Research Article

Design of Chinese-English Wireless Simultaneous Interpretation System Based on Speech Recognition Technology

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A Chinese-English wireless simultaneous interpretation system based on speech recognition technology is suggested to solve the problems of low translation accuracy and a high number of ambiguous terms in current Chinese-English simultaneous interpretation systems. The system’s general structure and hardware architecture are summarized. The chairman unit, representative unit, transliteration unit, and auditing unit are the four basic components of the simultaneous interpretation system. The CPU is then RF24E1 hardware wireless radio frequency transceiver chip, while the chairman machine, representative machine, translator, and auditorium are all created separately. Speech recognition technology is used by the system software to create a speech recognition process that properly produces speech-related semantics. The input text is used as the search criteria, a manual interactive synchronous translation program is created, and the results for the optimum translation impact are trimmed. The experimental findings reveal that this system’s sentence translation accuracy rate is 0.9–1.0, and the number of ambiguous terms is minimal, which is an improvement on previous systems’ low translation accuracy.

1. Introduction

International conferences are becoming increasingly common as the frequency of international interactions and collaboration grows. Representatives from many nations and areas talk and debate in the languages they are most comfortable with. To speak material, a simultaneous Chinese-English interpretation system is required. At present, the Chinese-English simultaneous interpretation system has become an indispensable facility in an international conference hall. The Chinese-English simultaneous interpretation system is a device that simultaneously translates the speaker’s language (original language) by the interpreter (translated language) and transmits it to the audience in conference occasions where different languages are used at the same time [1]. According to the transmission mode, the Chinese-English simultaneous interpretation system can be divided into infrared radiation type, wireless induction type, and frequency modulation transmission type according to the signal transmission mode. Because the FM transmitter has the advantages of strong anti-interference ability, large coverage area, and lower cost, the system adopts the FM transmitter.

According to the target language’s transmission mode, the Chinese-English simultaneous interpretation system may be split into a wired Chinese-English simultaneous interpretation system and a wireless Chinese-English simultaneous interpretation system. The wireless communication method can be divided into infrared radiation type, Bluetooth transmission method, and radio frequency transmission method according to the signal transmission method. The mainstream communication method of the current Chinese-English simultaneous interpretation system is infrared radiation instead of radio frequency transmission [2, 3]. The main reason is that the infrared radiation type has better confidentiality performance, while the radio frequency transmission type has poor confidentiality. However, this design adopts the radio frequency transmitting type.
This is because the radio frequency transmitting type has the advantages of strong anti-interference ability, large coverage area, and low cost, and the radio frequency transmitting type used in this design can encrypt the signal and play a good secret.

Simultaneous Chinese-English interpretation is an important component of today’s digital conference system. The Chinese-English wireless simultaneous interpretation system is now being researched by relevant academics. Based on the wireless sensor network structure of ZigBee transmission, literature [4] created an audio conference simultaneous interpretation system. Each microphone serves as a node in the wireless sensor network, which is made up of all of the microphones. The sound data collected by the microphones is transmitted to the sink node through ZigBee and then forwarded to the sound reinforcement system by the sink node. This design efficiently addresses the issue of excessive transmission distance and the inability to transmit in some blind regions. Literature [5] investigates intelligent computer-assisted interpretation (CAI) tools that analyze spoken language and detect terms that may not be translated by the interpreter, that is, predict which terms the simultaneous interpreter will not translate, and investigates the method of performing this task using a supervised sequence marker.

We provide a number of task-specific functions that are clearly designed to notify when the interpreter is having trouble translating words.

Speech recognition is a technique that allows machines to recognize and understand speech signals and translate them into equivalent messages or commands. English has long been a vital tool for individuals to communicate with one another in today’s economic globalization. However, the level of spoken English among Chinese people is often low due to constraints in learning mode and context. This paper designs and implements a Chinese-English wireless simultaneous interpretation system based on speech recognition technology and completes a set of simultaneous interpretation systems for small, medium, and ad hoc conferences.

