A Multi-Lingual and Text-Speech Dialog Support System for e-health

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Abstract. This paper reports a web-based remote collaborative medical diagnosis system. This system provides a dialogue platform using text and speech, by Chinese and Uyghur, containing information such as disease names and symptoms for different medical classifications. The interactive text and speech between doctors or patients can be translated bilingually between Chinese and Uyghur automatically. At last, diagnosis report will be generated for the doctor and the patient. Finally, the performance of the e-health service system is evaluated.

1. Introduction

Medical Expert Consultation System Abstract CSCW (Computer Supported Cooperative Work) is a very active research field in Computer Science. The high-speed internet and advanced artificial intelligence (AI) help many complicated CSCW systems to be realized today [1].

A large population of people living in the countryside in China, and most of them are relatively poor, especially in the areas with the ethnic minorities such as Xinjiang. Due to shortage of medical resources and complex language environment, it is still difficult to see a doctor for them. Telemedicine is expected to bring more convenience to them with the development of Internet and application of AI technology [2,3].

The whole task is very challenging. We aimed and developed the key techniques such as multi-lingual translation by text and speech for the remote medical and e-health.

The development of our e-health system followed the procedures. First, a high-quality Chinese and Uyghur and Kazak languages text and speech corpora is built, focusing on the various medical terms in collaboration with medical and health institutions, such as hospital clinics and professionals from medical universities. Second, a set of parallel of speech and sentences (PS) is built, including a larger volume of words used in the medical and health field. Finally, a speech and sentence translation system between Chinese and Uyghur is developed [4,5].

The translation system can provide convenient interactive conversation in his/her native language between patient and doctor. The results of the translation obtained by searching through the PS followed by speech or machine translation (MT) are then displayed on the table or via voice. Patient can select the most suitable result from the translation candidates by clicking on the table buttons. Finally, a PDF file used as an electronic medical record (EMR) is generated by the system automatically.
The remainder of this paper is organized as follows, we present the related works in section 2 and discuss the overall translation system in section 3. Section 4 addresses the experimental results and the performance evaluation. The conclusions and future works are presented in section 5.

2. Related works
Until now, there have been only limited reports on domestic multilingual translation systems for health care research and development. In our previous study, we have reported an electronic medical record translation system that applied the strategy of statistical and example-based machine translation for the Chinese and Uyghur languages [6,7].

The research group of the Ministry of Japan and Ikeda, reported a multi-lingual support system using a practical text-set for outpatient services [8]. They also confirmed that the system performance deteriorates with a larger number of unknown words. Collection of all the relevant words and dialogs in a native language considerably difficult.

In this study, we report a high-performance machine translation system focused on the e-health or telemedicine. Our system is built based on bilingual parallel sentences relevant to the medical field, provide text and speech interactive in Chinese and Uyghur and Kazak, and the translation of speech and text will be completed automatically.

3. The proposed system

3.1. Questionnaire for the Outpatient Service
An outpatient doctor may provide a patient's condition survey table, as shown in Figure 1, to the patient. The patient answers each question in his/her native language via voice or text input by pressing some buttons. For illustration purpose, a Uyghur Latin alphabet-based questionnaire is presented.

Figure 1. the complete interface
To use the system, a patient first answers the question as prompted, entry, depicted in Figure 1 (2) and Figure 1 (3). Next, when the patient clicks on the appropriate buttons, depicted in Figure 1 (2) or Figure 1 (4), the system will display an interface automatically, as shown in Figure 2, by text or voice respectively according to patient’s input, in two languages (the patient’s language and the doctor’s language). Column (3) of Figure 2 shows the PS search results and column (4) of Figure 2 shows the MT result for an entry in column (2) of Figure 2. The PS search results are shown in column (3) of Figure 2, obtained by an N-gram (2 gram or 4 gram) statistical language model and a maximum likelihood criterion. In this case, the system can provide three matching results.

![Figure 2. translation system](image)

If the instance or the input string does not exist in the PS, the system does not display the results. Column (4) of Figure 2 shows the result of the MT. Common machine translation systems may generate mistranslation results. Therefore, column (5) of Figure 2 is highlighted with a red string display, reminding the user that the machine translation results may have translation error.

In addition, column (4) of Figure 2 shows the results of the original input sentence that are repeatedly translated. Thus, the patient can repeatedly modify the original input, namely column (2) of Figure 2, and choose the most satisfactory translation result to improve the accuracy of the machine translation. The MT provides only one result and the PS gives three, hence, the translation system in Figure 2 can display and answer using voice four different translation results. Finally, the patient can select and click column (3) or column (4) of Figure 2 according to the actual situation, using the right button "use." Then the system prints a PDF file in two languages. Finally, both the doctor and the patient can save the PDF file for electronic medical records.

3.2. Parallel Sentence and Statistical Machine Translation
This section describes the PS system and the decoder of the machine translation. 240K Chinese sentences including medical, medicine, and drug-names were developed in our previous research [9,10]. Then, sentences in the Uyghur and Kazak languages corresponding to these Chinese sentences were added manually, and the speech by professional announcer were recorded. Finally, a multi-lingual, aligned medical corpus was created for the system test [8]. We applied a text and speech machine
translation based on the general Moses and HTK software, which was developed by the Key Laboratory of multiple language information technology of the Xinjiang University [11,12,13,14].

