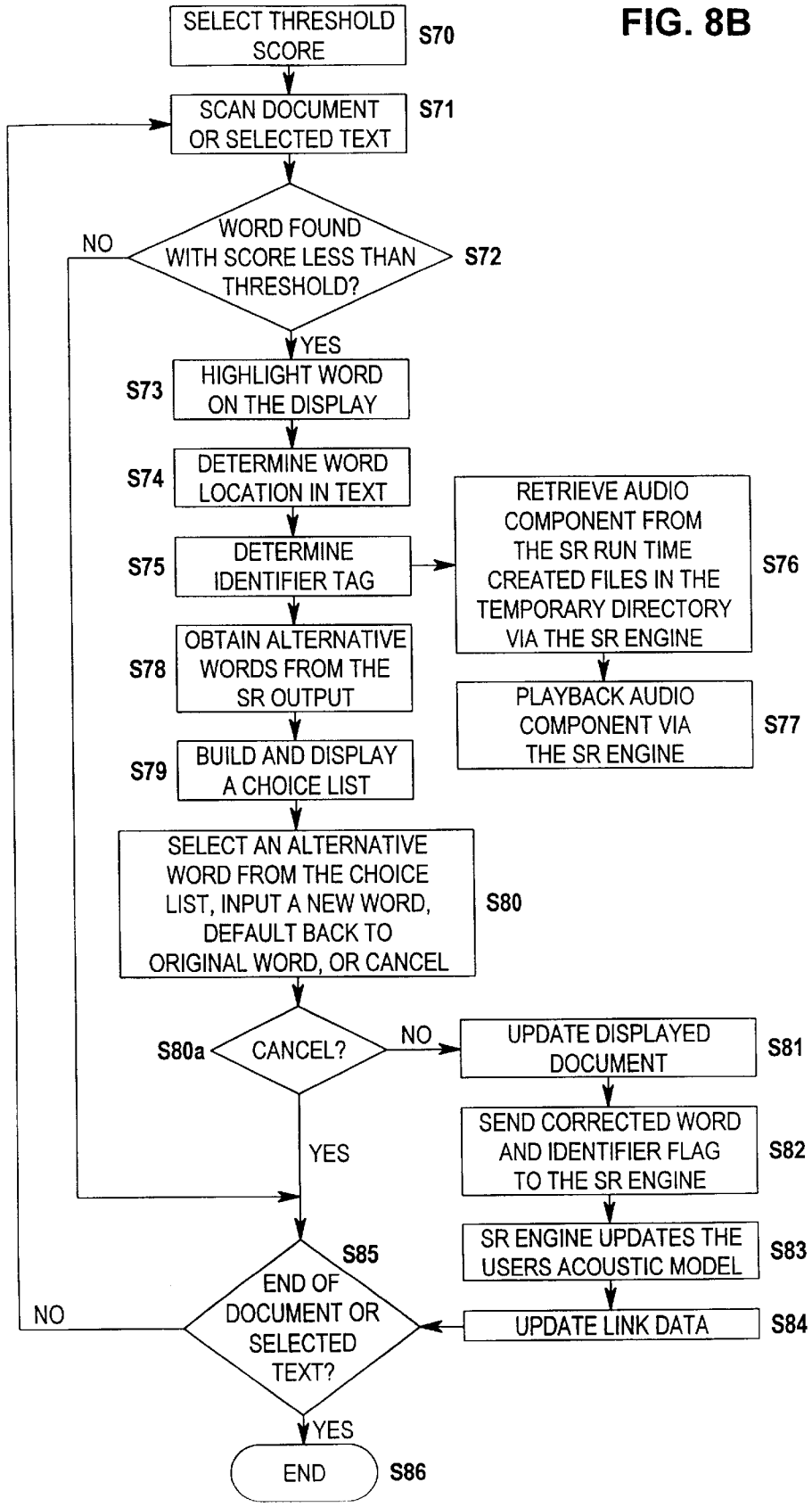


FIG. 8B
SELECT THRESHOLD SCORE
S70
SCAN DOCUMENT OR SELECTED TEXT
S71
WORD FOUND WITH SCORE LESS THAN THRESHOLD?
S72
NO
YES
HIGHLIGHT WORD ON THE DISPLAY
S73
DETERMINE WORD LOCATION IN TEXT
S74
DETERMINE IDENTIFIER TAG
S75
RETRIEVE AUDIO COMPONENT FROM THE SR RUN TIME CREATED FILES IN THE TEMPORARY DIRECTORY VIA THE SR ENGINE
S76
PLAYBACK AUDIO COMPONENT VIA THE SR ENGINE
S77
OBTAIN ALTERNATIVE WORDS FROM THE SR OUTPUT
S78
BUILD AND DISPLAY A CHOICE LIST
S79
SELECT AN ALTERNATIVE WORD FROM THE CHOICE LIST, INPUT A NEW WORD, DEFAULT BACK TO ORIGINAL WORD, OR CANCEL
S80
S80a
CANCEL?
NO
YES
UPDATE DISPLAYED DOCUMENT
S81
SEND CORRECTED WORD AND IDENTIFIER FLAG TO THE SR ENGINE
S82
SR ENGINE UPDATES THE USERS ACOUSTIC MODEL
S83
UPDATE LINK DATA
S84
S85
END OF DOCUMENT OR SELECTED TEXT?
NO
YES
END
S86

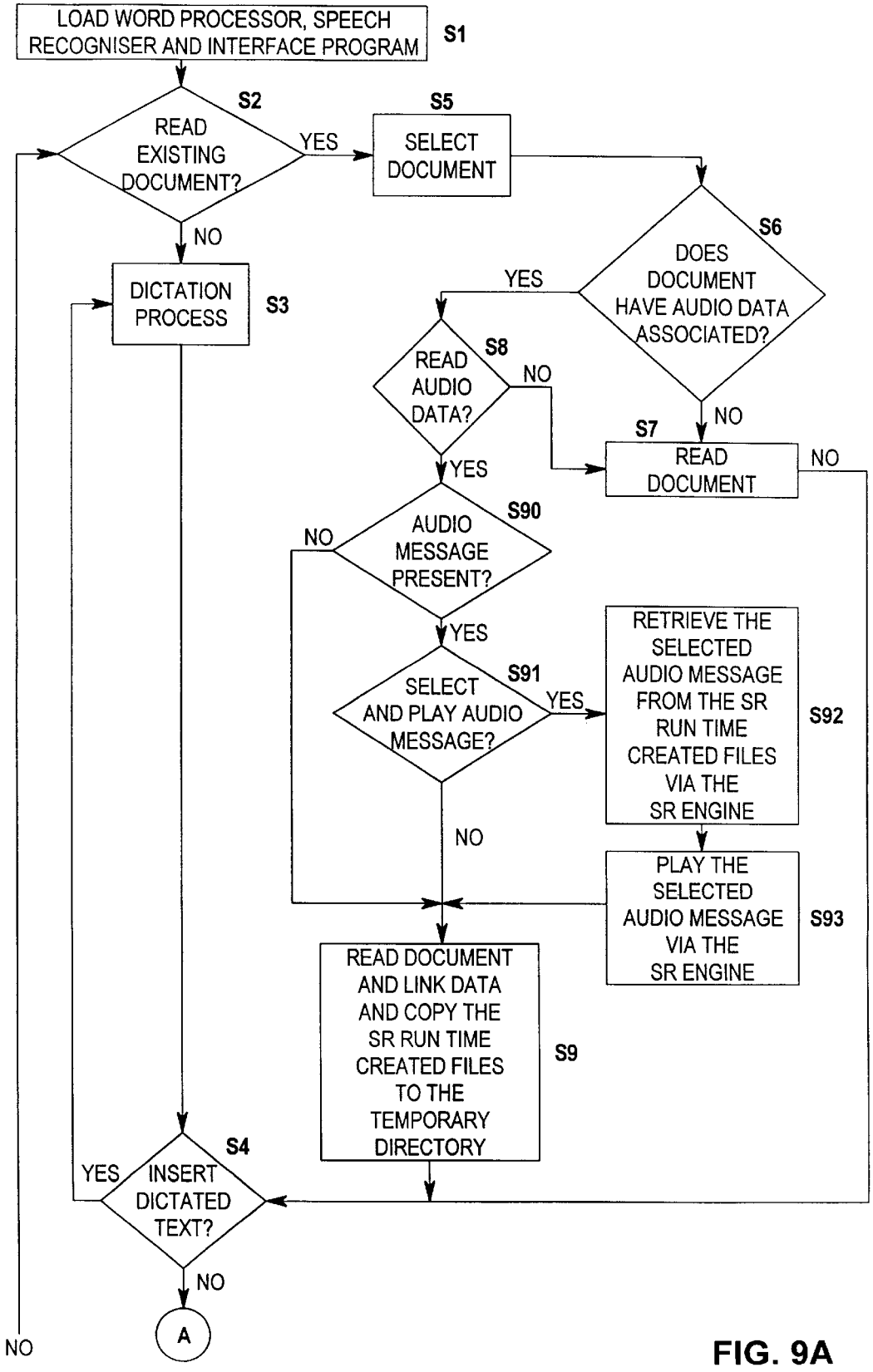

LOAD WORD PROCESSOR, SPEECH RECOGNISER AND INTERFACE PROGRAM
S1
S2
READ EXISTING DOCUMENT?
YES
NO
S5
SELECT DOCUMENT
S6
DOES DOCUMENT HAVE AUDIO DATA ASSOCIATED?
YES
NO
DICTATION PROCESS
S3
S8
READ AUDIO DATA?
NO
YES
S7
READ DOCUMENT
NO
S90
AUDIO MESSAGE PRESENT?
NO
YES
S91
SELECT AND PLAY AUDIO MESSAGE?
YES
NO
RETRIEVE THE SELECTED AUDIO MESSAGE FROM THE SR RUN TIME CREATED FILES VIA THE SR ENGINE
S92
PLAY THE SELECTED AUDIO MESSAGE VIA THE SR ENGINE
S93
READ DOCUMENT AND LINK DATA AND COPY THE SR RUN TIME CREATED FILES TO THE TEMPORARY DIRECTORY
S9
S4
INSERT DICTATED TEXT?
YES
NO
A
NO