2. Chinese-English Wireless Simultaneous Interpretation System Hardware Design

2.1. Hardware Overall Design Framework. The entire Chinese-English wireless simultaneous interpretation system consists of a chairman unit, a representative unit, a translation unit, an auditing unit, and others.

The basic structure of auxiliary equipment is shown in Figure 1.

The chairman unit, delegate unit, translator unit, and listener unit’s related entities are the chairman unit, delegate unit, translator, and auditor. They use the nRF24E1 chip to carry out wireless speech and control signal transmission. The chairman unit, delegate unit, and translator all have similar basic circuits; however, the auditorium does not include a voice sending module; only a voice receiving module is included.

The basic hardware parts of chairman machine, delegate machine, and translator are as follows:

1. nRF24E1 transceiver chip and basic peripheral circuit;
2. Microphone input filter amplifier circuit;
3. PWM demodulation circuit;
4. Keyboard and LCD or LED;
5. Memory EEPROM.

2.2. Wireless Radio Frequency Transceiver Chip nRF24E1. The chairman unit, the delegate unit, and the translator are used for data communication through the nRF24E1 wireless transceiver chip. Their basic circuits are all similar [6], as shown in Figure 2.

The nRF24E1 chip is the core of the wireless data acquisition and transceiver part. Through the embedded 8051 single-chip core, the A/D conversion module and the wireless transceiver module nRF2401 in the chip are controlled to realize the functions of data acquisition, transmission, and processing. The EEPROM part is the program memory of the nRF24E1 chip, with a capacity of 4 KB, which stores the programs required for system operation. When the module is powered on, first transfer the program in the EEPROM into the RAM of the chip, and then run the program. The RAM is connected with nRF24E1 chip through SPI (Serial Peripheral Interface). The nRF24E1 chip contains a 9-channel 10-bit ADC module that can convert the analog audio signal sent by the microphone to digital audio. A programmable PWM output is available on the nRF24E1 chip. The PWM can be designed to work in 6, 7, or 8 bits during use. The PWM modulator in the nRF24E1 chip has a maximum carrier frequency of 64 KHz, which makes data reception easier to filter. The system’s man-machine interface function is realized by the keyboard and LCD display screen [7].

2.3. Chairman Machine Design. The meeting host is usually assigned the chairman unit. The chairman machine is primarily in charge of controlling and managing the entire conference process. The central control unit is integrated into the chairman machine in this system. The central control unit is the system’s command and control center, allowing for unified management and control of the entire
system (including the representative unit, chairman unit, transliteration unit, and audio interface equipment). The following are its primary functions:

(1) The chairman unit has the priority function of full control of the conference order.

(2) Switch the conference mode. The meeting can be conducted under the management and control of the chairman unit; it can also be free to speak without being controlled and managed by the chairman unit. Of course, at the very beginning of the conference, the chairman unit can switch the conference mode.

(3) Allow the application to speak before approving or rejecting the representative’s application. After the chairman unit has given the representative unit permission to apply for speech, the representative unit can do so by pressing the key; the chairman unit then approves or refuses these applications in the order listed.

(4) It has buttons for selecting transliteration in multiple languages. By pressing the button, you can change the receiving channel so that you can receive transliteration in multiple languages.

(5) You can adjust the microphone input level and the total volume of the audio (there is a headphone jack), and you can adjust the headphone volume.

(6) A PA power amplifier can be connected to amplify and output the speaker’s speech. The speech of the representative unit cannot be directly connected to an external speaker. The voice signal must be sent to the chairman unit first and then amplified by the PA power amplifier. The chairman machine is mainly composed of the main controller, microphone, A/D converter, encoder, modulator, wireless transmitting module, wireless receiving module, demodulator, decoder, D/A converter, speaker, LCD display, light-emitting diode, keyboard, and other components. The structure block diagram of the chairman unit is shown in Figure 3.

