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An online reversed French Sign Language dictionary based on a learning approach for signs classification☆

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ABSTRACT

Sign Language contains very rich vocabulary units which can vary by a simple change in shape, position or movement. The characteristic of this language, to be practiced in space, has encouraged us to adopt a pragmatic approach, which facilitates access to its vocabulary. In this paper, we take advantage of digital techniques to build a human machine interface to create a dictionary of French Sign Language (FSL) to French as a web application. We notice that the FSL has not yet any fixed set of rules to learn this language. We hope that this application could contribute both in spreading and stabilizing the language. To this end, we develop a scalable research system, able to find the meaning of a FSL sign from some features of the sign itself. In this work, we set up a web platform for signs and we analyzed user requests that are connected to this platform. This analysis based on some experiments; aim to identify the parameters necessary to develop an application able to easily find the meaning of the sign in French. Therefore, by studying user behavior, we build a cognitive system that meets to needs.

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1. Introduction

The language is the main instrument of communication between individuals. This is a code that ensures a level of exchange between the transmitter and the receiver and vice-versa. Thus, it is based on various modalities (speech, writing, or gestures). Sign language (SL) is a language mainly used by deaf people and people with whom they communicate. Similarly, it is equivalent to any other language, as demonstrated by the work of Stokoe of the American Sign Language (ASL) [1]. It would be nice to meet a deaf person and exchange knowledge with it like we exchange with a tourist who speaks a different language. Unlike spoken language, SL is based on gestural-visual channel and non on vocal sound [2]. SL as spoken language has a vocabulary and a grammar. It also has the particular feature of being formed in space. This specificity creates certain difficulties for the computer implementation of this language. It is only recently, now that the computers have gained considerable power of information processing that the computer modeling of this language has become possible. This modeling has been treated with various aspects in the research domain.

Several works treated the sign language recognition by using computer vision. We cite [3] which use deterministic robust features based on hand trajectories in order to propose a sign level classifier. The classifier is based on sequential pattern trees approach by using Kinect features. Another work proposes a machine learning model for Indian sign language recognition using webcam images [4]. This model groups three methodologies: image processing, computer vision and neural networks. The sign interpretation is done by Haar Cascade classifier. In [5], the authors work on the recognition of the 36 Bangali alphabets in real-time using K-nearest neighbors (KNN) classifier. Whereas, other researches treat: automatic SL video processing [6], recognition of SL gestures [7], support for the SL acquisition and learning [8], and the categorization of SL [9]. Most of these approaches [3–7] are basically founded on image processing in order to recognize signs in real-time. While we develop in this work, a signs search engine based on an encoding of the FSL signs and not based on image processing. Thus, we avoid all the constraints related to image acquisition (quality, environmental management, equipment, etc.). Moreover, we do not work on a real-time translation but on a reversed dictionary which is always available. Furthermore, the majority of these approaches [4, 6–9] have treated the grammar of FSL or the conversion of FSL in the form of written language. Our approach that treats vocabularies units does not follow the same approach or the same direction of these researches. In fact, it focuses on the production of a reversed dictionary which does the translation from the FSL to French. In French Sign Language, there exist other works on dictionaries from French to FSL [10] but no previous works dealing

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with reversed dictionary (FSL to French) or works based on other techniques for the same production.

This work describes the first initiative of an online reversed dictionary that allows a search in FSL vocabulary. The idea is to provide a simple tool to help users who want to find the meaning of a sign. Lexical dictionaries are considered to be practical gateways between languages. In recent decades, they have been rapidly adapted to new technologies. So much indeed that, they have now for a great part abandoned their classic look of books, to conquer the world of the Internet. This development has allowed them to be more accessible and responsive through the use of different systems of indexing and adequate classification. The main goal of this work is to propose an online dictionary able to help the users to find the significance in French of a sign by inserting some choices of sign parameters. In this regard, we have studied the specification of FSL and created a database using a validation process by FSL experts. Then, we have put our dictionary online and performed a learning approach so that the dictionary is can be as effective for non-experts as for FSL experts. In order to achieve this task, we defined two main steps:

- Modeling the vocabulary of the FSL in order to be ergonomically exploitable within the constraints of human-machine interfaces: Based on some parameters of the FSL, we designed a simple model, which does not include necessarily all the strict rules of the sign description.
- Proposing an automatic classification protocol of FSL based on learning algorithms. The learning process will allow us to access to the sign with a minimum of parameters. The aim is to develop a platform capable to take account the user experiments in order to obtain an effective result.