FIG. 9A

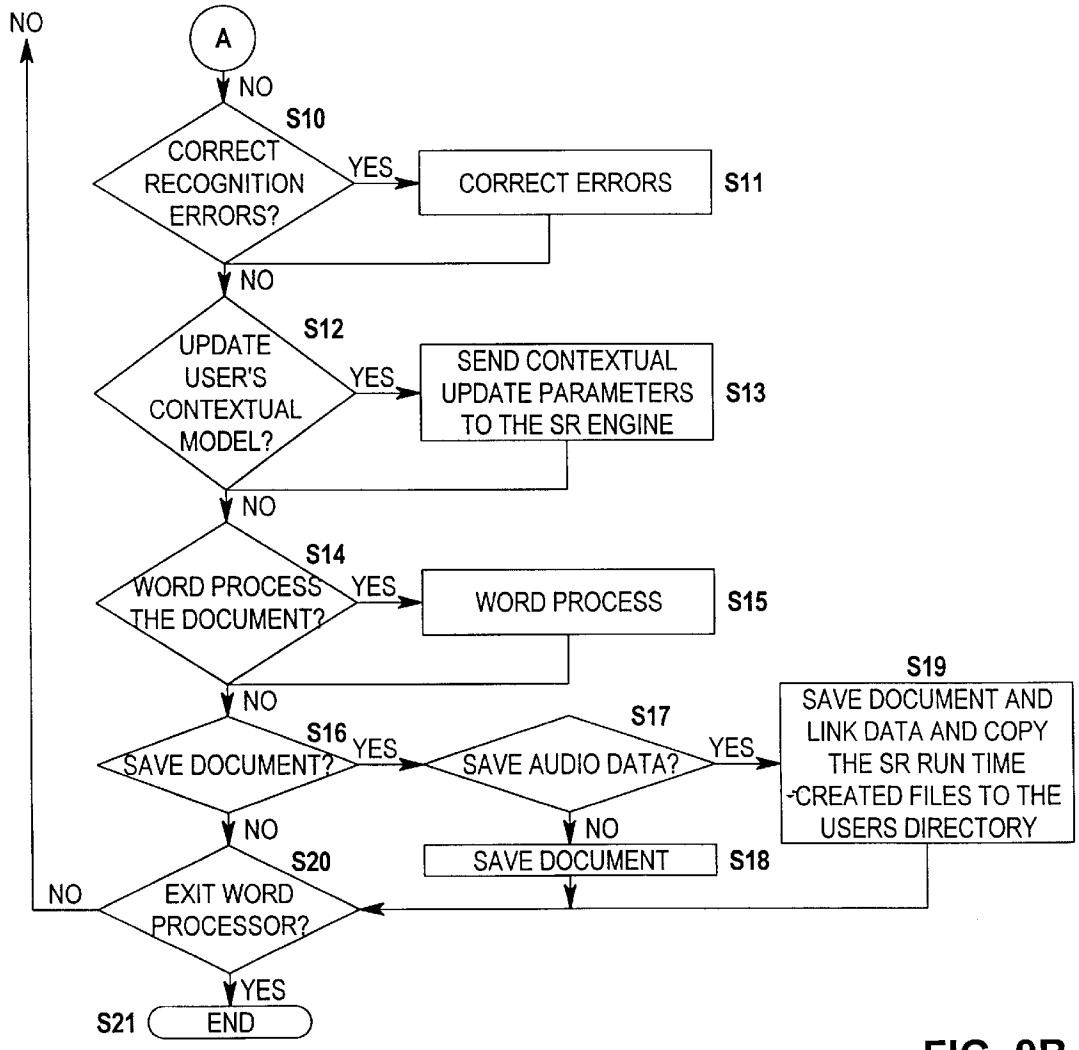

NO
A
NO
S10
CORRECT RECOGNITION ERRORS?
YES
CORRECT ERRORS
S11
NO
S12
UPDATE USER'S CONTEXTUAL MODEL?
YES
SEND CONTEXTUAL UPDATE PARAMETERS TO THE SR ENGINE
S13
NO
S14
WORD PROCESS THE DOCUMENT?
YES
WORD PROCESS
S15
NO
S16
SAVE DOCUMENT?
YES
S17
SAVE AUDIO DATA?
YES
S19
SAVE DOCUMENT AND LINK DATA AND COPY THE SR RUN TIME -CREATED FILES TO THE USERS DIRECTORY
NO
NO
SAVE DOCUMENT
S18
S20
NO
EXIT WORD PROCESSOR?
YES
S21
END

FIG. 9B

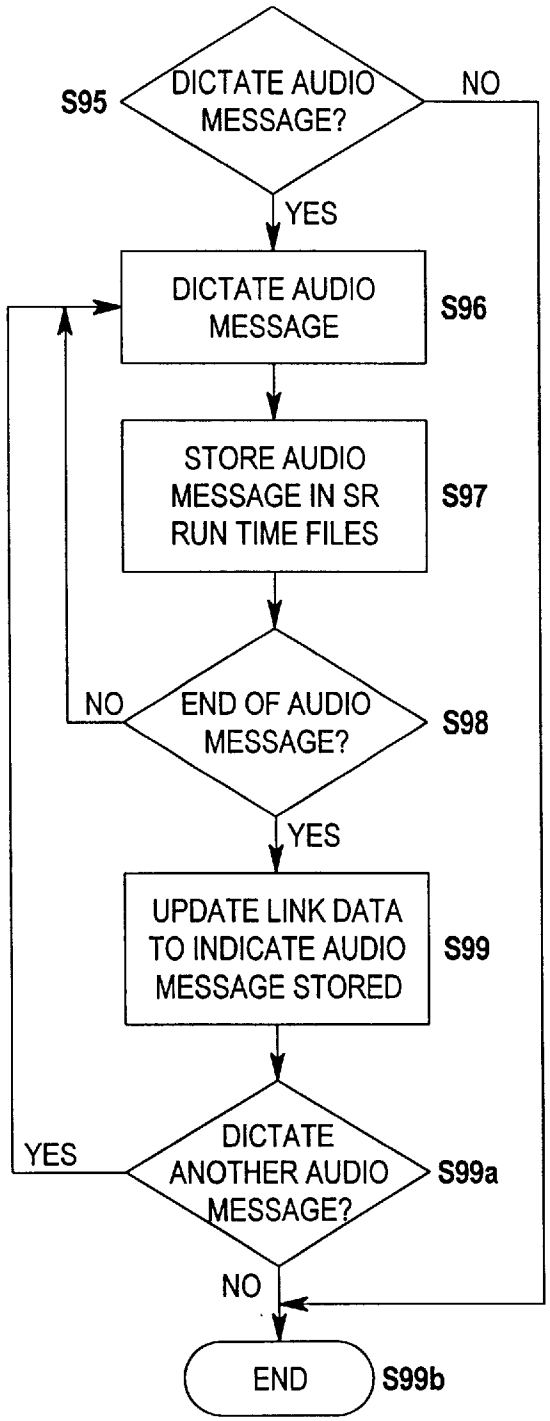

S95
DICTATE AUDIO MESSAGE?
NO
YES
DICTATE AUDIO MESSAGE
S96
STORE AUDIO MESSAGE IN SR RUN TIME FILES
S97
NO
END OF AUDIO MESSAGE?
S98
YES
UPDATE LINK DATA TO INDICATE AUDIO MESSAGE STORED
S99
YES
DICTATE ANOTHER AUDIO MESSAGE?
S99a
NO
END
S99b