4. Experimental results and discussions
In order to confirm the effectiveness of the questionnaire, we investigated the test results of the PS and the MT, and tested the performance using an integrated system (PS and MT).

4.1. Test conditions
Ten students, interested in science and engineering, and proficient in Chinese and Uyghur, participated in the experiment. They were asked to enter their own experience of the pathology and relevant medical information. Six students, who specialized in medicine, checked the results of the MT.

To increase the usability of the system, the source language is set to Uyghur and target language is Chinese. Additionally,

(1) We guaranteed confidentiality in this study. Private information was not revealed.

(2) Each participant filled both the investigation form and the system-provided form. These two forms were filled with the same content and in the same order.

(3) Taking into account the user’s familiarity with the system operation, the two forms were repeated twice. Table-1 shows examples of the questions. Answers were filled in both a paper-form and a system-provided form. The experiment was carried out with native speakers of the local language (Uyghur). The system assumes that 258 pairs of sentences can be used in the experiment.

4.2. Test by searching the PS only
In this experiment, we investigate two kinds of test results. Figure 3 shows a PS set search result and the MT for question No.1 in Table-1.

Table 1. Questionnaire contents

| No. | So'al Soroush Mazmi (Question content) | O'al Sorash Shekli (Question form) |
|-----|--------------------------------------|-----------------------------------|
| 1   | qandaq Alamet körülwatidu?           | ixtiyari kirgüzüsh               |
| 2   | qachandin bashlap?                   |                                   |
| 3   | iqki takxurux ainiki bilen tegxarganma? | qemni yaki kunupkini chëkip kirgüzüng |
| 4   | Qandaq dora yedingiz?                | ixtiyari kirgüzüsh               |
| 5   | dorini hazirmu yemsiz?               |                                   |

It is clear that the three results shown in (3) of Figures 2, 3, and 4, by searching the PS alone, are not better than the result of the MT shown in (4) of Figures 2, 3, and 4, for the answer sentence /axqazan mijaz yaqxiemes (meaning my stomach is upset) /. This is because the answer sentence contains commonly used words and does not contain medical terms. We can observe another translation result for question No.3 in Table-1, shown in figure 4. Here, an answer for question No.3, /iqki takxurux ainiki tegxarixni qlgohan/, contains medical terms, hence, the PS search results, (3) of Figures 4 is considerably better than that of the MT, (4) of Figures 3 and 4. Tests using MT only.

In this experiment, we assume that the machine translation is an independent implementation. Each sentence that appears in MT is compared with the results. Table-2 shows the results of the 10 sentences using the PS search. The column, results of the PS (Chinese), includes results of translation by the PS for the source language (Uyghur).
Figure 3. a translation result for

The column, results of the MT, includes results by the MT for the source language (Uyghur). The column, indicating correctness, shows a manual evaluation of the MT for the source language (Uyghur). In this experiment, 20 sentences were selected for the test and 10 sentences were evaluated after excluding repetitive sentences. From Table-2, it can be seen that there are four mistranslations among the 10 sentences or four of the translation results do not match the source language. In addition, for a sentence with ID: 1 in Table-2, although the result using MT and the result of the PS are close in meaning, the result by MT does not answer the question “What are the symptoms?”, hence, it is judged as an incorrect result.
From the above discussions, it is obvious that it is difficult to collect all the native language information used in the medical field and the machine translation technique cannot ensure the translation accuracy for the special terms used in the medical and health fields. If the mistranslation by MT is corrected using the PS search, then, the proposed method of merging both the PS and the SMT is feasible.

Table 2. Examples of the sentences used in the experiment

| ID | Source language (Uyghur) | results of PS (Chinese) | results of MT (Chinese) | correctness |
|----|--------------------------|-------------------------|-------------------------|-------------|
| 1  | شەھەرزە (fever)          | (have hot)              |                         | ×           |
| 2  | باش ناغەش (headache)    | (headache)              |                         | √           |
| 4  | مۆرە سەرچەب (shoulder ache) | (shoulder is very painful) | ×          |
| 8  | زۆکەم (have a cold)      | (have a cold)           |                         | √           |
| 21 | قۆرساق ناغەش (collywobbles) | (collywobbles)         |                         | √           |
| 47 | قەلتەش (food allergy)   | (food allergy)          |                         | ×           |
| 50 | باش قەپەش (dizzy)       | (dizzy)                 |                         | √           |
| 60 | نەشەقە يۆق (loss of appetite) | (loss of appetite)     |                         | √           |
| 72 | نەپەس قەلەتەش (dyspnoea) | (dyspnoea)              |                         | √           |
| 83 | ناغەش قەلتەقان (have a stomach ache) | (sometimes a stomach ache) | ×                |

5. Conclusions
In this paper, we have presented a multiple-lingual translation system that focuses on remote medical or e-health and outpatient services. The system merges the PS and the SMT approaches and translates the dialogues of the doctors and patients automatically, and creates an electronic medical record (EMR). Through experiments, we confirmed that the proposed method is feasible and practical. In the future, we will improve the system accuracy and extend our system to more languages, such as languages along the One Belt-One Road countries.

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