Press the button to set the chairman unit to “host speaking” status and display the status on the display when the host speaks. According to the switch, the host chooses whether to broadcast the voice through the speaker or the transmitter, allowing the representative to use it. The host can switch on the authorization to talk by pushing the button when the conference is in the stage of representative speaking. At this time, the representative unit can send a request to the chairman unit, and the number of the representative units is displayed on the display of the chairman unit, and the host decides which representative speaks and sends a confirmation signal to the corresponding representative machine. The representative who receives the confirmation signal can speak on the representative.
2.4. Representative Machine Design. The representative machine is a critical component of the overall system. To complete the speech, all delegates participating in the conference can use the delegate’s microprocessor to decode and demodulate the wireless reception A/D code D/A microphone LCD keyboard modulation wireless transmission mixer speaker LED 30 and can also receive statements from other representatives through the delegate machine. Delegates who want to speak can transmit a request to speak signal by pushing the want to speak button on the delegate machine when the conference enters the delegate speech stage. After receiving the confirmation signal, they will speak through the microphone. After the speech is finished, the chairman machine will reset; at the same time, other representatives can select the original sound of the representative’s speech or the transliteration translated by the translator by selecting the channel. Its main functions are as follows:

(1) There is a button for selecting multilingual transliteration. By pressing the button, you can change the receiving channel so that you can receive transliteration in multiple languages.

(2) The microphone input level can be adjusted, with a headphone jack, and the headphone volume can be adjusted.

(3) There is a highly directional microphone with a speaking indicator circle (green). When the green light is on, you can speak; when the speech is over, the green light is off; while waiting to speak, the green light flashes.

The main controller, microphone, A/D converter, encoder, modulator, wireless transmitting module, wireless receiving module, demodulator, decoder, D/A converter, earphone, light-emitting diode, keyboard, and other components make up the representative machine. Figure 4 depicts the system block diagram of the typical machine.

2.5. Transliteration Machine Design. The most crucial component of the system is the transliteration machine. The translator is in charge of translating the conference chairperson’s or delegates’ language into the languages of various countries, as well as sending out the translator’s voice. A channel is assigned to each translator (i.e., each language). The translator’s settings remain essentially unchanged throughout the conference, although the chairman’s speech and each participant’s speech are broadcast on their own channels.

Its main functions are as follows:

(1) Indirect and direct translation functions can be performed: direct translation is the direct translation of the speech of the delegate; indirect translation is the second translation of another transliterator’s transliteration (an understandable language) when the translator does not understand the language represented by the spoken language.

(2) It has buttons for selecting transliteration in multiple languages. By pressing the button, you can change the receiving channel so that you can receive transliteration in multiple languages.

(3) It has the interlock function of the same channel; that is, the same channel can only have one transliteration transmission. When a translation unit is fixed on a certain channel and the microphone is turned on, other translation units cannot turn on the microphone on the same channel. The number of channels is 4–6.

(4) One translation unit can be used by two translators in turn.
The main controller, microphone, A/D converter, encoder, modulator, wireless transmitting module, wireless receiving module, demodulator, decoder, D/A converter, earphone, light-emitting diode, keyboard, and other components make up the translator. Figure 5 depicts the translator’s system block diagram.

2.6. Design of Auditor. The listening machine is a wireless receiving device. Compared with the chairman machine, the delegate machine, and the translator, its function is simple. It can only receive voice signals but cannot send voice signals. Its specific functions are as follows:

1. There is a button for selecting multilingual transliteration. By pressing the button, you can change the receiving channel so that you can receive transliteration in multiple languages.
2. It has a headphone jack, and the headphone volume can be adjusted.

The auditorium is mainly composed of wireless receiving modules, demodulators, decoders, D/A converters, earphones, light-emitting diodes, keyboards, and other equipment.

