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FULL-LENGTH ARTICLE

Translation from Arabic speech to Arabic Sign Language based on cloud computing

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Abstract People with special-needs face a variety of different challenges and barriers that isolate them from their surroundings. Nowadays, several assistive technologies have been developed to reduce many of these barriers and simplify the communication between special-needs persons and the surrounding environment. However, few frameworks are presented to support them in the Arabic region either due to the lack of resources or the complexity of the Arabic language. The main goal of this work is to present a mobile-based framework that will help Arabic deaf people to communicate 'on the go' easily with virtually any one without the need of any specific devices or support from other people. The framework utilizes the power of cloud computing for the complex processing of the Arabic text. The speech processing produced a cartoon avatar showing the corresponding Egyptian Arabic Sign Language on the mobile handset of the deaf person.

1. Introduction

Special-needs persons suffer from discrimination and obstacles that limit their participation in different societal activities. Due to the lack of proper communication, they are denied from their rights to live independently, to work, or even to move freely.

A large number of special-needs cases live in developing countries, regularly neglected and in extreme poverty. This research focuses on people with hearing and speaking impairment (deaf and dumb) in Egypt. According to last official statistics, there are 360 million people worldwide have disabling hearing loss [1] where more than 3 million of them are located in Egypt [2]. Most of the Egyptian deaf lack the ability to read or to write the standard Arabic language. Therefore, the only way of communication among them is the Arabic Sign Language (ArSL) that is not understood by hearing people. This fact has a great impact on the social life of the Egyptian deaf community that comes to be quite isolated and has large difficulties to gain social experiences and relationships.

Recently, there has been a revolutionary change in approach, globally, to close the gap and guarantee that persons with handicaps enjoy the same standards of equality

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and rights as everyone else. The information technology plays an important role in the new methodology where several assistive systems have been developed to support deaf communities around the world.

For example the author in [3] has presented a concept that uses a pattern recognition algorithm to analyze the acoustic environment around the user, identify critical signature and give an alert to the user where an event of interest happened.

Another example presented in [4] makes the usage of low-cost portable gloves, these clothes contain sensors to collect data about hand gestures, and the collected data help to identify the ArSL signs performed by the deaf person.

However, the situation was quite different in the Arabic region where there is no real consideration of governments to the disabled people. For example, as marked by the report in [5], the Egyptian government limits an ArSL translation to News Programs on Television for only 10 min up to 7 h per week. Also, the administration does not allow deaf persons to get legislative documents translated into ArSL. Definitely, the disabled community is still out of the administration interests and future plans.

Even more, the assistive technologies directed to deaf communities in the Arabic countries are quite a few and limited. Besides the government ignorance, the complexity of the Arabic language and the ArSL is the main reason for this limitation. Arabic language is much wealthier than English and is considered as one of the most complex natural language [6]. Regarding ArSL, a standard dictionary can be found in [7] that contains 1600 of the basic and most common signs. Nonetheless, each country has its own modified version of this dictionary that holds new signs for its colloquial language and modified signs for most of the existing words. Even more, you can find for the same word a different sign in distinct cities of the same country [8].

As a conclusion, deaf individuals in developing Arabic countries can communicate with normal people only through an ArSL human interpreter who is very hard to find and in all the cases will break the conversation privacy. To help the Arabic deaf community to integrate with the society and to communicate easily with others, there is a big need to develop an automatic machine-based interpreter that can convert from Arabic speech to ArSL and vice versa [9]. The work in this paper focuses on the first direction, the Arabic speech to the ArSL, while the other direction has been discussed in [10].

In this paper, we introduce a mobile-based application that plays the role of an intermediate interpreter between normal and deaf persons, that helps to achieve a seamless communication on-the-go at almost real time.

However, the processing power of a mobile device may be inefficient for the conversion process. To solve this issue, we have connected the application to a cloud-based framework where we can delegate all heavy work to powerful resources on the cloud.

The rest of this paper is organized as follows. Section 2 shows some of the related works concerning ArSL translation systems. Section 3 describes the system architecture of the cloud-based framework. In Section 4, experiments and results are presented. Finally, Section 5 concludes the paper and discusses the future work.

2. Related work

There exist several attempts to convert Arabic speech to ArSL. In general, the conversion process has two main phases. First, the Arabic speech is transformed to text, and then in the second phase, the text is converted to its equivalent ArSL. Some existing work tries to convert directly from the Arabic speech to ArSL depending on third party tools for speech recognition. In this section, a review of the most popular Arabic speech to ArSL conversion systems is presented.

Authors in [11] introduce an Arabic speech to ArSL intelligent conversion system. The system is based on a knowledge base to resolve some of the Arabic language problems (e.g. derivational, diacritical and plural). According to the authors' evaluation, the system has accuracy up to 96%. Conversely, the system has two main problems. It is a desktop application and the system output is a sequence of still images without any motion. Therefore, it is more suitable for educational purposes, not for the on-to-go real-time translation.

The Research Lab LaTICE in Tunisia is currently working on the Websign project [12,13]. This project tries to develop a web-based interpreter of the ArSL. Websign is based on the technology of avatar (animation in the virtual world). The input of the system is a text and the output is an interpretation in sign language. This interpretation is built through a lexicon of word and signs. Utilizing the developed web service, a mobile application (MMSSign) has been introduced in [14] to convert text messages to its equivalent sign language in a form of an Multimedia Messaging Service (MMS) to help hearing persons to communicate with deaf people. The MMSSign can support sending discrete information on long periods (e.g. news, or weather status) but not for real-time translation.

In [15], Halawani introduced a desktop application to convert Arabic speech to ArSL. First, the human speech is converted into text through a speech recognition system, and then the text is converted to an avatar-based representation of its equivalent ArSL. The avatar from the author's context is simply the graphical representation of the sign (just an image). The translation process depends on a database of the ArSL signs. However, there is no provided information about how the size of the database will be limited and how the different dialects of the ArSL can be handled. As an improvement to this work, a system called ABTS-ArSL has been presented in [16].

The ABTS-ArSL is again a desktop application that is based on Microsoft Window 7 Speech Recognition Engine. The last two systems are machine-dependent and need a PC or a laptop to access them.

Al-Khalifa in [17] announced a mobile phone translator system to convert typed formal Arabic text to ArSL using a sign-avatar. The application depends on two processes (translation and presentation), and a sign dictionary. In the translation process, the sliding window technique is used to handle the occurrence of compound sentences. The system's presentation process relies on the Mobile 3D Graphics API (M3G) to animate a 3D signer avatar. For the sign dictionary, a local