FIG. 10

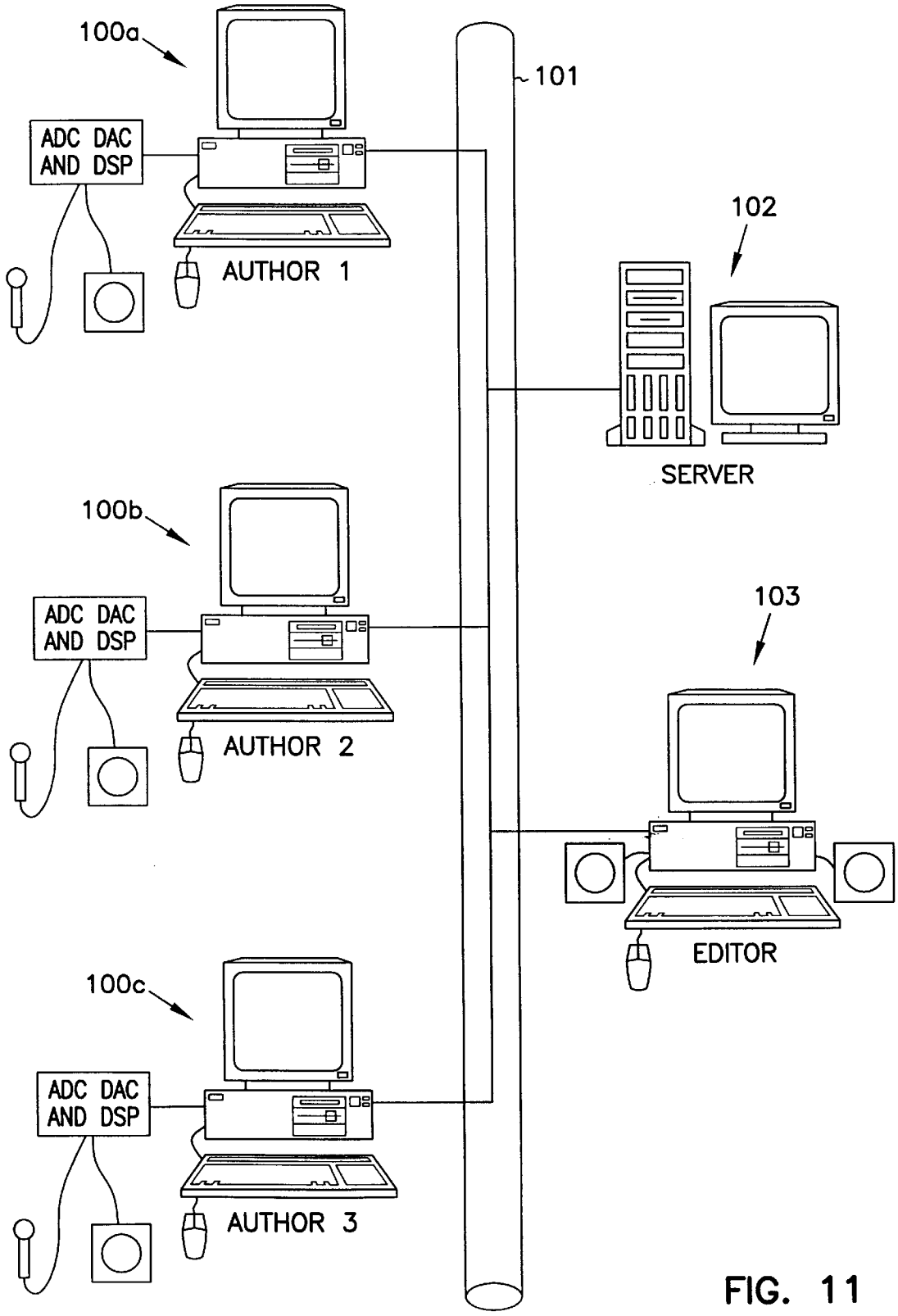

100a
ADC DAC
AND DSP
AUTHOR 1
101
102
SERVER
100b
ADC DAC
AND DSP
AUTHOR 2
103
EDITOR
100c
ADC DAC
AND DSP
AUTHOR 3

FIG. 11

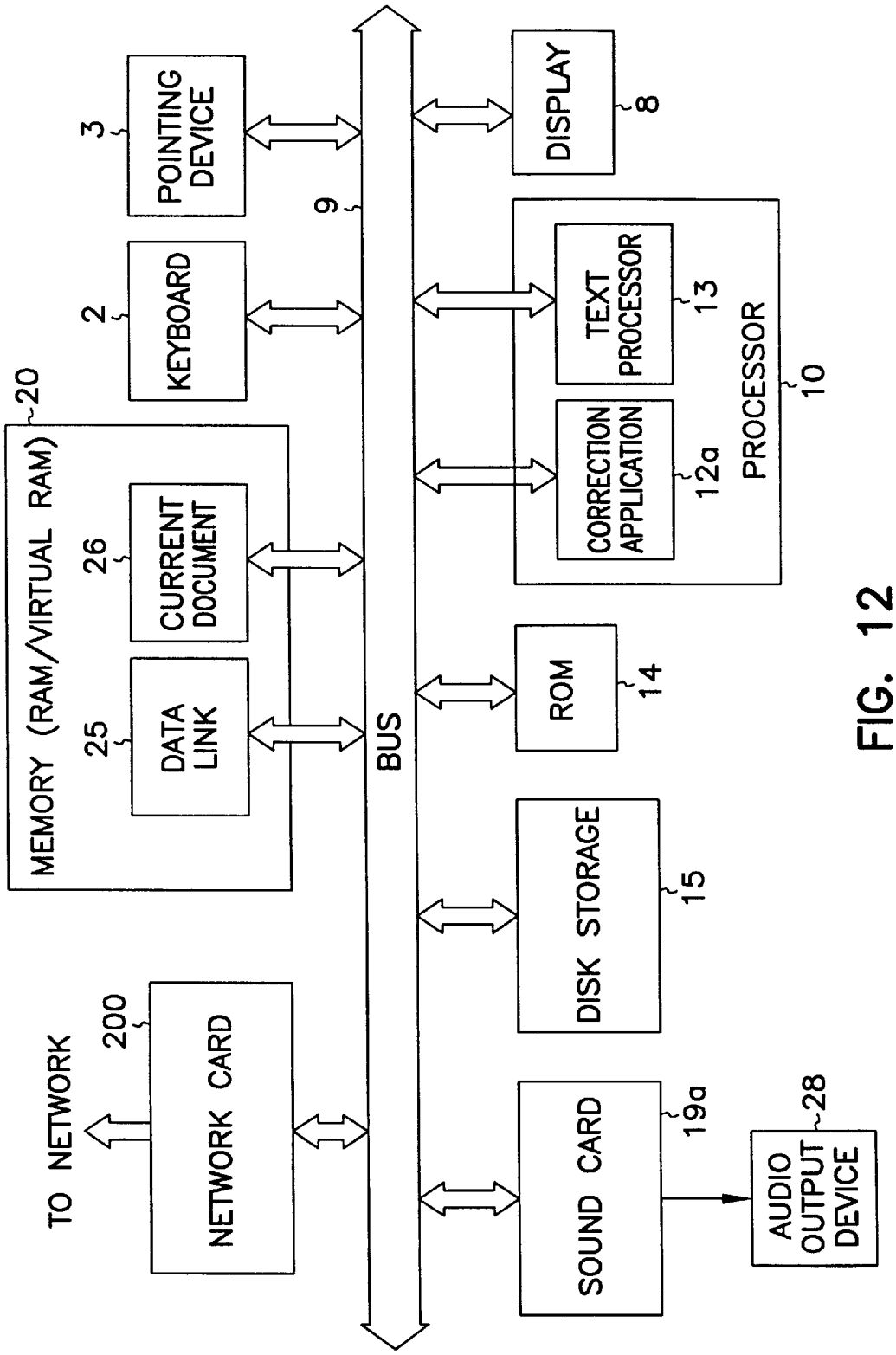

POINTING DEVICE
3
KEYBOARD
2
MEMORY (RAM/VIRTUAL RAM)
20
CURRENT DOCUMENT
26
DATA LINK
25
TO NETWORK
NETWORK CARD
200
9
BUS
DISPLAY
8
TEXT PROCESSOR
13
CORRECTION APPLICATION
12a
PROCESSOR
10
ROM
14
DISK STORAGE
15
SOUND CARD
19a
AUDIO OUTPUT DEVICE
28

FIG. 12

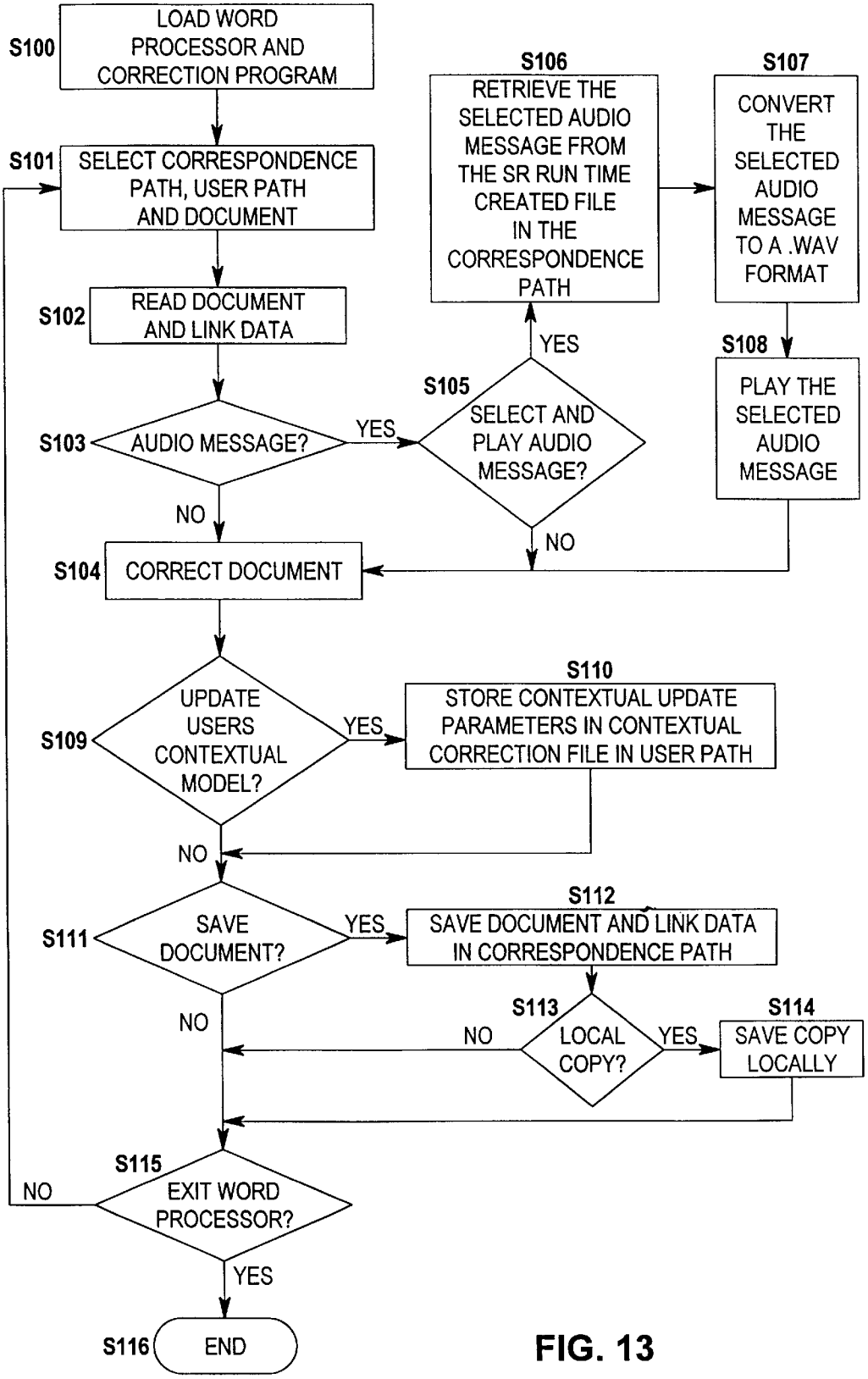

S100
LOAD WORD PROCESSOR AND CORRECTION PROGRAM
S101
SELECT CORRESPONDENCE PATH, USER PATH AND DOCUMENT
S102
READ DOCUMENT AND LINK DATA
S103
AUDIO MESSAGE?
YES
NO
S105
SELECT AND PLAY AUDIO MESSAGE?
YES
NO
S106
RETRIEVE THE SELECTED AUDIO MESSAGE FROM THE SR RUN TIME CREATED FILE IN THE CORRESPONDENCE PATH
S107
CONVERT THE SELECTED AUDIO MESSAGE TO A .WAV FORMAT
S108
PLAY THE SELECTED AUDIO MESSAGE
S104
CORRECT DOCUMENT
S109
UPDATE USERS CONTEXTUAL MODEL?
YES
NO
S110
STORE CONTEXTUAL UPDATE PARAMETERS IN CONTEXTUAL CORRECTION FILE IN USER PATH
S111
SAVE DOCUMENT?
YES
NO
S112
SAVE DOCUMENT AND LINK DATA IN CORRESPONDENCE PATH
S113
LOCAL COPY?
NO
YES
S114
SAVE COPY LOCALLY
S115
EXIT WORD PROCESSOR?
NO
YES
S116
END

FIG. 13

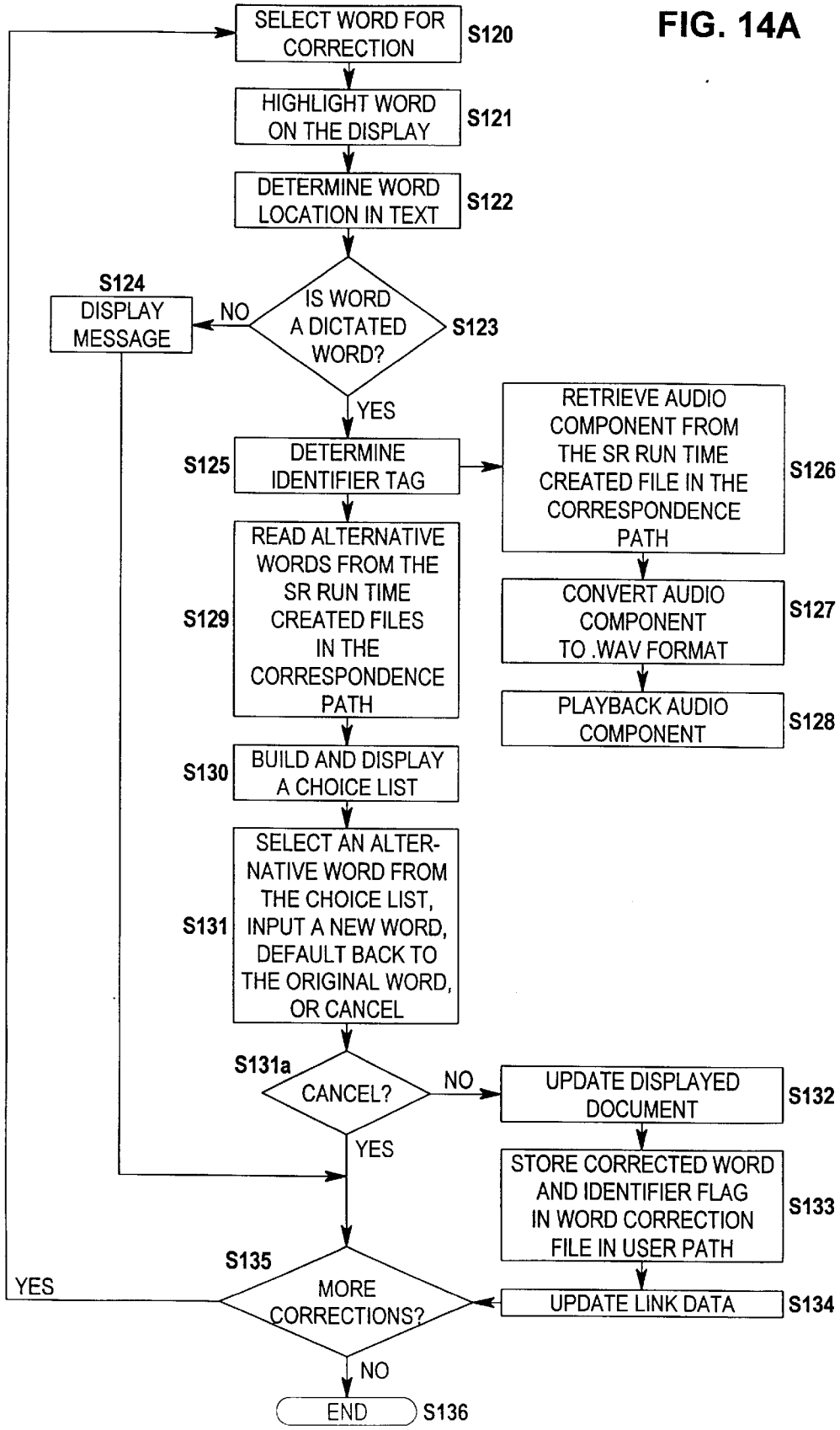


FIG. 14A
SELECT WORD FOR CORRECTION
S120
HIGHLIGHT WORD ON THE DISPLAY
S121
DETERMINE WORD LOCATION IN TEXT
S122
IS WORD A DICTATED WORD?
S123
NO
S124
DISPLAY MESSAGE
YES
S125
DETERMINE IDENTIFIER TAG
RETRIEVE AUDIO COMPONENT FROM THE SR RUN TIME CREATED FILE IN THE CORRESPONDENCE PATH
S126
CONVERT AUDIO COMPONENT TO .WAV FORMAT
S127
PLAYBACK AUDIO COMPONENT
S128
S129
READ ALTERNATIVE WORDS FROM THE SR RUN TIME CREATED FILES IN THE CORRESPONDENCE PATH
S130
BUILD AND DISPLAY A CHOICE LIST
S131
SELECT AN ALTERNATIVE WORD FROM THE CHOICE LIST, INPUT A NEW WORD, DEFAULT BACK TO THE ORIGINAL WORD, OR CANCEL
S131a
CANCEL?
NO
UPDATE DISPLAYED DOCUMENT
S132
STORE CORRECTED WORD AND IDENTIFIER FLAG IN WORD CORRECTION FILE IN USER PATH
S133
UPDATE LINK DATA
S134
YES
S135
MORE CORRECTIONS?
YES
NO
END
S136