3. Chinese-English Wireless Simultaneous Interpretation System Software Design Based on Speech Recognition Technology

Pattern recognition is a sort of speech recognition technology. The machine translates speech impulses into text by processing and analyzing them, as well as by recognizing and interpreting them. Many fields are involved in speech recognition technology. It can be integrated with other natural language processing technologies such as spoken language recognition, speech synthesis, and machine translation to create more complicated and intelligent applications, in addition to basic applications.

3.1. Wireless way. The Chinese-English wireless simultaneous interpretation method does not require cable transmission for transmission. The receiver only requires one receiver and is free to roam around. However, as compared to a connected connection, the reliability, security, and potential to be intercepted are all inferior. Furthermore, the general receiver is powered by a battery that must be replaced on a regular basis, which is more bothersome. The degree of complexity in achieving two-way transmission varies depending on the medium, although they are all more challenging than wired techniques. Radio waves refer to electromagnetic waves in the radio frequency band which propagate in free space (including air and vacuum). Radio frequency is an abbreviation for high-frequency alternating electromagnetic waves. Generally, alternating current with a change of less than 1000 times per second is called low-frequency current, and one with more than 10000 times is called high-frequency current, and radio frequency is such a high-frequency current. The wireless radio frequency data transmission module uses radio frequency as the transmission medium to achieve noncontact data transmission. It is appropriate for situations when there is a modest amount of data to exchange, the data transmission rate is low, and the power consumption is minimal. In the sphere of wireless communications, radio frequency technology plays a critical and indispensable role.

3.2. Chinese-English Wireless Simultaneous Interpretation Process Design Based on Speech Recognition Technology

3.2.1. Voice Recognition Function Design. The speech (original language) of the delegates in the conference is picked up by the microphone and transmitted to the transliteration unit through wireless frequency modulation and then translated into various prescribed languages by the translator, and then the transliteration is sent to each representative unit through wireless frequency modulation. There is a 9-channel 10-bit ADC embedded in the nRF24E1 chip. Its sampling frequency is 8 kHz, which means sampling once every 125 μm; meanwhile, the output value of PWM is also updated once every 125 μm. Before data communication in nRF24E1 must be synchronized (handshaking). In ShockBurst communication mode, each piece of RF data contains 24 bytes or 3 ms audio sampling signal [9].

The speech recognition process is shown in Figure 6.
The voice recognition system may accomplish speech recognition based on the four following working principles, as shown in Figure 6. First, use antialiasing band-pass filtering technology to efficiently reduce individual voice variances, sampling equipment, and noise in the sample environment; then extract the average energy and vibration peaks of the voice, as well as the average zero crossing. Speech acoustic metrics, such as frequency, can be used to quickly and precisely represent sound quality attributes [10]. Following that, the speech pattern database is created. The main goal of language repetition training is to allow the speaker to repeat the pronunciation while also removing redundant speech data from the original speech samples one by one, keeping only a portion of the key speech data, and scientifically classifying the key speech data according to the relevant scheme. Finally, the relevant semantics of the voice are determined based on voice similarity.

3.2.2. Manual Interactive Simultaneous Translation. The machine translation method of human-computer interaction function includes the following steps:

Step 1: read the machine translation model and select the corresponding domain according to the user of the translation domain.

Step 2: after reading the text, divide the text into a series of sentences to facilitate the processing of subsequent modules.

Step 3: by inputting text as the search condition, after receiving the user input text, search the matching translation on the search network, and different users can get the corresponding different translation results of the input [11].

Since the number of states in the $W_n$ set increases exponentially with the increase of $n$, it will take a lot of time if the set is not pruned. Therefore, pruning processing is required. The pruning process is as follows:

For the determined source language sentence $R_1, R_2, \ldots, R_n$, there is a phrase model $(f, g, s, d)$, and the four elements in the model, respectively, represent the phrase library, grammar model, distortion limit, and distortion parameter.

