Volume 12. No 2, May 2025
e-ISSN: 2527-9572 / ISSN: 2354-8924

Smart Assistant for Deaf and Mute Using Micro:bit

Intesar Abd Ul-Salam Asa'ad
Nineveh Education Directorate
University of Mosul, Nineveh Governorate,
Mosul, Iraq
entesaralasaad@gmail.com

Abstract - Deaf and mute people are an integral part of society. They have difficulty speaking or are unable to speak. Therefore, to overcome this difficulty, sign language emerged as a method of non-verbal communication commonly used by deaf and mute people. The problem that arises with sign language is that healthy people who do not suffer from hearing or speaking problems do not learn this language. This problem is dangerous because it creates a barrier between them. It is possible to solve this problem by taking advantage of modern technologies as they are more applicable and cheaper. In this research, the micro:bit was used as a means aimed at facilitating communication between deaf and mute people and other people through human-computer interaction. A program has been created that transforms what a mute wants into luminous expressive forms that can be easily understood by healthy people, such as his desire to eat or drink or any other needs. Another important point is to alert the deaf person to the presence of an external sound (car alarm, someone calling to the deaf person, etc.) by lighting up the micro:bit. The micro:bit is easy to use and low-cost. It was also improved by being developed into a watch worn by a disabled person. This device is expected to support deaf and mute people (especially children) in communicating effectively with others and regaining a sense of normalcy in their daily lives. This research idea was applied to a sample of ten deaf and mute children of different ages ranging from (2-10 years) after training them on how to use the program represented by the manual watch. It was noted that children under the age of six (4 children) benefited more than others, because children over 6 years old are able to express their needs and meet them compared to younger children.

Keywords: deaf and mute people, Sign language, Artificial intelligence, micro:bit.

I. INTRODUCTION

About 5% of people around the world have difficulty speaking or are unable to speak. Communicating with the hearing impaired is a major challenge in today's society. Sign language is an important means of communication between deaf and mute people and their communities. This language dates back to the seventeenth century, when it was known as the visual language[1].

There has been a rapid increase in the number of mute victims in recent years as a result of congenital malformations, accidents and mouth infections. Since these individuals cannot talk to normal people normally, they must rely on some form of visual communication. The micro:bit was used and programmed to help these people with special challenges achieve equality in society[2].

A number of computer scientists announced the emergence of artificial intelligence for the first time at the Dartmouth Conference in 1956 AD, and at that time the star of artificial intelligence shone in the technology space, heralding a promising future for the advancement of human civilization. Oxford also defines artificial intelligence as the theory and development of computer systems capable of performing tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages[3].

It can be said that artificial intelligence now exceeds many human capabilities due to the sheer volume of the number of diverse calculations that can be performed, and the complex decisions that can be made with incredible speed. Despite this, the basic definition of artificial intelligence is to achieve the goal of skillfully imitating human behavior. The use of artificial intelligence (AI) is increasing in various fields, and researchers are working to solve various problems by applying it using various technologies, including micro:bits. This research work also focuses on artificial intelligence and how it can be used to provide solutions for deaf and mute people[4].

The micro:bit device is known as a portable, programmable electronic board with a small area of 4*5 cm. It contains many electronic parts and sensors for motion, lighting, temperature, etc. In 2015, the British Broadcasting Corporation (BBC) contributed with many companies to the design of the micro:bit. Developing it for educational purposes and facilitating and developing programming skills for school students in particular. This contribution was part of the Make it Digital initiative, which aimed to eradicate computer literacy. The micro:bit is characterized by its small size, which is half the size of a credit card and contains an ARM Cortex-M processor, an accelerometer, a magnetometer, and a temperature

sensor. It is connected via Bluetooth or a USB port, and it also contains a screen consisting of 25 external lights[5]. Many projects can be applied through it, such as: designing games, robots, etc., as it is affordable, easy to use, fun and simple to program, as it can be programmed using building blocks by dragging and dropping and multiple programming languages such as: JavaScript and Python[6]. Figure 1 shows the front and back of the Micro:bit[7].

