

## "Trado" Electronic Device for Learning Sign Language in Real Time Through Voice Commands

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### Abstract

*The absence of tools for learning signed language in children with loss of listening ability is the main problem that currently exists when interacting with society. The purpose of this work is to provide an alternative for learning signed language in real time with people who have complete or partial hearing disabilities. Help was taken from the Google Assistant to receive the voice of the tutor, these commands are processed by the microcomputer to translate it into text and images that show "Sign Language" (SL), so that the student can understand the message that has been given to him. issued by your teacher. Through the experimental design, each of the phases belonging to the process that was carried out for the device was developed, with the use of parameters in the configuration of the main components, the limitations for the use of the device were established. This device includes an instant, simple and easy way to convert written text received by means of a scanner camera placed at the end of a finger, decipher, or interpret it and translate it into a binary system which is sent to the six active buttons that They form the representations of the Braille system.*

**Keywords:** Signed language, inclusion, feedback, hearing problems, special abilities.

### 1. INTRODUCTION

Students who are hard of hearing or hard of hearing have historically faced challenges in reading [1]. This phenomenon can be explained in part by the discrepancy between these students' language and reading systems; that is, the students' incomplete language system is not well adapted to the demands of the reading system [1].

In recent years, technology has been involved in disability, providing solutions to problems that exist in this area, but there are few devices or applications that help people with hearing disabilities to establish a regular conversation in a public or private establishment, this is because they do not have the ability to understand the reactions of the senders.

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The lack of knowledge of Ecuadorian sign language means that it is not possible to understand what a deaf person expresses, and vice versa. Taking into account the need for the auditory sense for the educational learning of people with this disability, tools are created that only help to a certain extent to understand the knowledge that is imparted by the teacher. The problem to be solved is the absence of tools that facilitate the learning of SL for students with hearing disabilities, at the time that there is teacher-student interaction, this device will help facilitate the student's understanding.

Therefore, it is proposed to implement an electronic device "Trado" that allows the learning of Sign Language in real time with people with hearing disabilities, through voice commands. Having to compare technologies that facilitate the design of the interface and communication with the components of the device, determine the parameters that allow the translation of voice commands into sign language and perform functional tests of the "Trado" device, for its subsequent implementation.

This research arises from the need to study the complications presented by students with hearing impairment, with the use of electronic components it is intended to make a device that facilitates the learning of sign language through voice commands and images that show the signs corresponding to the letters that will be shown on the screen.

The use of sign language in teaching deaf and hard of hearing children makes most of them academically more competitive than their hearing counterparts. [2]

Therefore, they could meet all academic standards in both teaching-learning aspects and assessment. [2]

The lack of tools to help people with hearing disabilities in the education sector generates a high degree of demotivation in them, reducing their desire to study. That is why an electronic device will be made controlled mainly by a microcomputer and a touch screen that allows interaction with the user.

## 2. MATERIALS AND METHODS

This research was carried out under a type of experimental research, given that, to begin with the development of this inquiry, first the analysis of the necessary information was carried out, compiled from articles, patents, books, theses and others, as a result of this analysis specific purposes were determined, the limitations and finally the demonstration of the results that were proposed to achieve.

In order to obtain a deep understanding of the criteria that motivated the development of this research, a small representative sample of the community in which this work is focused was taken, for the analysis of the data that were obtained through the tests of individual and collective functioning with each of the elements of the sample.

Under the deductive method, the research hypothesis was formulated, the study variables were identified, in order to reach logical conclusions based on the principles or bases that are the pillar of this development.

The social context in which this research work is focused is a society that suffers from tools that allow feedback with its tutor in charge of its daily teaching in basic education. Children with hearing impairments are the sample that will allow the study of the variables related to the main topic. To solve the problem for which this project arose, the research hypothesis is proposed, then it will be put into practice with the elements of the sample taken for this analysis, to verify it and verify that the solution to the problem on which this research is based has been met.

There are different devices or tools that have been developed for children with hearing impairments. But all of them only have the function of being usable for communication, without the focus of maintaining an interaction between both users, that is, the people

who do not have this disability and the person who does. As a result of this statement and the review of the state of the art, the following hypothesis arises: With the implementation of the electronic device "Trado", the learning of sign language is guaranteed, allowing teacher-student interaction in real time.

To carry out this phase of the proposed design, the following phases will be executed, which are shown in the following image (see Fig. 1).