Suppose that $W_n$ translates $n$ words into $m$ sets. If one element of $m$ sentences in $W_2$ consists of 2 words, it means that only two words are translated into sentences. For each state of $W_n$, there is a transition state, and all possible states will be added to the corresponding set and finally return to the state with the highest score [12].

Let $\beta$ be the search parameter and let $p$ be the transfer parameter; the resulting grammar model is

$$g = \text{next}(p, d). \quad (1)$$

After the search parameters are determined, all the unsatisfied in the collection are set:

$$a(g) > a(d) - \beta. \quad (2)$$

After removing all the parameters that do not satisfy formula $(2)$, the purpose of pruning is achieved.

Step 4: when translating a source language sentence, read the source language sentence’s translation possibilities first, and then expand the translation hypothesis.
from a small to a large container. If the difference between a score and the highest score in the container is greater than the threshold at each transition stage, the state will be dropped; if the state remains the same, all available conversion options will be expanded; if the old and new assumptions are the same, the score will be increased. Finding the translated sentence with the highest score in the largest container yields the best translation result [13].

3.3. The Key Technology of System Realization

3.3.1. Switching between Single-Channel Transceiver Mode and Dual-Channel Reception Mode. The communication between the various devices of the simultaneous interpretation system is mainly the voice signal. The original language is sent to the representative unit and transliteration unit through wireless frequency modulation; the transliteration unit translates the received speech signal into the specified language and then sends it to the representative unit and other transliteration units. Therefore, it is the most basic requirement to realize the voice signal communication between various devices. The nRF2401 wireless transceiver module in the nRF24E1 chip allows for transliteration communication between various devices. nRF24E1 is currently in ShockBurst transceiver mode. The nRF2401 wireless transceiver module works in single-channel mode, sending and receiving data across a single channel. While each device maintains voice communication, it also maintains control signal communication on occasion. For example, if the representative unit wishes to apply for speech and the interpreter suggests that the speaker slow down, the button must be pressed to transmit a request signal to the chairman unit; the chairman unit should also give a response signal according to the situation. In this way, there will be situations in which voice signals and control signals are communicated simultaneously between various devices. They occupy one channel, respectively, which requires the nRF24E1 chip to work in ShockBurst dual-channel receiving mode. Through one antenna, nRF24E1 can receive data sent by two 1 Mbps transmitters (such as nRF24E1, nRF2401, or nRF24E2) with a frequency difference of 8 MHz (8 frequency channels). The data of these two different channels are sent to two different sets of interfaces: data channel 1 is CLK1, DATA, and DR1; and data channel 2 is CLK2, DOUT2, and DR2. Therefore, in voice communication, nRF24E1 works in ShockBurst single-channel transceiver mode; when voice signals and control signals are communicating at the same time, nRF24E1 works in ShockBurst dual-channel receiving mode. This requires constant switching between the two modes [14].

Then there is the question of how to increase the simultaneous interpretation system's confidentiality via wireless frequency modulation. This difficulty is effectively solved by the nRF24E1 chip utilized in this system. First and foremost, the nRF24E1 chip operates at a frequency of 2.4–2.5 GHz. General wireless reception equipment (such as a radio) cannot reach this range due to its operating frequency band. Secondly, it is possible to assign an address to each nRF24E1 chip through a program, and only the nRF24E1 chip that has been assigned an address can communicate. What is transmitted between nRF24E1 chips is a 248-bit RF data packet, including 8-bit prefix + 32-bit address + 24 bytes of useful data + 16-bit CRC, and its structure is shown in Figure 5. The address refers to the address of the receiving end nRF24E1. Only the receiving address of the receiving end matches the address in the data packet, and the nRF24E1 chip of the receiving end can receive the data packet; otherwise, it will not be received. In this way, the confidentiality of the system can be improved, and the eavesdropping can be avoided.

4. Experimental Analysis

4.1. Analysis of the Experimental Environment. In the DPDK environment, where the automatic translation system is installed, two hosts supporting IPv4 and two IPv6 are connected to four routers, and then they are connected to a repeater. The resulting system test topology is shown in Figure 7.