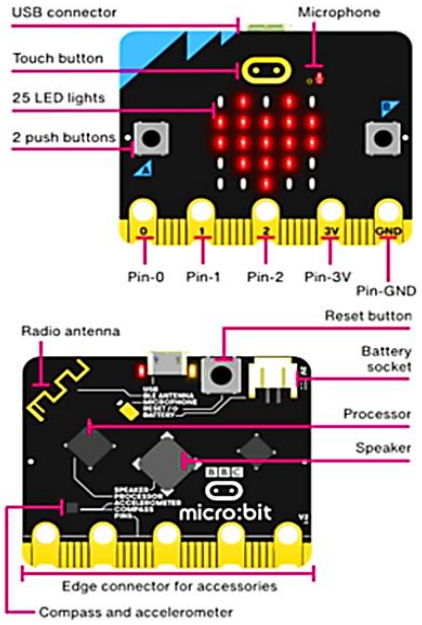

Figure 1: The Micro:bit

II. Method and Design

Research problem: One of the problems that deaf and mute people suffer from is their dependence on sign language to communicate with healthy people, who in turn may not understand this language because they do not need it, in addition to their failure to respond to any external sound as a result of losing their sense of hearing, which may expose them to difficult situations. Objective: This research aims to use artificial intelligence technologies such as micro:bit to help deaf and mute people communicate with healthy people, in addition to alerting them if there is an external sound that requires attention. Literature Reviews

1. Shubham K. Mishra et al. In 2019 they combined computer vision and machine learning with convolutional neural network in their research by creating a system that can recognize hand gestures without using sensors. Its aim is to facilitate communication between deaf and mute people and other people. The proposed system works to recognize words with alphabets, unlike other proposed systems that recognize alphabets only. The proposed system was tested on 10 test sets and worked with 86% accuracy[1].
2. In 2020, S.Kumuda and Preethi K Mane proposed a smart glove model to recognize sign language and convert it to the corresponding text. The proposed approach is based on detecting finger movements and hand gestures using a signal processing suite in LabVIEW software and a data acquisition device (NI USB 6008 DAQ card). The aim of this work is to provide a solution for trainers in deaf and mute schools to display letters with associated visual display with audio output, making learning highly interactive and encouraging[9].
3. In 2021, Dhaya Sindhu Battina and Lakshmisri S discussed the development of an artificial intelligence-based device that can help deaf people with disabilities understand and respond to body language. Some of its important components include Flex sensors, LCD module, Microcontroller, SD card memory, Hearing aids, etc. It works by reading body language and converting it into a sound that the user can hear on their hearing aids attached near the end of the hearing aid [10].
4. In 2021, Ahmad Muhammad Shukri and others designed a project based on micro:bit that aims to make life more comfortable and easier by automatically turning on electrical appliances such as lights and fans when someone arrives, and turning them off automatically when they leave. Using existing sensors in the micro:bit such as Passive Infrared (PIR) Sensor and Light Dependent (LDR) Sensor. The fan and lamp can also be controlled manually using a smartphone. By linking the smartphone and micro:bit via Bluetooth connection[11].
5. In 2022, Muhammad Imran Saleem and others demonstrated an automated system based on machine learning in their research, which provides an interface for communication between deaf and mute (DnM) and non-deaf and mute (NDnM). The system is an Appl through which hand gestures from people using DnM are converted into speech. NDnM people's speech is converted into text. The system was validated through a series of experiments, concluding that the system can correctly detect hand gestures, and the overall accuracy is often more than 90%[4].
6. In 2022, Aditi Naik and others published research on a smart glove for deaf and mute patients, which They enable them to easily communicate with others to express their feelings. The glove consists of a button on each finger bearing a specific message that can be pressed and displayed on the screen for the subject. These messages will be displayed via the application called “CONVOHAND” which is built on the well-known application MIT APP INVENTOR. This application is linked to the Arduino by a Bluetooth module[12].
7. In 2022, Md Abdullah Al Rakib and others presented research on the Dumb Communication Translator, which is a tool that translates hand movements into sensible speech. The main goal of

this research is to connect deaf and mute people to the real world through an advanced methodology. It is based on human-computer interaction, where the patient is connected to the outside world by translating his sign language into the traditional language. In this work, Arduino Uno, MP3 and amplifier were used. Some buttons were used to generate the audio signal at the output[2].

8. In 2023, Abdallah Abualkishik and others presented research on a proposed system for recognizing the gestures of deaf and mute people using the convolutional neural network (CNN) method. It aims to convert dynamic deaf signals from live video into text and speech using a raspberry pi device and a regular camera to detect and convert the deaf signal. The system can recognize 31 hand gestures, including the letters A to Z and the unique word (I love). The proposed system achieved an accuracy of up to 99.8% ([13].

III. Results and Discussion

To evaluate the performance of the proposed project and ensure its success, a personal criterion based on human perception is used by asking a sample of people who suffer from hearing and speech problems to use this device after training them on it to know the extent of their response to it and thus achieve the desired benefit from it through Communicate effectively with healthy people.