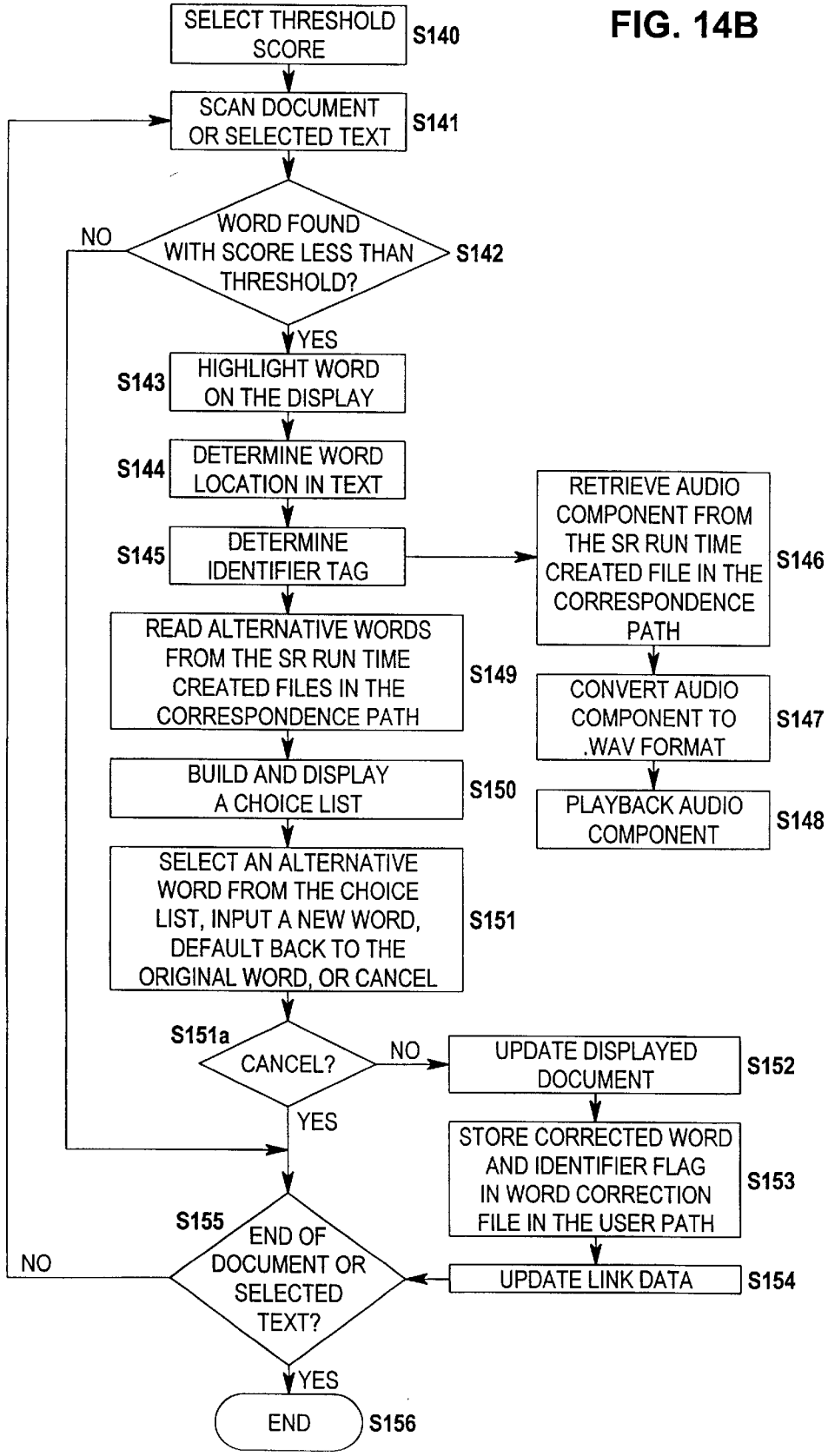


FIG. 14B
SELECT THRESHOLD SCORE
S140
SCAN DOCUMENT OR SELECTED TEXT
S141
WORD FOUND WITH SCORE LESS THAN THRESHOLD?
S142
NO
YES
HIGHLIGHT WORD ON THE DISPLAY
S143
DETERMINE WORD LOCATION IN TEXT
S144
DETERMINE IDENTIFIER TAG
S145
RETRIEVE AUDIO COMPONENT FROM THE SR RUN TIME CREATED FILE IN THE CORRESPONDENCE PATH
S146
CONVERT AUDIO COMPONENT TO .WAV FORMAT
S147
PLAYBACK AUDIO COMPONENT
S148
READ ALTERNATIVE WORDS FROM THE SR RUN TIME CREATED FILES IN THE CORRESPONDENCE PATH
S149
BUILD AND DISPLAY A CHOICE LIST
S150
SELECT AN ALTERNATIVE WORD FROM THE CHOICE LIST, INPUT A NEW WORD, DEFAULT BACK TO THE ORIGINAL WORD, OR CANCEL
S151
S151a
CANCEL?
NO
YES
UPDATE DISPLAYED DOCUMENT
S152
STORE CORRECTED WORD AND IDENTIFIER FLAG IN WORD CORRECTION FILE IN THE USER PATH
S153
UPDATE LINK DATA
S154
S155
END OF DOCUMENT OR SELECTED TEXT?
NO
YES
END
S156

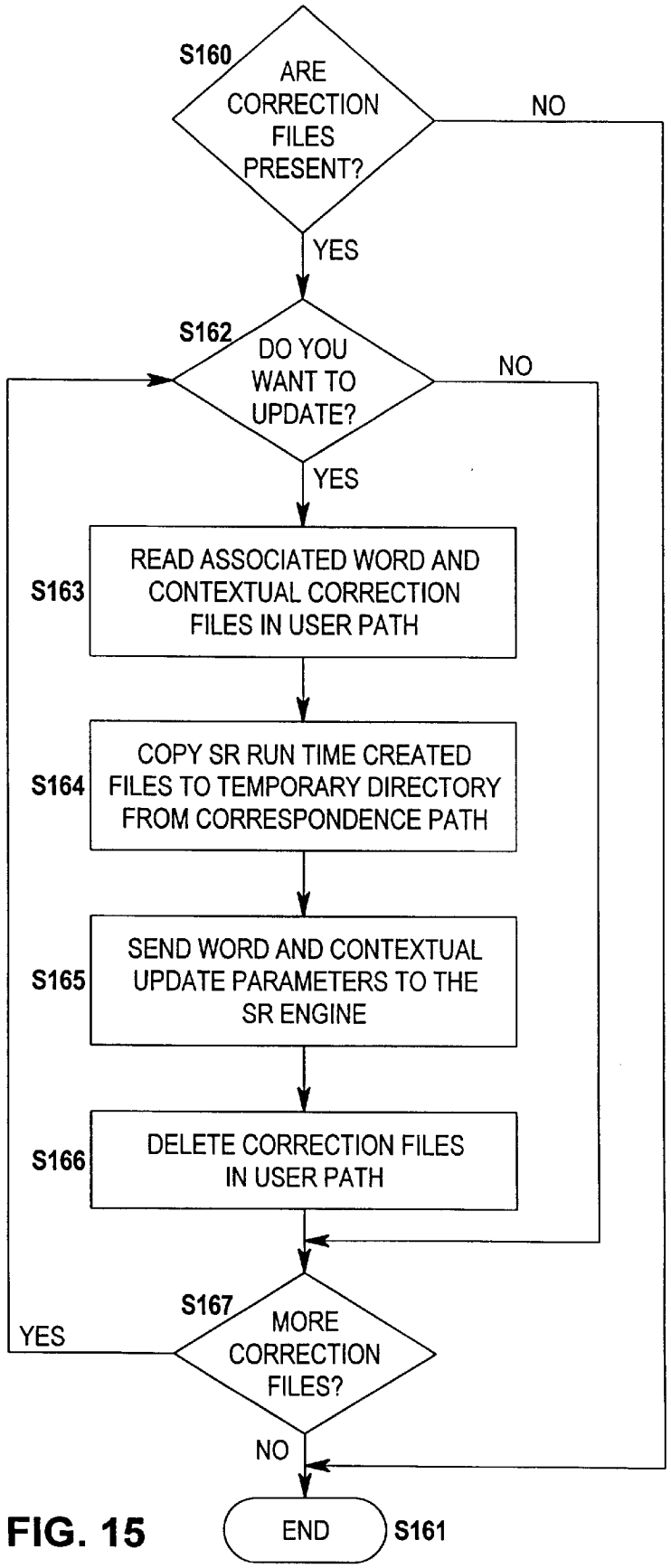

S160
ARE CORRECTION FILES PRESENT?
NO
YES
S162
DO YOU WANT TO UPDATE?
NO
YES
S163
READ ASSOCIATED WORD AND CONTEXTUAL CORRECTION FILES IN USER PATH
S164
COPY SR RUN TIME CREATED FILES TO TEMPORARY DIRECTORY FROM CORRESPONDENCE PATH
S165
SEND WORD AND CONTEXTUAL UPDATE PARAMETERS TO THE SR ENGINE
S166
DELETE CORRECTION FILES IN USER PATH
S167
MORE CORRECTION FILES?
YES
NO
END
S161

FIG. 15

SPEECH-TO-TEXT DICTATION SYSTEM WITH AUDIO MESSAGE CAPABILITY

This application is a division of U.S. patent application Ser. No. 08/720,373 filed Sep. 27, 1996.

FIELD OF THE INVENTION

The present invention generally relates to the field of data processing and in particular the field of processing the output of a speech recognition engine.

BACKGROUND ART

The use of speech recognition as an alternative method of inputting data to a computer is becoming more prevalent as speech recognition algorithms become ever more sophisticated and the processing capabilities of modern computers increases. Speech recognition systems are particularly attractive for people wishing to use computers who do not have keyboard skills.