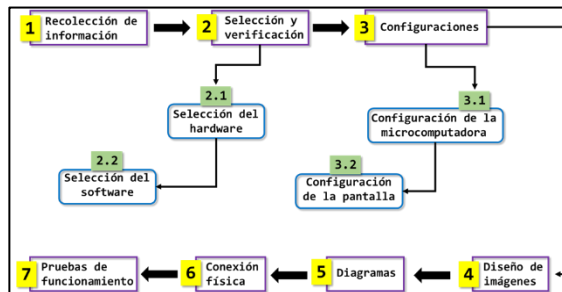


Fig. 1 Phases of research design.

The acquisition of the components generated a process of verification of the functionality to check their good condition with respect to their characteristics, so the technical characteristics of each component used were specified to justify the use of each component in the final product, as well as individual functional tests were carried out for each of the components. to avoid possible failures when they are already complemented to the final prototype.

Regarding the use of software, the Raspbian Operating System was used for the microcomputer, in the case of the screen there is the graphic programming language that already comes by default in this component, the Python programming language served for the modeling of the code that allows the translation of speech to images.

The sample that was considered for the research are the students of the Fe y Alegría Special Educational Unit of the city of Santo Domingo (UEEFA), considering as a sample study criterion students who are in the area of special abilities with hearing problems. Because there is a small number of students with this disability at the institution, only the 60 students enrolled in this area were taken.

### 3. RESULTS

#### 3.1 Component Selection

The 4.3-inch touch screen was chosen for its comfort, as it is designed for child interaction (similar to a tablet), the resolution and color quality of the image make it ideal for capturing children's attention. In addition to the audio and video functions, it also has an information storage facility.

The AC/DC power supply was chosen because in case of failure it is easier to replace, being an external element it does not consume much energy in relation to an internal battery, in addition to this it does not need to be recharged and its autonomy is limited to the time of use to which it remains connected to the outlet.

The features that motivated the choice of the Raspberry pi 3b+ are: its compatibility with most cards can be powered from an external source, it has ample memory for code storage, as well as its wireless connection function, among other functionalities that make this component stand out.

### 3.2 Image Design

For the design of the signs made in the "ibis Paint X" application, 3 layers of work were created in which the edges of the features of the hand were outlined, then a suitable shade that resembles the skin tone was sought, to color the inner part of the edges.

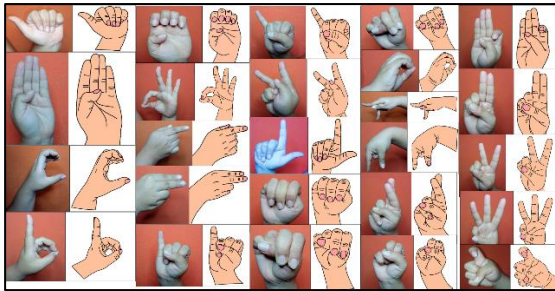


Fig. 2 Image design. Author

Source: <https://n9.cl/lenguadesenasecuadoriana>

To finish with this process, the file was saved as an image, it should be noted that all the signs were developed by the authors, to carry a single thread in terms of the design of the images on the screen of the device, below, the results of the process that was carried out in the design of images are shown (Go to link 1). [https://youtu.be/3Nk\\_dg1\\_zU](https://youtu.be/3Nk_dg1_zU)

### 3.3 Electronic diagram

Through the use of simulation software, the electronic diagram of the components compacted together was made, to go from a simulated prototype to the final product.

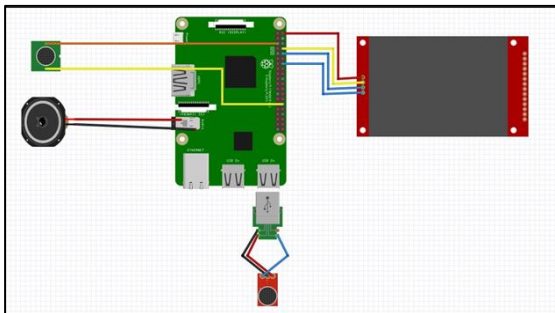


Fig. 3 Electronic diagram made in Fritzing.

### 3.4 Block Diagram

With the design of the block diagram, all the physical connections of the components are shown in the way in which they should be connected to each other, for their subsequent physical connection.

