Recognition of Mexican Sign Language through the Leap Motion Controller

Luis Obed Romero Nájera, Máximo López Sánchez, Juan Gabriel González Serna, Rodrigo Pineda Tapia, Julia Yazmín Arana Llanes
Department of Computer Science
National Center for Research and Technological Development, CENIDET
Interior Internado Palmira S/N, Col. Palmira
Cuernavaca, Morelos 62490, México
{obedrn; maximo; gabriel; rodrigo; juliaarana}@cenidet.edu.mx

ABSTRACT - *The Mexican Sign Language (MSL) is the language used by the Deaf community in the urban regions of Mexico. The National Institute of Statistics and Geography (INEGI in Spanish) showed in the results of the National poll of Income and Household Expenditure 2012 that 6.6% of the population of this country has a disability to achieve at least one of the activities such as walking, seeing, hearing, speaking or communicate, learn, and be able to make personal and mental care. Also reports that 8.6% of the national population presents disability to speak and 16.5% to hear* [1]. *This paper aims to show the use of Leap Motion Controller (LMC) to identify the elements of the Mexican Sign Language, as well as finding an opportunity area to help people who have this disability, and can communicate with people who do not suffer it; and learn the MSL.*

Keywords – *HCI, Mexican Sign Language, Leap Motion Controller, Deafness.*

1 Introduction

Hearing impairment is the restriction on the perception of sound, people who leads with this impairment from this disability have to use different forms of communication to relate with others. *INEGI* (in spanish, *Instituto Nacional de Estadística y Geografía*) in the study of Persons with disabilities in Mexico, "A vision to 2010", reports that for every 100 people with disabilities, 12 of them have difficulty hearing. This same study reports that the causes of hearing impairment are 13.4% in births, 25% through illness, 9% by an accident, 44.5% due to advanced age and 6.5% corresponds to some other cause [2]. In Mexico the natural language of people with this condition is known as the Mexican Sign Language [3].

The General Law for the Inclusion of Persons with Disabilities (Current text published in the Official Journal of the Federation on May 30, 2011) says: *"The language of a deaf community, which consists of a series of gestural signs articulated with the hands and accompanied by facial expressions, deliberate look and body movement, endowed with linguistic function is part of the linguistic heritage of the community and the grammar and vocabulary is so rich and complex as any oral language"* [4].

1.1 Mexican Sign Language - MSL

The Mexican Sign Language or MSL is the natural language of the Deaf community. Usually these languages have emerged between the deaf communities and are part of their culture and a reflection of his worldview; Also this language is in a constant production process, as happens with any other natural language [5].

The Mexican Sign Language (MSL) contains special rules, for example, point to a person is not considered as disrespectful or impolite.

Similar, if a person wants to be an interpreter of the MSL must wear colors that contrast with his skin, avoid wearing rings with movements, necklaces, long earrings, bracelets and scarves, should not be used painted nails and avoid chewing gum during interpretation, because sometimes the mouth movements correspond to words that are being made with the signs.In the case of men, if they wear a tie, it is recommended to use vest as it is can interfere with hand movements [6].

The Mexican Sign Language can be represented in two ways: *dactylology* and *ideograms*. The *dactylology* is the representation of the spelling of the spoken language and is represented by the alphabet, each word of the alphabet can be represented by making a hand sign. While the *ideogram* way is the representation of a word with one or more signs. [6].

2 Related works

During the investigation we found some related works, the following being the most representative:

2.1 Design and implementation of a translator hands sign language to a language text system using artificial vision in a controlled environment [7]

This system interprets the Ecuadorian signs language alphabet made with hands and then converts into text and voice; also, has a coach that shows how to do the signs for the user without hearing disabilities, so the user can communicate with other people that have this disability, and vice versa. It was developed in different stages, to name a few, the acquisition stage, digital image processing, Labview Vision Asistant, etc.

The system was developed in a controlled environment, it use a commercial computer camera with USB peripheral input, a fluorescent bulb for lighting and black colored fomix, this because the color black does not generate much shine when is illuminated with focus.

They performed 6 samples per letter because there is a small difference between the two hands. With the help of and Vision Assistant and the classification methods: nearest neighbor, nearest neighbor and minimum distance, they were generated 9 databases with 24 letters of the alphabet having a 82.15% success rate in tests.

2.2 Image recognition of Mexican Sign Language. [8]

The system developed in this work can recognize 25 words of the Mexican Sign Language alphabet using the Kinect device. The system has two main modules which are: learning and recognition. These modules are supported by three processes: standardization, strengthening and forgetfulness, which recognize the signs by using patterns that are stored in evolutionary matrices.