Proposed project:

In this research, the micro:bit was used as a means aimed at facilitating communication between deaf and mute people and other people through interaction between humans and micro:bits. A program has been created that transforms what a mute wants into luminous expressive forms that can be easily understood by healthy people, such as his desire to eat or drink or any other needs. Another important point is to alert the deaf person to the presence of an external sound (car alarm, someone calling to the mute person, etc.) by lighting up the micro:bit. The device is easy to use and low cost and can be improved by developing it into a wristwatch for a disabled person to wear. This device is expected to support deaf and mute people (especially children) in communicating effectively with others and regaining a sense of normalcy in their daily lives.

The proposed project work system can be divided into two parts:

First: The signals issued: These cases represent the patient's desire to express his need, represented in the form of a light signal issued by the micro:bit, which are:

1. Desire to eat: Instead of using sign language to express the mute's needs, the mute person uses the microbet and its buttons. When the mute feels hungry and wants to eat, he presses the A button to the left of the micro:bit. Then the screen will light up with a bowl-like sign. When a healthy person sees this sign, he will know that the mute needs to eat. Figure 2 shows this. - A light signal from the microbe indicates the patient's desire to eat.

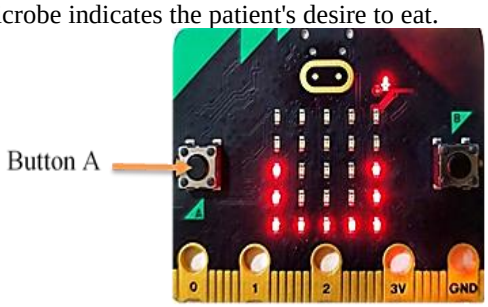

Figure 2. The light signal indicating hunger

2. The need to drink water: When a mute person feels thirsty, once he presses the B button located to the right of the micro:bit, the screen of this unit will light up with a light signal that resembles a cup of water. A healthy person trained to understand these signals knows that the mute person is thirsty and wants to drink water. Figure 3 shows the micro:bit optical signal for this case.

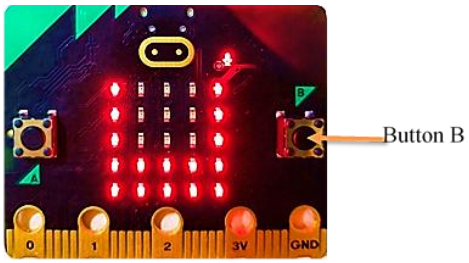

Figure 3. The light signal indicating thirst

3. Other needs: The micro:bit contains a touchable button that a mute person can use to express his desire for other needs, such as his feeling of fear of a certain thing or his desire to go to the bathroom...etc. When you touch this button, the micro:bit will emit a sound similar to the sound of an alarm clock that a healthy person trained to understand these signals hears. Figure 4 shows the state of the micro:bit when it emits a specific sound when the sound button is touched. We notice that the light signals on the micro:bit screen go out and a new signal that looks like a small microphone appears next to the touch button.

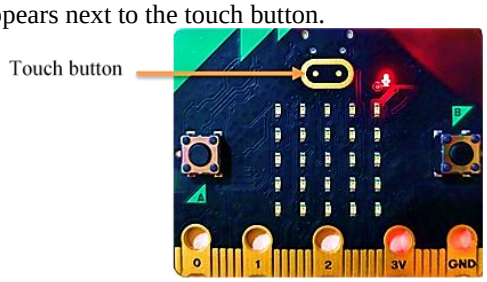

Figure 4. The light signal indicating other needs

Second: Received signals: The micro:bit contains many sensors that can sense external conditions such as temperature, lighting, sound, etc., at certain degrees specific to each sensor. An external sound sensor

(Microphone) was used that detects the presence of external sound with a range of (0-250 Decibel dB). The threshold limit for the sound sensor was determined by setting the pitch of this sensor to 177 dB. That is, if the external sound is greater than the threshold limit (177 dB), the micro:bit screen will light up. The heart shape was chosen as a light signal that appears and disappears successively with a time interval. Quite simply, the goal of this movement is to attract the attention of the deaf child who cannot hear external sounds in the presence of something surrounding him may be the sound of a car alarm near him, or the sound of someone calling him, or other sounds. a child who has been trained to understand this signal will pay attention and respond to the external event. Figure 5.