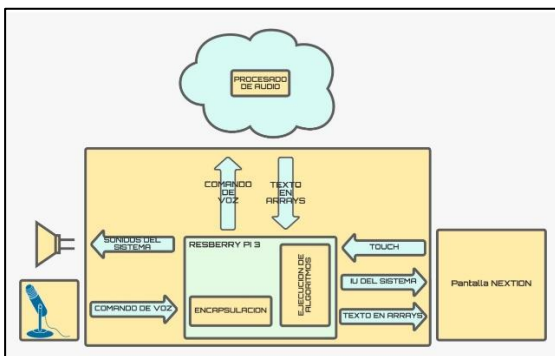


Fig. 4 Block diagram

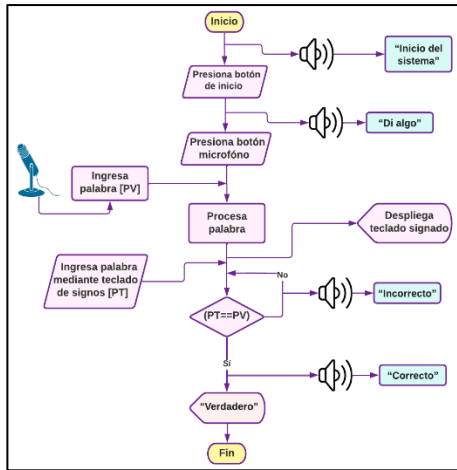


Fig. 5 Flowchart

### 3.5 Code Modeling

#### 3.5.1 Speech Recognition

It was imported from the Python-based library with the Google library, if the microphone is active, it receives the voice and prints the message "Say something" by console, this message is entered into the Google machine and saved in a variable. This is serialized and saved by console, if there is a mispronounced word or interference due to noise, this has an error control and if it does not understand it gives the message through the speakers "I did not understand".

#### 3.5.2 Audio playback

The "gtts" library changes the text from a string to audio, the word that is entered by sign keyboard is saved in a variable and converted to text, where the language in which the word that is selected on the sign keyboard will be translated from image to text is also specified. It is set as a condition, if there is data, the value it detects is printed. When you press a button on the screen, it sends serial data to the Raspberry, this component identifies what it receives to give another value as a response.



Fig. 6 Message translated into signed language.

#### 3.5.3 Sending data to the screen

Among them is the "struct" library which is used to structure a piece of data, it was used to establish the hexadecimal structure in a single package. By means of a function, the entire frame is located, it is here where the data is packaged for shipping.

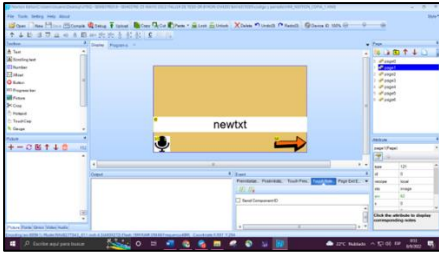


Fig. 7 Positioning of images on the screen.

In this function is the image and its coordinates, it must be recorded on the screen otherwise it could not be assigned the coordinates for its position in the interface. All pages must already be created on the screen so that they can be packaged and the corresponding data submitted.

### 3.5.4 Feedback

Pressing the play button begins the stage in which the entered word is compared with the word that was selected through the sign pad.

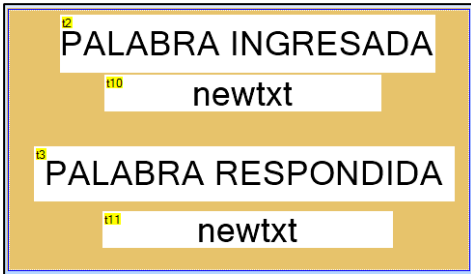


Fig. 8 Interface for comparing words.

By validating that the established condition is met, page 4 of the screen shows an image that shows that the student obtained a satisfactory result, while the tutor listens to him through the speakers, as shown below.



Fig. 9 "Congratulations" result of the comparison.

On the contrary, if the student does not select the word correctly, an inequality is detected between the word entered by the microphone and the one selected incorrectly and he goes to page 5 of the screen, where he shows an image so that the student visually understands that he has done it wrong and can try again. In the same way, the teacher will hear it through the speakers.



Fig. 10 "Congratulations" result of the comparison.

When pressing a key or image of a sign, a frame is sent to the Raspberry, that is to say that to form the word that is entered by the microphone, each image must be pressed, this indicates that each image selected on the board sends a frame, these are added as they are pressed. For each image, which represents a letter, a pattern was assigned.