Given the absence of an institutionalized written of SL, we find ourselves confronted with the difficulty of analyzing this language. We must also respect the ergonomic constraints of human-machine interfaces. Regarding this, the main objective of this research is to find a compromise between the modeling of signs and consistency of results. To do this, the developed tool must therefore answer the needs of users who can be in our case: hearing people in the learning phase who need to be familiar with the FSL lexicon; and deaf people, for whom the FSL is the first language and who seek to know the French translation of a sign.

During this research, we worked with a set of FSL parameters, which may present a satisfactory representation space of a sign. The user gives the parameters of an unknown sign and the system brings him a tag cloud that answers to his request. For this purpose, the developed system behind the interface computes similarity values and follows classification and learning algorithms in order to recognize the sign and assign to it the French signification.

This paper is organized as follows. In Section 2, we present the used modeling sign parameters for the developed system. Sections 3 and 4 are devoted to the experiments. In these sections, we describe the learning approaches and the classification algorithms. We present and analyze the obtained results. The last section concludes the work.

2. Modeling parameters and encoding system

Recall that SL is practiced in spatial space. This special character poses some difficulties related to the computer implementation of this language [6, 9]. There are two main difficulties: the first is that we do not have good defined rules concerning the FSL parameters (for example: the number of handshapes). The second difficulty concerns the procedure of converting easily the parameters to an exploitable format without overloading the system. In fact, the real challenge that needs to be met is to know what we must identify and keep from the large amount of information to be processed [11]. This permits to achieve a more flexible communication facilitating the communication between the communities of deaf and hearing people.

Table 1
Number of handshapes regarding different authors.

Author	Number of handshapes
Cuxac	39
IVT	61
Bonnal	44
Braffort	55/139

Researchers who are interested in the study of the SL structure have different views regarding the number of features used to define a sign. For example, Stokoe selected three parameters for the ASL structure [12]. It is based on 55 symbols grouped into three groups: handshape, position and movement. These parameters have been extended in Battison's work with the addition of the palm orientation of hand as fourth parameter of signs [13]. However, the majority of researchers believe that signs are made up of five parameters including facial expressions [14]. We can find also the concept of the dominant hand and the dominated hand in the SL. The dominant hand, generally the right hand for right-handed people, is one which performs a gesture during the production of a sign. For ergonomics reasons, in order to build a simple and fast search system, we have decided to work with three parameters instead of five. The reason is the following: if we introduce five parameters and for each of them, we choose one element in a set of varieties, it becomes very heavy especially for a novice user. This process takes a lot of time and makes the searching process very hard to accomplish. So, one of our ergonomic reasons is to reduce the number of parameters in order to simplify the process and to increase its speed. The reduced number of parameters is compensated by the use of an intelligent classification which learns from the behavior of users. The three selected parameters are:

2.1. *Handshape*

The handshape shows the spatial morphology and gestures of the hand. Currently in the FSL, no fixed number of handshapes is officially defined or recognized. We have found a wide variety of proposals. Boutora conducted a study on the categorical perception of manual handshapes in FSL based on the comparison of some previous studies made in the field of ASL [15]. The FSL specialists do not all agree on how to define handshapes. According to Cuxac [2], there are 39 basic handshapes. However, Braffort [7] has set up 55 handshapes from previously defined 139 handshapes. This number was reached by following articulatory measures of hand fingers in the course of making a gesture recognition model.

Table 1 shows that there is no consensus between FSL experts on the exact number of handshapes. There are also no rules to define it. At the first, when we started the encoding process, we tried to encode the signs with 39 handshapes [2]. Next, we faced to the first obstacle: some signs have handshapes which are not present in the 39. We concluded that some details are missing. The others works contain a lot of details [7] which can disturb the users. So we decided to propose our system of handshapes.

After a thorough study of statistics of FSL videos, we selected an initial number of handshapes, based on ergonomic criteria. To avoid a too high workload in our dictionary interfaces, we selected 59 handshapes which seemed sufficient to access the vocabulary of our corpus. These 59 handshapes must be presented in an ergonomic interface which is adapted for HCI (Human Computer Interaction). For this, in order to facilitate this HCI, we propose a handshapes distribution in homogeneous groups of observations. Each group is well differentiated from the others. The goal is to can offer a selection inside each group. However, when codifying a sign, we do not carry out the classes but just the handshape.

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