There are several speech recognition systems currently on the market which can operate on a desktop computer. One such system is called DragonDictate (Trade Mark). This system allows a user to input both speech data and speech commands. The system can interface with many different applications to allow the recognised text output to be directly input into the application, e.g. a word processor. This system, however, suffers from the disadvantage that there is no audio recording of the dictation stored which can be replayed to aid the correction of the recognised text.

Another system which is currently on the market is IBM VoiceType version 1.1 (Trade Mark). In this system the recognised text from the speech recognition engine is input directly into a proprietary text processor and audio data is stored. This system, however, does not allow the recognised text to be directly input into any other application. The dictated text can only be input directly into the proprietary text processor provided whereupon at the end of dictation the text can be cut and pasted into other applications. Corrections to the dictated text in order to update the speech recogniser models can only be carried out within the text processor window. Text for recognition correction can be selected and the audio component corresponding to the text is played back to assist in the correction process. When all of the corrections have been completed, the text can either be saved or cut ready for pasting into another application. Either of these operations can cause the corrections made to be used to update the speech recogniser: the user has limited control over when the updates are made.

Not only is this system disadvantaged in not allowing direct dictation into applications, the system also does not allow the audio data to be stored in association with the text when the document is saved or when the text is cut and pasted into another application. Even a simple text processing operation, e.g. an insertion operation within a body of text, will prevent the playback of the audio component for that body of text including the change.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an interface between the output of a speech recognition engine and an application capable of processing the output which operates in a data processing apparatus to link the relationship between the output data and the audio data to allow the audio data to be played back for any output data which has been dictated even if the data as a whole has been processed in such a way as to move, reorder, delete, insert or format the data.

This object of the present invention can be achieved by a data processing apparatus comprising input means for receiving recognition data and corresponding audio data from a speech recognition engine, the recognition data including a string of recognised data characters and audio identifiers identifying audio components corresponding to a character component of the recognised characters; processing means for receiving and processing the input recognised characters to replace, insert, and/or move characters in the recognised characters and/or to position the recognised characters; link means for forming link data linking the audio and identifiers to the characters component positions in the character string even after processing; display means for displaying the characters being processed by the processing means; user operable selection means for selecting characters in the displayed characters for audio playback, where the link data identifies any selected audio components, if present, which are linked to the selected characters; and audio playback means for playing back the selected audio components in the order of the character component positions in the character string.

Thus, in accordance with this aspect of the present invention, positional changes of characters in the character string due to processing operations are monitored and the links which identify the corresponding audio component are updated accordingly. In this way, the corresponding audio component for any dictated character in the character string can be immediately identified even after processing. This allows for the audio component associated with any character to be played back by a selection operation by a user. This feature greatly enhances the ability to correct incorrectly recognised characters since a user will be able to hear what was dictated in order to decide what was actually said rather than what the speech recogniser recognised. This feature of being able to play back audio components corresponding to the characters is maintained even when dictated characters are inserted into previously dictated characters.

In the present invention the character data output from the speech recognition engine can comprise text or symbols in any language, numerals or any unicode. The characters can comprise words forming text or any unicode characters and the system can be configured to recognise dictated numbers and input the corresponding numeric characters to the application instead of the word descriptions.

The processing means of the present invention can comprise any application running on a processor which enables character data from a speech recognition engine to be entered and manipulated, e.g. a word processor, presentation applications such as Microsoft PowerPoint (Trade Mark) spreadsheets such as Excel (Trade Mark), email applications and CAD applications. In this aspect of the present invention the dictated character positions in the document, drawing or product of the application is linked to the corresponding audio component by link data.

In one aspect of the present invention the link data and audio data can all be stored. In this way the audio data is maintained for playback at a later time when, for instance, it may be wished to carry out corrections to correct speech recognition errors. The storage of the character data, link data and the audio data allows for corrections to be postponed or even delegated to another person on another machine.

Corrections to the incorrectly recognised character data can be made by correcting the character string which causes the playback of the audio component. The characters can then be corrected and the corrected characters and the audio

identifier for the audio component corresponding to the corrected characters are passed to the speech recognition engine for updating user models used in the recognition process.

Where the output of the speech recognition engine includes a list of alternative characters together with an indicator which indicates the likelihood that the word is correct, when a word is selected for correction, a choice list can be displayed which comprises the alternative words listed alphabetically for ease of use. Corrections can then be carried out either by selecting one of the alternative characters or entering a new character.

In one embodiment, in order to maintain the links between the character components and the corresponding audio components, a list of character locations in the character string and positions in the corresponding audio components is kept. Where the character string is formed of a plurality of separate dictated passages, the audio data is separately stored and the list identifies in which of the stored audio passages and at which position the audio component lies in the audio passage.

In addition to the updating of the speech recognition model due to incorrectly recognised words, a passage of characters, or all of the characters, can be selected for updating the contextual model used by the speech recognition engine. Thus, in this embodiment of the invention the operator has control over when the contextual model is to be updated based on the corrections made to the characters.

It is an object of another aspect of the present invention to enable audio messages to be recorded and stored in association with a file containing character data output from a speech recognition engine to allow instructions or a reminder to be recorded.

In accordance with this object of the present invention there is provided data processing apparatus comprising means for receiving recognition data from a speech recognition engine and corresponding audio data, the recognition data including recognised characters; display means for displaying the recognised characters; storage means for storing the recognised characters as a file; means for selectively disabling the display and storage of recognised characters or recognition carried out by the speech recognition engine for a period of time; and means for storing the audio data for a period of time in the storage means as an audio message associated with the file.

It is an object of another aspect of the present invention to provide for the automatic detection of possibly incorrectly recognised characters in the character data output from the speech recognition engine.

In accordance with this aspect of the present invention, there is provided data correction apparatus comprising means for receiving recognition data from a speech recognition engine, said recognition data including recognised characters representing the most likely characters, and a likelihood indicator for each character indicating the likelihood that the character is correct; display means for displaying the recognised character; automatic error detection means for detecting possible errors in recognition of characters in the -recognised characters by scanning the likelihood indicators for the recognised characters and detecting if the likelihood indicator for a character is below the likelihood threshold, whereby said display means highlights at least the first, if any, character having a likelihood indicator below the likelihood threshold; user operable selection means for selecting a character to replace an incorrectly recognised character highlighted in the recognised characters; and correction means for replacing the incorrectly recognised character and the selected character to correct the recognised characters.

The likelihood threshold can be selectively set by a user to a suitable level to reduce the number of characters which are falsely identified as incorrectly recognised whilst increasing the chances of correctly identifying incorrectly recognised characters. The provision of automatic detection of possible recognition errors can significantly decrease the time taken for correcting character data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic drawing of a speech recognition system in accordance with one embodiment of the present invention;

FIG. **2** is a schematic diagram of the internal structure of the speech recognition system;

FIG. **3** is a table representing the data output from the speech recognition engine;

FIG. **4** illustrates the data structure of the link data file;

FIG. **5** is a flow chart illustrating the overall operation of the speech recognition system in accordance with one embodiment of the present invention;

FIG. **6** is a flow diagram of the dictation process of FIG. **5**;

FIG. **7** is a flow diagram of the word processing process of FIG. **5**;

FIG. **8***a* is a flow diagram of the manual correction process of FIG. **5**;

FIG. **8***b* is a flow diagram of the automatic correction process of FIG. **5**;

FIG. **9**A is a flow diagram of the overall operation of the speech recognition system in accordance with another embodiment of the present invention in which audio messages can be played;

FIG. **9**B is a continuation of the flow diagram of FIG. **9**A;

FIG. **10** is a flow diagram of an optional step for the dictation of an audio message in the sequence of FIG. **9**;

FIG. **11** is a schematic drawing of a network of speech recognition systems comprising author work stations wherein the network is provided with an editor work station which can access and edit documents in the author work stations;

FIG. **12** is a schematic diagram of the internal structure of the editor work station;

FIG. **13** is a flow diagram of the overall operation of the operation of the editor work station of FIG. **11**;

FIG. **14***a* is a flow diagram of the manual correction process of FIG. **13**;

FIG. **14***b* is a flow diagram of the automatic correction process of FIG. **13**; and

FIG. **15** is a flow diagram of the speech recognition model update process which is carried out by the author work stations after corrections have been made to recognised text by the editor work station.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A specific embodiment will now be described with application to word processing of text output of a speech recognition engine.

Referring to FIG. **1** there is illustrated a speech recognition system in accordance with one embodiment of the

present invention which comprises an IBM (Trade Mark) compatible PC (personal computer) **1** having a keyboard **2** for inputting and correcting text and a pointing device **3** which in this embodiment is a mouse. Software applications are loaded into the computer from computer storage medium such as the floppy disc **4**, an optical disk (CD ROM), or digital tape. The software applications comprise the speech recognition application which comprises the speech recognition engine, the application for processing text such as a word processor and the interface application to control the flow of text into the text processing application, to control the flow of updating information from the text processing application to the speech recognition application and for maintaining links between the text and the audio data.

The system is provided with a microphone **5**, a loudspeaker **6** and an interface device **7**. During dictation the audio signal from the microphone **5** is input into the interface device **7** which includes an analog to digital converter and a digital signal processor to digitise and condition the signal for input into the computer **1**. During playback of the recorded audio signal, the audio signal is output from the computer **1** to the interface device **7** in digital form and is converted to an analog signal by a digital to analog converter within the interface device **7**. The analog signal is then output from the interface device **7** to play back the audio recording.

In the specific embodiment of the present invention the interface device **7** is provided with the IBM VoiceType system. Also, the speech recognition engine used in the specific example is the IBM VoiceType speech recognition engine. The present invention is not, however, limited to any specific speech recognition engine and can also be used with any conventional hardware for recording and playing back sound in a personal computer, e.g. in an IBM compatible machine the sixteen bit sound blaster compatible standard can be used. The present invention can be used with either continuous or discrete speech recognition engines.

Referring now to FIG. **2**, this diagram illustrates a schematic overview of the internal architecture of the computer. A bus **9** links all of the components of the system and the Read Only Memory (ROM) **14** containing conventional systems programs and data. The processor **10** runs three applications simultaneously: the speech recognition engine application **11**, the speech recognition interface application **12** and the text processor application **13**. The memory **20**, which can comprise random access memory (RAM) or in a Windows (Trade Mark) environment, virtual RAM. Within the memory **20** data is stored for the speech recognition engine application **11**. This data comprises a user model **21** which can be updated to improve the accuracy of the recognition, a language model **22** and a dictionary **23** to which a user can add new words. The user model **21** comprises an acoustic model and a contextual model. During operation of the speech recognition engine application **11** the application utilises the user model **21**, the language model **22** and the dictionary **23** in the memory **20** and outputs speech recognition data **24** to the memory **20**. The speech recognition interface application **12** receives the speech recognition output data **24** and forms link data **25**. The text component of the speech recognition output data **24** is also passed by the speech recognition interface application **12** to the text processor application **13** to form a current document **26** in the memory. The display **8** displays the text of the current document **26** stored in the memory **20** and the keyboard **2** can be used to insert, delete and move text. The pointing device **3** can also be used to select text and word processing operations in the conventional well known manner within Windows applications.

The system is also provided with non-volatile storage in the form of disk storage **15**. Within the disk storage **15** two directories are provided. A temporary directory used by the speech recognition engine **11** for the storage of run time files which contain the speech recognition output data. A user's directory is also provided for the storage of document files by the text processor application **13** and associated link data formed by the speech recognition interface **12**.