The recognition module starts when the Kinect takes capture of the image of the performed sign and this is compared to those found in the database, while the learning module appears when it detects a new pattern, ie there is at least 90% similarity between the image stored in the database and taken by Kinect.

The process of strengthening gathers information patterns, which have a value equal or above the threshold. During the process of forgetting eliminate pattern areas with few occurrences and and they are insignificant. The end result was the recognition of 25 letters of the MSL alphabet with a similarity percentage of 90% and above.

2.3 Transforming Indian Sign Language into text using Leap Motion [9]

The system implements algorithms such as *Dynamic Time Warping* (DTW), *Intelligence Sense* (IS), using Leap Motion Controller device converts the signs of Indian language text in an appropriate Signs.

The sign recognized by a viewer and a optimal match between two time series is calculated from capture of the text and the DTW algorithm. In these time, the data are deformed into nonlinearly form, causing similar region alineation thereby obtaining a minimum distance between them, adding them to a knowledge base that contain the metric calculation of each signal.

The Leap Motion Controller assigns a unique ID when it detects a hand, finger or tool. The ID remains the same, as long as that entity remains visible within the field of view of the device. If tracking is lost and recovered, the Leap Motion can assign a new ID, just as the system discards an inappropriate signal that does not match the knowledge base.

2.4 Arabic Sign Language recognition using the Leap Motion Controller. [10]

This paper proposes an approach to the recognition of sign language Arabic, it was developed with the Java programming language in conjunction with the NetBeans IDE using the device Leap Motion Controller (LMC) for detection of the hands and fingers; thus the LMC will provide data and information of the movements.

In the acquisition of data, the system includes a pre-processing state, a state of extraction and a classification state. To develop the system were required to implement classifiers such as: Multiplayer Perceptron Neural Networks (MLP) and Nave Bayes Classifier (NBC).

They were taken 10 samples of each letter and each sample has 10 data frames, which implies a total of 100 samples per letter; taking into account the 28 letters of alphabet system would 2800 data tables. All this information was collected and imported into MATLAB for analysis and processing. The results obtained in this study were: With 98.3% of the NBC classifier and 99.1% of MLP classifier.

2.5 Towards the development of a mexican speech-to-sign-language translator for the deaf community [11]

This Paper present an application in which the development of a mexican speech-to-sign-language translator can assist to normal people to interact with deaf people. The ASR (Mexican Automatic Speech Recognizer)

is the main module and likewise has the Text Interpreter and MSL (Mexican Sign Language) Database.

To have a good performance the ASR was necessary the use of a corpus Mexican Spanish Corpus DIMEx100. This corpus aims to make it possible the construction of acoustic models and pronunciation of dictionaries. With the tool TranscribeMex it is possible to obtain the definition of the phonemes Mexican Spanish language.

One requirement is that the samples must be labelled at the orthographic and phonetic levels to perform supervised training of the acoustic models of the ASR system. The Orthographic labelling was performed manually with the software Wavesurfer. The algorithm used was the HMM (Hidden Markov Models).

In the module of Text Interpreter and MSL Database; where the word is found, the interpreter proceeds to display the sequence of MSL movements associated to that word, otherwise, if the word is not found in the database, the word is "spelled" and described the dactylology way of MSL.

The vocabulary consists of 25 words, 23 letters of the alphabet, obtaining accuracy at 97.2% and a set of 400 words used in total.

3 Implementation of Leap Motion in identifying signs

3.1 Leap Motion Controller

The Leap Motion Controller (LMC) is a USB peripheral device that detects and reads movements within a 3-D interaction space to precisely translate and control software on a computing device [12]. As is illustrated in Figure 1, the controller consists of three Infrared Light emitters and two Infrared Light cameras [13].

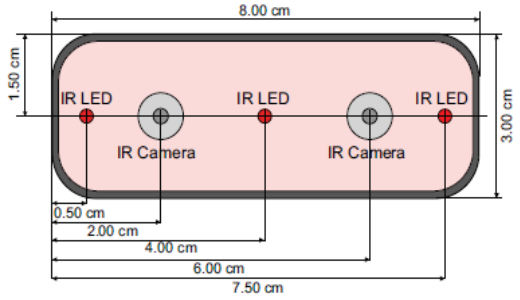

Figure 1 Schematic View of LMC [13]

The effective range of the Leap Motion Controller extends from approximately 25 to 600 millimeters above the device (1 inch to 2 feet). In Figure 2 the origin is centered at the top of the Leap Motion Controller.