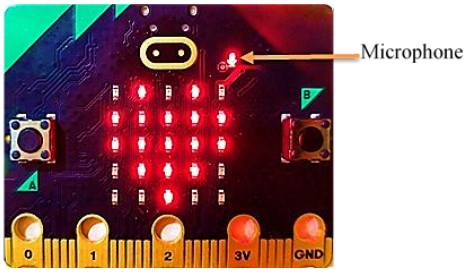

Figure 5 . The light signal indicating the presence of a high-intensity external sound

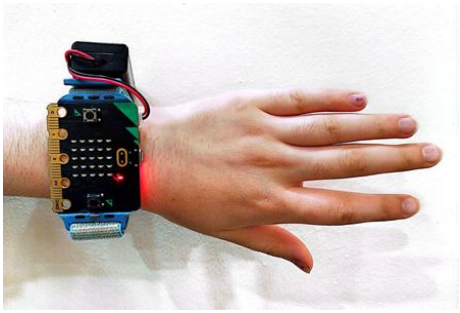

Figure (6) shows the final image of the smart assistant for the deaf and mute in the form of a wristwatch.

Pros and cons of the proposed project:

The idea of the project is useful for the deaf and mute, and even for autistic and disabled patients who suffer from difficulty in speech and even movement. However, it is necessary to mention the pros and cons of the proposed project.

Positives:

a. The proposed watch is characterized by its cheap price, which does not exceed $50.
b. Small size and ease of use.
c. The micro:bit screen that lights up in response to a specific event makes the user enjoy using it, especially children.
d. It is characterized by ease of programming, which allows it to be easily modified according to the user's need.

Negatives:

a. The sound produced by the microbet is not strong enough for a distant person to hear it, as its range reaches 3 or 4 meters.
b. The battery is somewhat large compared to the size of the watch, and this may hinder ease of use.

This research idea was applied to a sample of ten deaf and mute children of different ages ranging from (2-10 years) after training them on how to use the program represented by the manual watch. It was noted that children under the age of six (4 in number) benefited more than others, because children over 6 are able to express their needs and meet them compared to younger children. The research results can be summarized in the following points:

1. The children expressed their joy with this piece due to its ease of use and its screen lighting in different ways according to the user's desire.
2. When someone raised his voice somewhat, the deaf and dumb children did not hear him, and this is normal. But they all responded effectively and had different reactions as a result of the illumination of the micro:bit screen (shown in Figure 5) which according to training alerted them to the presence of the sound of a person or a car alarm, which was often behind them and they would not be able to see it. This was the first goal on which the idea of the proposed project was based.
3. It was noted that children under the age of six respond more than others, because children over the age of 6 are able to express their needs and meet them compared to younger children.
4. It should be noted that this programmed micro:bit piece can be used by the elderly as well for patients who suffer from difficulty in movement, by placing the piece close to the patient's finger, as soon as the patient touches the touch button (as shown in Figure 4), the device emits a sound that the person accompanying the patient hears so that he can carry out his duty towards the patient.

Comparison of results between literature reviews and the proposed project:

Table 1. literature reviews and the proposed project

	year	**the description**	**Hardware**	**Cost**
My project	2024	manual watch	Micro:bit	**Cheaper**
Others	2020, 2022	smart glove	Arduino Uno	**More expensive**

IV. Conclusion

Deaf and mute people are an integral part of society. The main goal of the idea of this research is to treat the condition of hearing loss in deaf people, which may expose them to many problems, especially children under the age of ten, and to exploit the power

of other senses in these people, such as the sense of sight, through the use of modern technologies such as micro:bit because of its Effects that may particularly attract children, such as lighting up the micro:bit screen in a way that quickly attracts the child and alerts him that something is happening. The micro:bit contains a sound sensor (microphone) that can be programmed to treat some important situations that a deaf person may be exposed to, such as being called by a specific person in a somewhat loud voice, or it may be the loud sound of a car alarm in public or recreational places, etc. Therefore, we exploited the micro:bit's sound sensor and programmed it. After experimenting several times, the threshold limit was adopted at (177 dB). When a slightly loud external sound is heard (higher than 177 dB), the micro:bit screen lights up with an image of a human heart in an oscillating manner to attract the attention of the child, who is being trained to understand this signal and alert him to the possibility of a car nearby to avoid being run over...etc. This was the primary goal of the research, and the microbit was programmed to benefit more in helping people with hearing and speech impairment by making the child press its buttons when it needed to eat, drink fluids, or anything last. This research idea was applied to a sample of ten deaf and mute children of different ages ranging from (2-10 years) after training them on how to use the program represented by the manual watch. It was noted that children under the age of six (4 children) benefited more than others, because children over 6 years old are able to express their needs and meet them compared to younger children. It should be noted that this programmed micro:bit piece can be used by the elderly as well for patients who suffer from difficulty in movement, by placing the piece close to the patient's finger, as soon as the patient touches the touch button, the device emits a sound that the person accompanying the patient hears so that he can carry out his duty towards the patient.

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