An audio input device **16** inputs the dictated audio signal to an analog to digital converter **17**. Although in FIG. **1** the audio input device **16** is illustrated to be a microphone **5**, the audio input could alternatively comprise a pre-recorded signal source, e.g. a digital audio tape (DAT). The digitised signal from the analog to digital converter **17** is then passed to a digital signal processor **18** for conditioning of the signal before input to the input/output device **19** of the computer **1**. In this way the speech recognition engine application **11** is able to read the digitised input audio data via the bus **9** and output speech recognition output data **24** into the memory **20**.

When the speech recognition interface application **12** interacts with the text processor application **13** following the selection of text for audio playback by the user using the pointing device **3**, audio data which is stored in the temporary directory in the disc storage **15** is accessed and output over the bus **9** via the input/output device **19** to a digital to analog converter **27** to generate an analog audio signal to drive an audio output device **28** for playback of the audio signal selected by the user.

In the specific embodiment the audio data is stored in one or more files in the temporary directory of the disk storage **15** since the storage audio data requires a great deal of storage capacity and it is impractical to hold audio data of any length in the volatile memory **20**.

In the specific embodiment the operating system operating by the processor **10** is Windows 3.1, 3.11, 95 or NT. The text processor application **13** can be any word processor such as Microsoft Word (Trade Mark), Wordperfect (Trade Mark) or Lotus Word Pro (Trade Mark). The speech recognition engine application **11** is the IBM VoiceType.

When the speech recognition engine application **11** is activated and receives audio data via the interface device **7**, the speech recognition output data **24** is temporarily held in the volatile memory **20**. The output data is then passed to files which are opened in the temporary directory of the disk storage **15**. The audio data for each period of dictation is stored in a single file.

Also in temporary directory on the disc storage **15**, two files are stored by the speech recognition engine application **11** which includes the information illustrated in tabular form in FIG. **3**. For each period of dictation an audio data file, and a pair of information files are generated containing the information illustrated in FIG. **3**. Each of the words recognised is identified by an identifier tag which identifies the position in the sequence of word. Also, the audio start point and audio end point of the audio component in the associated audio data file is indicated to enable the retrieval and playback of the audio component corresponding to the word. For each word, a list of alternative words and their scores is given where n is the score, i.e. the likelihood that the word is correct, and w is the word. The list of alternative words is ordered such that the most likely word appears first. Alternatives, if any, are then listed in order with the word having the highest score first and the word having the lowest score last.

The speech recognition interface application **12** receives the output of the speech recognition engine application **11**

and forms link data **25** in the volatile memory **20**. FIG. **4** illustrates the form of the link data for each recognised word output from the speech recognition engine **11**. The speech recognition interface application **12** receives the recognised word at the head of the alternative list shown in FIG. **3** and outputs the word using the dynamic data exchange (DDE) protocol in the Windows operating system. The position of a word in the text in the text processor application **13** is determined by determining the counter number indicating the position of the first character in the text for the word. This character number is entered under the character number field. The link data **25** also includes information identifying where the audio data can be found in the files in the temporary directory of the disk storage **15**. This information is provided in the tag field. The tag field will not only include the identified tag identifying the position of the audio component for a word within a file, it will also include an identification of which file contains the audio component. The next field is the word score which is an indication of the likelihood that the word has been recognised correctly. The next field is the word length field. This gives the number of characters forming the recognised word. The next field in the link data **25** is the character string forming the actual word and this is followed by the vocabulary length field which is a number indicating the number of characters in the vocabulary description string. The final field is the vocabulary description string which is a string of characters describing the vocabulary in which the word recognised by the speech recognition engine application **11** can be found in the dictionary **23**.

FIG. **5** is an overview of the operation of the embodiment of the present invention. In step **S1** the word processor application **13**, the speech recognition engine application **11** and the speech recognition interface application **12** is loaded from a storage medium such as the disk storage **15**. The programs can of course be loaded from any computer readable storage medium such as optical discs (CD ROM) or digital tape.

Once the programs are loaded, a user can select whether to read an existing document in step **S2**. If no existing document is to be read text can be entered using the dictation process step **S3** which will be described in more detail hereinafter. When a passage of dictated text is complete, the dictation process is finished and in step **S4** the user can decide whether to insert further dictated text. If further dictated text is to be inserted, the process returns to step **S3**. If no further dictated text is to be inserted then the dictation process is finished.

If in step **S2** after the programs have been loaded a user requests that an existing document be read, in step **S5** the document to be read is selected and in step **S6** it is determined whether the document selected has audio data associated with it. If there is no audio data associated with it, i.e. it is a conventional word processor document, in step **S7** the document is read and the process moves to step **S4** which is a point at which the document has been loaded and the user can insert dictated text if desired.

If in step **S6** it is determined that the document does have audio data associated with it, the user is given the option to read the audio data in step **S8**. If the user declines to read the audio data then only the document is read in step **S7** and the document will be treated within the word processor as a conventional word processor document. If in step **S8** the user selects to read the audio data, in step **S9** the document is read together with the associated link data from the user's directory in the disk storage **15** and the speech recogniser run time created files are copied from the user's directory to the temporary directory in the disk storage **15**. The document is thus open in the word processor and in step **S4** the user can insert dictated text if desired.

If no more dictated text is to be inserted in step **S4**, in step **S10** the user can decide whether to correct recognition errors in the recognised text. If in step **S10** it is decided by the user that they are to correct errors then the process moves to step **S11** to correct the errors as will be described hereafter.

Once the recognition errors have been corrected by the user or if the recognition error is not to be corrected by the user, the process moves to step **S12** wherein the user can decide whether to update the user's contextual model. This is a second form of correction for the speech recognition process. The user model **21** comprises an acoustic model and a contextual model. The recognition errors corrected in step **S11** will correct the acoustic model, i.e. the recognition errors. Once all of the recognition errors have been corrected, the contextual model can be updated in step **S13** by selecting the text to be used for the update and sending the number of corrected words together with a list of the corrected words to the speech recognition engine for updating the contextual model.

In step **S14** the user can then decide whether or not to word process the document in the conventional manner. If a document is to be word processed, the word processing operation in step **S15** is carried out as will be described in more detail hereinafter. This word processing operation can be carried out at any time after or before the dictation process. The document being formed in the word processor can thus comprise a mixture of conventionally entered text, i.e. via the keyboard or via the insertion of text from elsewhere, and directly dictated text.

When the user has finished dictating, inserting and editing the text, in step **S16** the user has the option of whether or not to save the document. If the document is to be saved, in step **S17** the user is given the option of saving the document without the audio data as a conventional word processor document in step **S18**, or saving the document together with the link data and audio data in step **S19**. In step **S19**, in order to save the link data and audio data, the document and link data, by default, is saved in the user's directory and a copy of the speech recogniser run time created files is made in the user's directory.

Once the document has been saved, the user has the option to exit the word processor in step **S20**. If the word processor is exited in step **S20** the process terminates in step **S21**, otherwise the user has the option of whether or not to read an existing document in step **S2**.

Referring now to FIG. **6**, this document illustrates the dictation process, step **S3**, of FIG. **5** in more detail.

In step **S30** the dictation is started and in step **S31** the speech recognition engine application **11** outputs speech recognition data **24** and stores the data in run time files in a temporary directory of the disk storage **15**. Also, the audio data is stored in parallel as a run time file in the temporary directory in step **S32**. The speech recognition interface application **12** detects whether the most likely words output from the speech recognition engine application **11** are firm or infirm, i.e. whether the speech recognition engine application **11** has finished recognising that word or not in step **S33**. If the speech recognition engine application **11** has not finished recognising that word, a word is still output as the most likely, but this could change, e.g. when contextual information is taken into consideration. In step **S34**, the speech recognition interface application **12** forms links between positions of firm words and corresponding audio

data components thus forming the link data **25**. In step S**35** the speech recognition interface application **12** outputs the words to the word processor application **13** and the text is displayed on the screen with the infirm words being displayed in reverse video format. In step S**36** the process determines whether dictation is finished and if has not it returns to step S**30**. If dictation has finished, in step S**37** it is determined whether the dictated text is inserted into previously dictated text and, if so, the link data is updated to take into consideration the change in character positions of the previously dictated words. The dictation process is then terminated in step S**38**.

Referring now to FIG. **7**, this illustrates the word processing process of step S**15** of FIG. **5** in more detail. In step S**40** a user can position the cursor in the text on the display using the keyboard **2** or the pointing device **3**. In step S**41** the user can delete and/or insert text by, for example, typing using a keyboard or inserting text from elsewhere using conventional word processing techniques. In step S**42** the speech recognition interface application **12** updates the links between the recognised words and associated audio components, i.e. the character number in the first field of the link data **25** is amended to indicate the correct character position of the word in the text. The word processing process is then terminated in step S**43**.

Referring now to FIG. **8***a,* this diagram illustrates a manual method of carrying out the error correction of step S**11** of FIG. **5**. In step S**50** the user selects a word which is believed to be incorrectly recognised for correction. The selected word is then highlighted on the display in step S**51** and in step S**52** the speech recognition interface application **12** determines the word location in the text. In step S**53** it is determined whether the word is a dictated word or not by comparing the word location with the link data **25**. If the word is not a dictated word a message is displayed informing the user that the word is not a dictated word in step S**54** and in step S**65** the system waits for more corrections. If the word is a dictated word, in step S**55** the speech recognition interface application **12** determines the identified tag for the selected word using the link data **25** and the speech recognition output data. The audio component is then retrieved from the speech recognition run time created files in the temporary directory view the speech recognition engine application **11** in step S**56** and in step S**57** the audio component is played back via the speech recognition engine application **11**. In step S**55**, once the identified tag has been determined, in addition to retrieval of the audio component, the alternative words from the speech recognition output data in step S**58** is obtained and the choice list is built and displayed on the display in step S**59**. In step S**60** a user can select an alternative word from the choice list, input a new word, default back to the original word or cancel if the original word is correct or the word was selected for correction in error. If a user cancels the operation in step S**60***a* the process proceeds to determine whether more corrections are required. If the user does not cancel the operation in step S**61** the displayed document is updated and in step S**62** the corrected word and the corresponding identifier flag is sent to the speech recognition engine application **11**. In step S**63** the speech recognition engine application **11** updates the user's acoustic model within the user model **21**. In step S**64** the link data is updated, e.g. if the correct word has more characters in it than the replaced word, the character position of all subsequent words will change and thus the link data will need to be updated. In step S**65**, if more corrections are required the user will in step S**50** select another word for correction and repeat the process. Otherwise the correction process is finished and terminates in step S**66**.

Referring now to FIG. **8***b,* this diagram illustrates a method of automatically detecting possible recognition errors in the text. In step S**70** the user selects a threshold score to be used to detect possible recognition errors. In step S**71** the document or selected text is scanned to compare the threshold score with the score for each of the words. In step S**72** the document is scanned to compare the threshold score with the score for the next word. If in step S**72** it is found that the score for the word is greater than the threshold, the process proceeds to step S**85** where it is determined whether the end of the document has been reached. If it is not the end of the document then the process returns to step S**71** to compare the score for the next word with the threshold score. If in step S**72** it is determined that the score for the word is less than the threshold score, the word is highlighted on the display in step S**73**. In step S**74** the speech recognition interface application **12** determines the word location in the text and in step S**75** the identifier tag for the word is determined. In step S**76** the audio component is retrieved from the speech recognition run time created files in the temporary directory via the speech recognition engine application **11** for playback of the audio component via the speech recognition engine application **11** in step S**77**. Once the identifier tag is determined in step S**75**, in step S**78** the alternative words for the word having the score less than the threshold is obtained from the output of the speech recogniser engine application **11**. In step S**79** a choice list is built and displayed on the display. The choice list comprises the list of alternative words displayed alphabetically. In step S**80** a user can select an alternative word from the choice list, input a new word, default back to the original word, or cancel if the original word is thought to be correct. If a user cancels the operation in step S**80***a,* the process proceeds to step S**85** to determine whether the end of the document or selected text has been reached. If the user does not cancel the operation, in step S**81** the displayed document is updated and in step S**82** the corrected word and identifier flag is sent to the speech recogniser engine application **11**. In step S**83** the speech recognition engine application **11** updates the user's acoustic model in the user model **21**. In step S**84** the link data is updated, e.g. if the correct word contains more or less than characters than the original word, the character number indicating the position of the first character of all of the following words will change and thus the link data for these words must be updated. In step S**85** it is determined whether the end of the document, or the selected text, has been reached. If so, the process is terminated in step S**86**, otherwise the process returns to step S**71** to continue scanning the document or selected text.