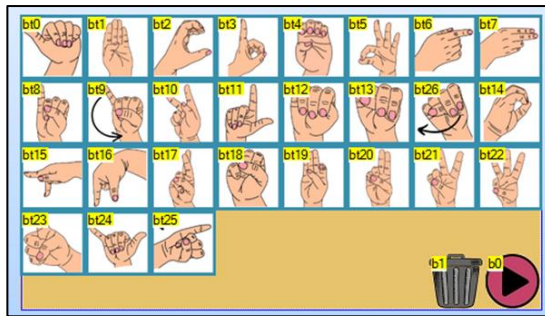


Fig. 11 Sign board design.

Each word that the tutor enters through the microphone must have a maximum of 8 characters due to the size of the screen and to have a better visualization of the images a number greater than 8 characters was not established, otherwise the images would be much smaller and not very visible to the user. You can enter words with accents, but the letter with an accent is not printed on the screen, as well as the words that have "ñ" on the screen, the device detects them, but converts them into "n" to print on the screen.

### 3.6 Network Configuration

In order for the device to work, it must have an internet connection, this is because the Google Voice Assistant was used. In the Windows CMD console, a ping was performed to see the local ip of the raspberry.

In the VNC Viewer software, the connection was established to remotely access the raspberry system, the ip of the raspberry was added, a name was also placed to identify the login in the remote connection.

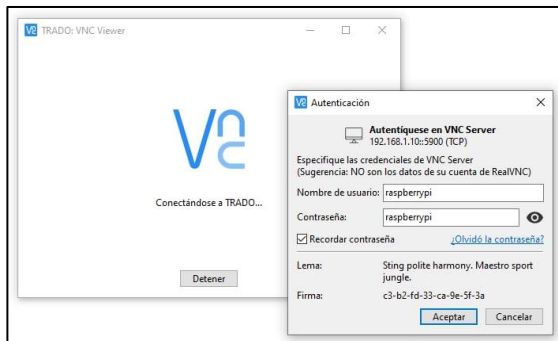


Fig. 12 Authentication.

Once the raspberry was accessed, the WIFI networks were added, so that the device automatically connects when it detects an available network.

The interface in which the student interacts with his teacher is shown, here he will select each sign that has been shown in the message that his teacher entered by voice commands.

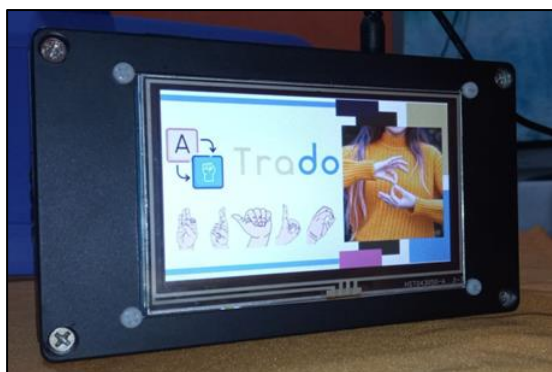


Fig. 13 System boot interface on the device.

To see how the device works, go to the following link: <https://youtu.be/qm1G8UpVssQ>

#### 4. DISCUSSION

The information collected in this research was carried out through an exhaustive search in different repositories with scientific articles related to the topic of this project.

In the study on glove-based sign language recognition using machine learning techniques conducted by the University of Michigan, the University of Michigan (FDA) has been working to create an intelligent system capable of recognizing numerical digits based on sign language based on sign language in order to mechanize the communication process between a deaf-mute person and others [11] [11]. With the movement of the hands, the translation of sign language into oral language is carried out [11]. The system sits inside a glove with flexible sensors on each finger for data collection [11].

On the other hand, in his research he explains what his real-time translator from written code to braille system consists of, which proposes a new way of interpreting and translating signed language, in real time, written data to a system of signals easy to recognize by touch thanks to a dot or braille translator cell located at the end of any finger of the glove. Depending on the need of the interpreter, they can be interchanged [12] [12].

This device comprises an instantaneous, simple and easy way to convert written text received by means of a scanner camera placed on the end of a finger, decipher or interpret it and translate it into a binary system which is sent to the six active buttons that form the representations of the Braille system [12].

#### 5. CONCLUSIONS

The use of a series of parameters and specifications in the configuration of the microcomputer, allowed the programming, the use of libraries, and conditions, to work in a unified way within the interaction with the device, right here the maximum number of letters of a word that is translated into sign language was established, prior to its use in the device.

Finally, after having carried out the above mentioned in this project, through the physical connections of the device, it was found that the electronic circuit was optimally compacted between the different components inside the polypropylene box, with a cool environment, this connection process results in the correct tests of operation of the device with the students.



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