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Takalem : A deep learning approach for Algerian sign language recognition

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Dedication

To my dear mother
To my dear father
To my dear sisters
To my dear brothers
To my adorable grandmother
To all my uncles, aunts and cousins
To all my friends and colleagues
To every one who have supported me

Fathi Abdelmalek

Acronyms

AJSL Algerian jewish sign language

ANN Artificial Neural Network

ASP Algerian sign language

CNN Convolutional Neural Network

DL Deep Learning

FSL French sign language

HMM Hidden Markov Model

ML Machine Learning

RNN Recurrent Neural Network

SL Sign language

SLR Sign language recognition

Abstract

Keywords— sign language recognition, artificial intelligence, machine learning, deep learning

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State of the art

Chapter 1

Sign languages and sign language recognition

1 Introduction

Deaf, mute, and hard-of-hearing people, have their language system, its Sign language (SL), there are over 300 different SL used in the world, and each one has a unique grammar and vocabulary, one of them is Algerian sign language (ASP), is used by more than 240,000 individuals around Algeria. Sign language recognition (SLR) technology aims to provide a means of automatically interpreting SL and translating it into text or speech, to facilitate the communication process between normal and deaf/mute people.

Recent advancements in wearable sensor technology have made it possible to develop SLR systems using sensor gloves. These gloves contain multiple sensors that measure various parameters related to hand movement and position. Machine Learning (ML) and Deep Learning (DL) algorithms can then be used to analyze the sensor data and recognize the corresponding SL gestures.

In this chapter, we will provide an overview of sign languages and SLR technology. We will discuss the challenges associated with SLR and the potential benefits of developing such technology.

2 Sign languages

SL is one of the methods of communication, which is defined as a set of visual symbols or gestures that are used in a very systematic way for words, concepts, or ideas of a language.[1]

Despite the complexity of sign languages, they can be broken down into smaller units, such as signs, hand shapes, and movements. Sign languages typically use a combination of these units to form words and sentences. For example, ASP uses hand shapes, movements, and facial expressions to convey meaning.

Sign languages are not just visual representations of spoken languages, they are unique and independent languages with their syntax, grammar, and vocabulary. Recognizing and understanding them is therefore crucial for effective communication be-

tween hearing and deaf communities. In recent years, there has been increasing interest in developing technology to aid sign language recognition and translation.

2.1 Sign languages in Algeria

There is no official ASP document or reference except for a dictionary published recently by the Algerian government. It contains some signs used by the deaf and other signs borrowed from the Old French sign language (FSL).[2]

There is also Algerian jewish sign language (AJSL), an old SL which developed in several Jewish communities in the region of M'zab, Algeria, which is located in the northern part of the Sahara desert.[3]

2.2 Algerian Sign Language

ASP is an SL (also known as LSA, (Langue des signes algérienne)) derived from FSL, used by the deaf/mute community of Algeria. It was officially recognized by the Algerian law as official SL in Algeria in May 2002[4]. Technically, it is a visual-gestural language that uses hand shapes, movements, and facial expressions to convey meaning. Therefore, this community is often excluded from basic communication, this has caused many deaf Algerians to go without access to education, employment opportunities, and other basic rights. For that, The government of Algeria opened many deaf schools around the country to teach them the language itself, and basic education like any normal person.

Even with the existence of deaf schools, the teachers themselves are not qualified neither master ASP, all of them are hearing individuals who hold different degrees which are not related to deaf education or SL, and they have never been trained to use the language before they get hired, some teachers attend training courses to learn alphabet only. And this makes it difficult for those pupils to get basic education and go even to middle or high school and college, most of them are marginalized and can only be manual workers, they are denied access to a high-quality education that meets their special needs to improve their lives and live as equal to their peers.[2]

3 Sign language recognition

SLR is the process of interpreting and translating the gestures, movements, and facial expressions of SL into written or spoken language. It involves capturing, processing, and analyzing data from various sensors and devices such as gloves and cameras.

The task of SLR is a challenging one due to the complexity and variability of sign languages. Sign languages are rich and expressive, and there are many different sign languages used around the world, each with their own unique vocabulary, grammar, and syntax. Moreover, sign languages are not universal, meaning that a sign used in one language may have a completely different meaning in another language.

Despite these challenges, significant progress has been made in the field of SLR in recent years, thanks to advances in sensor technology, computer vision, ML and DL. Researchers have proposed a wide range of approaches to tackle the problem of SLR, including rule-based systems, template matching, Hidden Markov Model (HMM), Artificial Neural Network (ANN), and DL methods.

In recent years, DL-based methods, particularly Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN), have shown promising results in SLR, achieving state-of-the-art performance on several benchmark datasets. These methods can learn meaningful representations of the data directly from raw input, which makes them well-suited to complex and dynamic data like SL.

4 Conclusion

In this chapter, we have introduced sign languages and the importance of SLR systems in facilitating communication between deaf or hard-of-hearing individuals and the hearing world. We have also presented a review of the literature on SLR systems, including the techniques and methodologies that have been used to develop these systems.

From our review, it is clear that SLR is a challenging task that requires the use of sophisticated techniques such as ML, computer vision, and signal processing. While progress has been made in this area, there are still many open challenges that need to be addressed, such as improving the accuracy and robustness of recognition systems, developing systems that can recognize different sign languages, and addressing the issue of data sparsity.

In summary, the field of SLR is a promising area of research with many potential applications. We hope that this chapter has provided the reader with a good understanding of the current state of the art in SLR and the challenges that lie ahead.

Chapter 2

Related works

1 Introduction

In this section, we provide an introduction to the topic of SLR and its importance in facilitating communication for the deaf and hard of hearing community. We present an overview of the goals and objectives of this study, highlighting the significance of developing accurate and efficient SLR systems. Additionally, we outline the specific objectives of this research and provide an overview of the subsequent sections in this chapter.

1.1 Background

In this subsection, we provide background information on sign languages, their unique characteristics, and their importance as a means of communication for individuals with hearing impairments. We discuss the complexity of sign languages and the challenges associated with their recognition, emphasizing the need for advanced technologies to aid in real-time sign language interpretation.

1.2 Motivation

In this subsection, we discuss the motivation behind the development of sign language recognition systems. We highlight the limitations of traditional communication methods for individuals with hearing impairments and the potential impact that accurate and efficient sign language recognition can have on their daily lives. We also discuss the growing interest in using machine learning and artificial intelligence techniques to enhance sign language recognition capabilities.

1.3 Objectives

In this subsection, we outline the specific objectives of this research project. We identify the main goals and targets that we aim to achieve, such as designing a wearable sign language recognition system, developing robust machine learning models, and evaluating the system's performance through experiments and user studies. We also highlight the potential applications and benefits of the proposed system in real-world scenarios.

1.4 Overview of the Chapter

In this subsection, we provide an overview of the subsequent sections in this chapter. We briefly describe the content and organization of each section, outlining the main topics and discussions that will be covered. This serves as a roadmap for the reader, giving them a clear understanding of what to expect in the rest of the chapter.

By following this structure, you can introduce the context, motivation, objectives, and the overall organization of Chapter 2 in your thesis. Feel free to customize the content and add more details based on the specific focus and requirements of your research.

2 Methods of sign language recognition

3 Synthesis

4 Conclusion

Part II

Contribution

Chapter 1

Conception of Takalem gloves

Chapter 2

Results and discussion

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