Thus in the process described with reference to FIGS. **5** to **8**, the user is able to harness the output of the speech recognition engine to maintain links between the words in the text and the corresponding audio components in the audio data even if the words are moved or are dispersed with non dictated text or text which has been dictated at some other time. Link data effectively acts as a pointer between the position of the text in the document and the position of the corresponding audio component in the audio data. In this way the dictated text can be ordered in any way and mixed with non dictated text without losing the ability to play back the audio components when selected by a user.

Also, since not only audio data but also the link data is stored in non-volatile storage such as the disk storage **15**, the user is able to reopen a document and play back the corresponding audio data. This enables a user to dictate a

document and store it without correction thereby allowing correction at a later date, i.e. delaying the correction. When the document link data and audio data is read, the system returns to a state as if the text had just been dictated. The text can be corrected and the corrections can be fed back to the speech recognition engine to update the user model **21**.

Referring now to FIGS. **9**A and **9**B, there is illustrated a flow diagram illustrating the feature of another aspect of the present invention. In FIGS. **9**A and **9**B, many steps are the same as those illustrated in FIG. **5** and thus the same references are used. In this aspect of the present invention, when audio data is associated with a document (S**6**) and a user selects to read audio data (step S**8**), the system determines whether there are any audio messages associated with the document in step S**90**.

If there are no audio messages associated with a document the process proceeds to step S**9** where the document and link data is read and the speech recognition run time created files are copied from the user's directory to the temporary directory and the system proceeds as described with regard to FIG. **5**. If however there are one or more audio messages associated with the document, the user is given the option to select the audio message which is to be played in step S**91**. If an audio message is not to be played then the process proceeds to step S**9**. If however the user selects to play a selected audio message, in step S**92** the selected audio message is retrieved from the speech recognition run time created files via the speech recognition engine applications **11** and in step S**93** the selected audio message is played via the speech recognition engine application **11**. The process then proceeds to step S**9** as described with reference to FIG. **5**. Although FIGS. **9**A and **9**B illustrates the audio note only being playable at a particular time, an audio note can be played at any time during the creation of a document or after a document has been read.

In FIG. **10** there is illustrated a procedure for dictating one or more audio messages which can be carried out at any time. In step S**95** the user can elect whether or not to dictate an audio message to be associated with a document to be created. If no audio message is to be created the process terminates in step S**99***b*. If an audio message is to be created in step S**96** the dictation of the audio message is initiated and in step S**97** the audio message is stored in the speech recognition run time files. In step S**98** it is determined whether the dictation of the audio message has finished and if not the process returns to step S**96**. If the audio message has finished in step S**99** the link data is updated to indicate that the document includes an audio message and in step S**99***a* another audio message can be selected to be dictated and the process returns to step S**96**. Otherwise the process can be terminated in step S**99***b*.

This aspect of the present invention illustrated in FIGS. **9**A, **9**B and **10** allows for a user to dictate one or more messages which is stored in association with a document. During the dictation of an audio message no recognised text is input to the text processor application **13**. This is achieved in the specific embodiment by failing to pass the text to the text processor application **13**. This could alternatively be achieved by disabling the recognition capability of the speech recogniser engine application **11** so that only the audio data is stored.

In the specific example the audio message merely comprises a normal audio data file which has the speech recognition data of FIG. **3** in corresponding run time files and which is ignored.

As can be seen with regard to FIG. **9**, when a user opens a document the link data is examined to determine whether there are any audio messages associated with a document and if so an option is displayed to allow the user to select and play a message. If the user selects to play the message the link data identifies the audio data file containing the audio message which is retrieved and played back via the speech recognition engine **11**.

This aspect of the present invention can be used without the features of correcting the user model and can in its simplest form comprise a method of recording and digitising audio messages and storing the audio messages with a document which could simply be created in a conventional manner without involving speech recognition. The audio message allows for instructions or reminding information to be attached to a document in audio form.

Another aspect of the present invention will now be described with reference to FIGS. **11** to **15**. In this aspect of the present invention the correction of the incorrectly recognised words in a dictated passage of text can be carried out on a machine which is separate to the machine containing the speech recognition engine **11** and user model **21**. In FIG. **11** there is illustrated a network of author work stations **100***a*, **100***b* and **100***c* which comprise the system as described with regard to FIGS. **1** to **10**. The author work stations **100***a*, **100***b* and **100***c* are connected via a network **101** under the control of a network server **102** to an editor work station **103**. The network **101** can comprise any conventional computer network such as an ethernet or token ring.

Although in FIG. **11** access to the files of the author work stations is achieved via the network **101**, any method of obtaining copies of the documents, associated link data files, and associated speech recognition run time created files can be used. For instance, the documents could be transferred by copying the relevant files on to a computer readable medium such as a floppy disc which can be read by the editor work station and amended. Also correction files (to be explained hereinafter) can be stored on the disc and the disc can be re-read by the author work station for updating of the user model **21** by the speech recognition engine application **11**. Further, although three other work stations and a single editor work station are illustrated any number can be used on the network.

FIG. **12** illustrates the architecture of the editor work station **103**. Like reference numerals in FIG. **12** to the reference numerals of FIG. **2** represent like components. In the editor work station **103** there is no user model **21**, language model **22**, dictionary **23** or SR output data **24** in the memory **20**. Also the processor **10** does not include the speech recognition engine application **11** and the speech recognition interface application **12** is replaced with the correcting application **12***a*. In the disk storage **15** there is no partition of the disk into the temporary directory and the user's directory. The documents can however be stored locally into a disk storage **15**. The editor work station differs from the author work station further in that there is no input/output device **19**, digital signal processor **18**, and analogue to digital converter **17**, audio input device **16**, and digital to analogue converter **27**. Instead the audio output device **28** (loudspeaker or loudspeakers) receives its output from a conventional multimedia sound card **19***a*.

The editor work station **103** is also provided with a network card **200** to interface the editor work station **103** with the network **101** to allow for the document, link data and speech recognition run time created files to be read from a correspondence path. Of course, although not illustrated in FIG. **2**, the author work station **100***a*, **100***b* and **100***c* will include a similar network card **200** in this embodiment.

FIG. **13** is a flow diagram of the operation of the editor work station in accordance with the specific embodiment of the present invention. In step **S100** the word processor application and a correction application is loaded. The correction application comprises a modified form of the speech recognition interface application. In step **S101** the user selects a correspondence path, a user path and a document for correction. The correspondence path is the directory in which the user has saved the document, the link data file, and the speech recognition run time created files. The user path is the directory in which the speech recognition data, specifically the user model **21**, is stored. In step **S102** the document and link data file is read. In step **S102** the document and link data file can simply be read over the network or it can be copied so that the editor work station **103** has a local copy. If a local copy is made, it is important that when corrections are made the corrected document is stored in the correspondence path together with the amended link data file. In step **S103** the link data determines whether there are any audio messages associated with the read document. If there are no audio messages the process proceeds to step **S104** for the correction of the document. If an audio message is present in step **S105** the user is given an option to select the audio message for playing. If an audio message is not to be played the process proceeds to step **S104**. If an audio message is to be played the selected audio message is retrieved from the speech recognition run time created files in step **S106** and in step **S107** the selected audio message is converted to a conventional sound format, e.g. .WAV. In step **S108** the audio message is then played through the conventional sound card **19***a* and loud speakers **28** and the process then proceeds to step **S104**. Once the document has been corrected, the details of which will be described in more detail hereinafter, in step **S109** the editor is given the option as to whether to update the user's contextual model. If the editor does not wish to update the user's contextual model the process proceeds to step **S111** where the editor is given the option as to whether or not to save the document. If the user's contextual model is to be updated in step **S110** the user selects text containing corrections whereupon context update parameters are stored in a contextual correction file in the user path. The contextual update parameters include the number of corrected words and a list of the corrected words. The process then proceeds to step **S111**. If the document is to be saved, in step **S112** the document and associated link data is stored in the correspondence path and in step **S113** the editor is given the option as to whether to store a copy locally in the editor work station **103** in step **S114**. In step **S115** the editor can then either exit the word processor, in which case the process terminates in step **S116**, or select another document by returning to step **S101**.

Referring now to FIG. **14***a,* this document is a flow diagram of the method of manually correcting the document corresponding to step **S104** of FIG. **13**. In step **S120** the editor selects a word for correction and in step **S121** the word is highlighted on the display. In step **S122** the correction application determines the word location in the text and in step **S123** it is determined whether the word is a dictated word or not by comparing the word location with the link data **25**. If the word is not a dictated word a message is displayed informing the editor that the word is not a dictated word in step **S124** and in step **S135** the system awaits further corrections. If the word is a dictated word in step **S125** the identified tag is determined. In step **S126** the audio component from the speech recognition run time created file is retrieved from the correspondence path and the audio component corresponding to the selected word is converted to a conventional audio format (.WAV) in step **S127**. The audio component is then played back using the conventional multimedia sound card and loudspeakers in step **S128**.

Once the identified tag is determined in step **S125** the alternative words are read from the speech recognition run time created files in the correspondence path in step **S129** and in step **S130** a choice list is built and displayed. The choice list comprises the alternative words listed alphabetically for ease of use. In step **S131** the editor can select an alternative word from the choice list, input a new word, default back to the original word, or cancel if the original word is considered to be correct or the editor incorrectly selected the word. If an editor cancels the operation in step **S131***a* the process proceeds to step **S135** to determine whether more corrections are required. If the user does not cancel the operation, in step **S132** the displayed document is updated and in step **S133** the corrected word and identifier flag is stored in a word correction file in the user path. In step **S134** the link data is updated e.g. if the correct word is of different length to the replaced word, the character number identifying the position of the first character of each of the proceeding words will be changed and thus the link data for all of the following words must be changed. In step **S135**, if the user makes no more corrections, the process ends at step **S136** otherwise the user can select another word in step **S120**.

FIG. **14***b* is a flow diagram of an automatic method of correcting recognition errors corresponding to the correction step **S104** in FIG. **13**. In step **S140** the editor can select the desired threshold score for the automatic correction process. In step **S141** the document or selected text is scanned to compare the score of the next word with the threshold score. In step **S142** if the score for the word is greater than the threshold, in step **S155** it is determined whether it is the end of the document or selected text and if it is the process terminates in step **S156**. Otherwise the scanning of the document in step **S141** continues for each word in the selected text or until the end of the document is reached. If in step **S142** it is determined that the score for a word is less than the threshold an in step **S143** the word is highlighted on the display and in step **S144** the word location in the text is determined. In step **S145** the identifer tag for the word is determined from the link data **25** and in step **S146** the audio component is retrieved from the SR run time created files. In step **S147** the audio component is converted to a standard audio format (.WAV format) and in step **S148** the audio component is played back using the conventional multimedia sound card **19***a* and loudspeakers **28**.