Select 123,425 sentences in English from the translation library, of which 1,000 sentences come from translation materials in the news field. Divide the 1000 into 5 data sets, each of which contains 200 English sentences. The methods in literature [4] and literature [5] are used as experimental comparison methods to test the effectiveness of the Chinese-English wireless simultaneous interpretation system.

4.2. Experimental Results and Analysis. After registering and completing the system login, ambiguous words in the data set in the above table are the research objects, indicating that the Chinese-English wireless simultaneous interpretation system can give multiple meanings to ambiguous words, based on the experimental test environment and corpus data set up above. The number of uncertain words recognized by three automatic Chinese-English wireless simultaneous interpretation systems should be recorded and summarized. Table 1 shows the outcomes of the experiment.

The experimental results in Table 1 reveal that, for the same experimental data set, the three Chinese-English wireless simultaneous interpretation systems have varied levels of ambiguous word recognition. The comparison standard is the number of unclear words displayed during the experimental preparation stage. [4] The system's ability to recognize ambiguous words is the poorest. The average number of ambiguous words identified is 400 to 500, with the lowest number of recognition. Literature [5] has a strong ability to systematically translate uncertain words, with between 500 and 600 recognitions.
Figure 7: Topology of the test environment.

Table 1: The number of ambiguous words identified by three Chinese-English wireless simultaneous interpretation systems.

| Data set name | Recognize the number of ambiguous words/a |
|---------------|------------------------------------------|
|               | Literature [4] system | Literature [5] system | Design system |
| Data set 1    | 441                       | 574                      | 995           |
| Data set 2    | 424                       | 525                      | 897           |
| Data set 3    | 457                       | 565                      | 903           |
| Data set 4    | 452                       | 572                      | 908           |
| Data set 5    | 463                       | 581                      | 852           |

Figure 8: Comparison and analysis of translation accuracy of three Chinese-English wireless simultaneous interpretation systems. (a) Literature [4] system. (b) Literature [5] system. (c) This text’s system.
The article’s Chinese-English wireless simultaneous interpretation system recognizes the most confusing words and can effectively identify all ambiguous words in the experiment. The Chinese-English wireless simultaneous interpretation system designed in the paper is superior to the two traditional Chinese-English wireless simultaneous interpretation systems. The speech interpretation system is the most accurate at identifying confusing words.

To understand the sentences in the aforementioned five databases concurrently, the system in document [4], the system in document [5], and this text’s system were employed. Figure 8 illustrates the precision of the translation results.

From the experimental results shown in Figure 8, it can be seen that, with the same number of sentence pairs as the experimental object, the system in document [4] has the smallest translation accuracy rate, which can only correctly translate most of the sentence pairs, and the accuracy rate is between 40% and 80%; the accuracy value is small. The translation accuracy rate of the system in literature [5] is between 45% and 90%, and the translation accuracy rate is relatively high, which can meet most of the needs of English translation. The article’s Chinese-English wireless simultaneous interpretation system has a translation accuracy rate of more than 95% and can translate the majority of the sentence pairs prepared in the experiment, which meets the needs of public English automatic translation. Based on the following trial results, it can be shown that the article’s Chinese-English wireless simultaneous interpretation system can not only identify ambiguous English terms but also correctly translate translation tasks in public English, making it acceptable for practical application.

5. Conclusion

This study provides a set of its own system plans based on investigation of various existing simultaneous interpretation systems. It combines today’s most popular radio frequency modules with a variety of self-designed other modules and peripheral circuits to complete a set of special simultaneous interpretation systems used in small, medium, and ad hoc conferences; Chinese-English simultaneous interpretation is realized through speech recognition technology, and the system’s functional module structure is based on the design of the system’s functional module structure. The results of the experiments reveal that the system has excellent recognition efficiency and accuracy and that it fits the requirements for Chinese-English wireless simultaneous interpretation.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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