The x- and z-axes lie in the horizontal plane, with the x-axis running parallel to the long edge of the device. The y-axis is vertical, with positive values increasing upwards while the z-axis has positive values increasing toward the user [12].

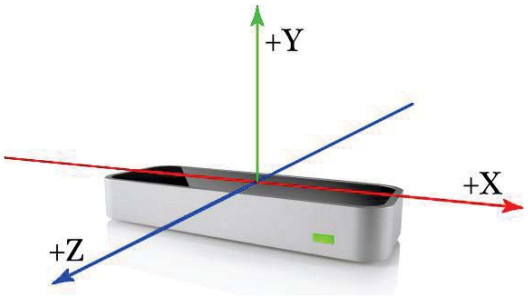

Figure 2 Coordinate system [12]

In the paper of Potter, Araullo & Carter (2013) The Leap Motion controller: A view on sign language they give an approach suitability of use of Leap Motion Controller for recognition of Australian sign language, showing its strengths and weaknesses of the mentioned device.

The strengths that stand out is the accuracy level with which the LMC account if you include the Leap Motion API. The LMC can consistently recognize individual digits in a hand, being able to identify, measure digit, address and fingertip location, likewise the LMC is also capable of tracking very small movements.

The weaknesses in the LMC are the precision and fidelity of detection when the hands do not have linear of sight with the controller. Another weakness mentioned is when the fingertips of one hand touching the fingertips of the other hand or when there is a close approximated between the fingertips, the LMC is unable to recognize the gesture and therefore cannot be displayed.

3.2 Identification of the Mexican Sign Language

The signs are made with hands, facial gestures and body movements.

The book *"Manos a Voz"* [6] which has a collection of 1,113 words divided into 15 topics: alphabet, food, animals, antonyms, house, calendar, colors, school, family, fruits and vegetables, numbers and related words, body parts, pronouns - adjectives - prepositions - articles, and other words. Some of the signs presented in the book *"Manos a voz*", will be used to perform the research of the recognition of the Mexican Sign Language using the Leap Motion Controller; only some signs of this book because of the limitations that the LMC has be recognized, as illustrated in Figure 3 the LMC only recognizes our hands and arm, before that limit the number of signs to be recognized is restricted.

Figure 3 Word blow in LSM *[6]*

Signs like the one illustrated in Figure 4 which is the word blow comes with a facial gesture; these signs are accompanied by facial gestures they will not be detected by the LMC.

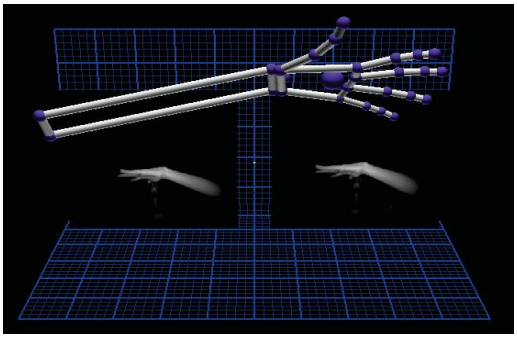

Figure 4 Display LMC.

4 Future work

Order to overcome the limitations that the Leap Motion Controller might implement algorithms for pattern recognition, to sign on which must unite hand or fingertips are recognized. Among the algorithms that could be used they are:

▪*Hidden Markov Model* – HMM: Composed of a finite set of states in which each of them is associated with a probability distribution. The major feature is its double stochastic process, hidden or not observable either observable [14].

▪*Support Vector Machine* – SVM: This is a supervised classification method aimed at determining the optimal boundary between two groups [15]. Applications that can be developed with the use of this algorithm are: image classification, character recognition, protein detection, pattern classification, identification of functions, etc. [16].

▪*Multilayer Perceptron* – MLP: This is a supervised neural network consists of several layers, usually they are three: the input layer, the hidden layer and output layer. The integration of several layers allows you to solve problems that are not linearly separable [17].

▪*Dynamic Time Warping* – DTW: Algorithm used to find the optimal alignment between two temporal sequences. This algorithm is used primarily in applications for speech recognition [18].

5 Conclusions

Based on the study of related research and study of Leap Motion Controller made by [19] we can conclude that it will be necessary to implement an algorithm of those mentioned before for the wide range of signs that contains the Mexican Sign Language, it can be recognized.

Likewise catalog signs which are candidates to be recognized and discard those that may not be recognized even with the support of an algorithm.

Furthermore, seek the support of a specialist in the area of sign language, to make the sign correctly and check if there is any sign that represents the same as those signs that have not been recognized.

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