When the identifer tag is determined for the word in step **S145** in step **S149** the alternative words from the speech recognition run time created files can be read in the correspondence path and in step **S150** a choice list can be built and displayed. The choice list comprises a list of the alternative words in alphabetical order. In step **S151** the editor can select an alternative word from the choice list, input a new word, default back to the original word, or cancel if it is considered that the original word was correct. If the editor cancels the operation in step **S151** the process proceeds to step **S155** to determine whether the end of the document or selected text has been reached. If the editor does not cancel the operation, in step **S152** the displayed document is updated and in step **S153** the corrected word and identifer flag are stored in a word correction file in the user path. In step **S154** the link data **25** is updated e.g. if the correct word has a different length to the original word the position of the following words will change and thus the link

data needs to be updated. In step **S155** it is determined whether it is the end of the document, or selected text, and if so the process terminates in step **S156**.

Referring now to FIG. **15**, this is a flow diagram of the additional steps which are carried out at a networked author work station when the speech recognition engine application and the speech recognition interface application is loaded. In step **S160** the speech recognition interface application detects whether there are any word correction files or contextual correction files present in the user path. If no correction files are detected at present then the process terminates in step **S161** allowing the user to continue to step **S2** in FIGS. **5** or **9**A. If correction files are detected to be present in step **S160** the author is given the option as to whether to carry out updating of the user model **21** at this time for the selected correction files in step **S162**. If no updating is to be carried out for the selected correction files the process proceeds to step **S167** to determine if there are more correction files present. If the author selects to carry out the updating of the user model **21** using the selected correction files, in step **S163** the associated word and/or contextual correction files are read from the user path. In step **S164** the speech recognition run time created files are copied from the correspondence path to the temporary directory and in step **S165** the word and contextual update parameters are sent to the speech recognition engine application **11** by the speech recognition interface application **12**. In step **S166** the read correction files are then deleted in the user path. In step **S167** it is then determined whether there are any more correction files present in the user path and if so the user is given the option as to whether to update using these files in step **S162**. If in step **S167** there are no more correction files present then the process terminates in step **S161** allowing the user to proceed to step **S2** in FIGS. **5** or **9**A.

Although in step **S162** the author can select each associated word and contextual correction file for updating, the author may also be given the opportunity to elect for the updating to be carried out for all of the correction files present in the user path.

This aspect of the present invention illustrated in FIGS. **11** to **15** allows an author to dictate documents, save them and delegate correction to an editor by a separate machine. The corrections made by the editor are then fed back to update the author's user model to increase the accuracy of the speech recognition thereafter. However, since the author's user model is not copied, there is no danger of there being more than one copy of the user model whereby one of the copies could be out of date. Also, since the editor does not have access to the author's user model, the corrections being carried out by the editor does not prevent the author from continuing to use the speech recognition engine application which requires access to the user model. By delegating the correction to the editor whereby updates are generated in files, dictation by the author and correction by the editor can be carried out in parallel.

The delegated correction feature is enhanced by the provision of the audio note capability allowing an author to dictate instructions to the editor to be attached to the document to be edited. The audio message capability can not only be used in conjunction with the delegated correction facility, but can also be used on its own simply to provide audio messages with a document.

The delegated correction system also provides a cost reduction for users since the editor need not be supplied with the speech recognition software and system components. The editor work station **103** can simply comprise a standard multimedia PC. It is of course possible to provide a plurality of such editor work stations in the network to serve any number of author work stations.

The delegated correction system can also operate without a network by physically moving files between the author and editor work stations on computer readable storage media such as floppy disks.

Although in the embodiments described hereinabove word processing is described as occuring after dictation, word processing of the document can take place at any time.

Further, although in the embodiments the recording and playing of audio messages is described as occuring at specific points in the process they can be recorded or played at any time.

What has been described hereinabove are specific embodiments and it would be clear to a skilled person in the art that modifications are possible and the present invention is not limited to the specific embodiments.

What is claimed is:

1. A method of processing data comprising:

receiving recognition data from a speech recognition engine and audio data, the recognition data including recognised characters;

displaying the recognised characters;

storing the recognised characters as a file;

selectively disabling one of the display and storage of the recognised characters said the speech recognition engine for a period of time; and

storing received audio data during said period of time as an audio message associated with the file.

2. A method according to claim **1** including the steps of reading the file for display and said audio message associated with the file; and playing back the read audio message.

3. A method of processing data comprising reading a file of recognised characters and an associated audio message stored using the method of claim **1**;

displaying the read recognised characters; and

audibly outputting the read audio message.

4. Data processing apparatus comprising

means for receiving recognition data from a speech recognition engine and audio data, the recognition data including recognised characters corresponding to received audio data;

display means for displaying the recognised characters;

storage means for storing the recognised characters as a file;

means for selectively disabling one of the display and storage of the recognised characters and the speech recognition engine for a period of time; and means for storing received audio data during said period of time in said storage means as an audio message associated with the file.

5. Data processing apparatus as claimed in claim **4** including reading means for reading the file for display on said display means and for reading said audio message associated with the file; and

audio play back means for playing back the read audio message.

6. Data processing apparatus comprising means for reading a file and associated audio message stored using the data processing apparatus of claim **4**, display means for displaying the file, and audio playback means for playing back the audio message.

7. A computer usable medium having computer readable instructions stored therein for causing the processor in a data processing apparatus to process signals defining a string of characters and audio data to store the characters and the audio data, the instructions comprising instructions for

a) causing the processor to receive the string of characters from a speech recognition engine and the audio data;

b) causing the processor to generate an image of the characters on a display;

c) causing the processor to generate an image of the characters as a file;

d) causing the processor to selectively disable one of the display and storage of the characters and the speech recognition engine for a period of time; and

e) causing the processor to store received audio data during said period of time as an audio message associated with the file.

8. A computer usable medium as claimed in claim 7 including instructions for

a) causing the processor to read the stored characters and audio message;

b) causing the processor to generate an image of the characters for display; and

c) causing the processor to send the audio message to an audio play back device.

9. A data processing method comprising inputting audio data; and

selecting one of receiving recognition data from a speech recognition engine and storing the recognition data and corresponding audio data in a file, said recognition data including recognised characters corresponding to input audio data, or storing only the input audio data in association with a file of recognition data.

10. A data processing method according to claim 9 including the step of reading the file of recognition data and any audio data associated with the file having no corresponding recognition data, and audibly outputting the read audio data associated with the file.

11. Data processing apparatus comprising:

input means for inputting audio data;

means for receiving recognition data from a speech recognition engine, said recognition data including recognised characters corresponding to input audio data;

storage means for storing the recognised characters in a file and for storing the audio data; and

user operable selection means for selecting one of the recognised characters and corresponding audio data for storage in said storage means, or only audio data for storage in said storage means in association with a file of recognised characters.

12. Data processing apparatus according to claim 11 including means for reading the file of recognised characters and any audio data associated with the file having no corresponding recognised characters, and audio output means for audibly outputting the read audio data associated with the file.

13. A computer usable medium having computer readable instructions stored therein for causing the processor in a data processing apparatus to process signals defining recognition data from a speech recognition engine and audio data to store the recognition data and the audio data, the instructions comprising instructions for:

a) causing the processor to receive audio data signals;

b) causing the processor to receive recognition data signals from a speech recognition engine; and

c) selectively causing the processor to store the recognition data signals in a file in storage means and to store corresponding audio data signals in said storage means, or to store only the audio data signals in association with a file of recognition data signals in said storage means.

14. A computer usable medium according to claim 13 including instructions for:

a) causing the processor to read the stored recognition data signals and audio data signals; and

b) causing the processor to generate an audible output using the read audio data signals.

15. A speech recognition method comprising:

inputting speech data;

selectively performing speech recognition on input speech data to generate the recognised characters;

visibly outputting the recognised characters;

storing recognised characters corresponding to a portion of input speech data as a file when speech recognition is performed; and

storing a portion of the input speech data in association with a file of recognised characters as an audio message when speech recognition is not performed.

16. A speech recognition method according to claim 15 including:

reading one of the stored files of recognised characters for visible output;

reading any audio message associated with the read file; and

audibly outputting any read audio message.

17. A speech recognition method comprising:

reading a file of recognised characters and any associated audio message stored using the method of claim 15;

visibly outputting the recognised characters of the read file; and

audibly outputting any read audio message.

18. Speech recognition apparatus comprising:

input means for inputting speech data;

recogniser means for receiving input speech data and for selectively performing speech recognition to generate recognised characters;

output means for visibly outputting the recognised characters, storage means for storing the input speech data and recognised characters; storage control means for:

controlling said storage means to store recognised characters from said recogniser means corresponding to a portion of input speech data as a file when said recogniser means is operating, and

for controlling said storage means to store a portion of the input speech data in association with a file of recognised characters as an audio message when said recogniser means is not operating.

19. Speech recognition apparatus according to claim 18 including means for reading one of the stored files of recognised characters for visible output on said visible output means, and for reading any audio message associated with the read file; and audible output means for audibly outputting any read audio message.

20. Speech recognition apparatus comprising means for reading a file of recognised characters and any associated audio message stored using the apparatus of claim 18; output means for visibly outputting the recognised characters of the read file; and audible output means for audibly outputting any read audio message.

21. A computer usable medium having computer readable instructions stored therein for causing a processor in a speech recognition apparatus to process signal defining recognised characters and audio data to store the recognised characters and audio data, the instructions comprising instructions for:

a) causing the processor to receive input speech data;

b) causing the processor to perform speech recognition on the input speech data to generate recognised characters;

c) causing the processor to visibly output the recognised characters;

d) causing the processor to store the input speech data and recognised characters, in storage means; and

e) causing the processor to control said storage means to store recognised characters corresponding to a portion of input speech data as a file when speech recognition is being carried out, and to control said storage means to store a portion of the input speech data in association with a file of recognised characters as an audio message when speech recognition is not being carried out.

22. A computer usable medium according to claim 21 including instructions for:

a) causing the processor to read one of the stored files of recognised characters and any associated audio message;

b) causing the processor to visibly output the read recognised characters; and

c) causing the processor to audibly output any read audio message.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,857,099
DATED : January 5, 1999
INVENTOR(S) : Mitchell et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Inventors field 75, line 1, delete "Allen" and insert --Alan--, therefor.

In the abstract field 57, line 11, delete "loosing" and insert --losing--, therefor.

Column 4,
Line 30, delete "8a" and insert --8A--, therefor.
Line 32, delete "8b" and insert --8B--, therefor.
Line 51, delete "14a" and insert --14A--, therefor.
Line 53, delete "14b" and insert --14B--, therefor.

Column 9,
Line 26, delete "8a" and insert --8A--, therefor.

Column 10,
Line 3, delete "8b" and insert --8B--, therefor.

Column 11,
Line 32, delete "illustrates" and insert --illustrate--, therefor.
Line 66, delete "FIG. 9" and insert --FIGS. 9A and 9B--, therefor.

Column 13,
Line 53, delete "14a" and insert --14A--, therefor.

Column 14,
Line 28, delete "14b" and insert --14B--, therefor.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,857,099
DATED : January 5, 1999
INVENTOR(S) : Mitchell et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 16,
Line 30, delete "said" and insert --and--, therefor.
Line 36, insert a paragraph break before "playing".

Column 18,
Line 45, insert a paragraph break before "storage".
Line 46, insert a paragraph break before "storage".

Signed and Sealed this

Seventh Day of August, 2001

Attest:

Nicholas P. Godici

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office