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Procedia Computer Science 117 (2017) 2–9

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd International Conference on Arabic Computational Linguistics, ACLing 2017, 5-6 November 2017, Dubai, United Arab Emirates

Transform-based Arabic sign language recognition

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Abstract

Sign language is an independent language that uses gestures and body language to convey meaning. Sign language recognition facilities the communication between deaf and community. In this paper, we investigated the use of different transformation techniques for extraction and description of features from an accumulation of signs' frames into a single image. We show the performance of three transformation techniques (viz. Fourier, Hartley, and Log-Gabor transforms) applied on the whole and slices of the accumulated sign's image. In addition, different classification schemes are tested and compared. Overall system's accuracy reached over 99% for Hartley transform which is comparable with other works using the same dataset.

Peer-review under responsibility of the scientific committee of the 3rd International Conference on Arabic Computational Linguistics.

Keywords: Arabic Sign Language recognition; Frequency Transforms; Fourier transform; Hartley transform; MLP

1. Introduction

Deaf and hard hearing population form a large number in the Arab world and 70 million worldwide[1]. This community uses sign language as the first language for communication. Sign language differs from one country to another and sometimes within the same country. In Arabic countries, there are several sign languages like Jordanian, Saudi, Egyptian, Yemeni [1]. In 1999, the League of Arab States (LAS) and the Arab League Educational, Cultural and Scientific Organization (ALECSO) standardized the Arabic Sign Language (ArSL) and published a dictionary consists of about 3200 words [2].

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[1] Deaf World Federation, http://www.wfdeaf.org/

1877-0509
Peer-review under responsibility of the scientific committee of the 3rd International Conference on Arabic Computational Linguistics.
10.1016/j.procs.2017.10.087

ArSL language is used in almost all Arabic countries and mainly in Arabic Gulf countries such as Qatar and United Arab Emirates. However, this language does not replace the national language of some countries that use it with its local sign language. Currently, most of the TV channels in Arabic countries use ArSL to translate their programs and news.

ArSL is a complete language with grammar and structure that differ from Arabic. ArSL sentence starts usually with the subject while question sentence ends with question words in ArSL. Fig. 1 shows an example of an Arabic question sentence with its ArSL equivalent. ArSL does not inflect signs to show gender and number. However, it uses dedicated signs to show signs' gender and number (we refer to [3] for more information about ArSL grammar and structure). Converting ArSL sentence into Arabic is a two stages problem: recognition and machine translation. The first stage involves recognizing the ArSL sentences' signs and mapping them to their equivalent Arabic words. The second stage is translating the recognized ArSL sentence into Arabic. The translation involves changing the structure and grammar of ArSL into Arabic. In this work, we are addressing the ArSL recognition.

ArSL	Arabic
؟ انت اسم ماذا	ما اسمك؟
? Ant Asm mA*A	mA Asmk?
? YOU NAME WHAT	What is your name?

Fig. 1. Arabic question sentence in ArSL structure

Sign language is an independent language that uses gestures and body language such as hand shapes, lip patterns, and facial expressions to convey meaning [4]. It uses finger spelling to spell names or words that are not in the language vocabulary. For words that are in the language vocabulary, sign language uses dedicated sign for each word. Facial expressions such as eye gaze direction, eyebrows, eye blinks, and mouth are used to express the feelings and emotions [5].

Many deaf are unable to read and write spoken languages. These problems increase the isolation of deaf from the society. Automatic sign language recognition (SLR) systems are important for solving these problems. These systems are the equivalent to speech-recognition systems used by speaking people. SLR systems acquire the signs and convert them into other forms of language such as speech or text. While automatic speech recognition has now advanced to the point of being commercially available, automatic SLR and especially ArSL are still in their infancy. In addition, publicly available databases are limited both in quality and quantity, rendering many traditional pattern recognition learning algorithms inadequate for classifiers building.

There are contradicting requirements in the recognition of signs. For example, some signs involve hand motion in a large area while others involve changing of just one finger status. Thus no constant field of view can be assumed otherwise the sign with finger motion will be treated as noise. Also, the same sign may be performed at different speeds.

In this work, we evaluated the efficiency of different frequency domain transforms for ArSL recognition. These transforms include Fourier, Hartley, and Log-Gabor. These transforms are evaluated using different machine learning tools. The obtained results show that Hartley transform is efficient for recognizing ArSL signs.

This paper is organized as follows. Section 2 reviews some related works of ArSL recognition. In section 3 we describe the proposed work, followed by a description of the experimental results in section 4. Finally, Section 5 presents our conclusions.

2. Literature review

ArSL recognition is still in its infancy compared with recognition systems for other sign languages like American, British, German…etc. Mohandes et al addressed isolated words using skin color model in chromatic color space to detect the face [6]. The region growing is used to search for orange and yellow gloves (worn by signer to ease the segmentation) to locate hands and extract the following features: Hands' centroids with respect to face centroid, area