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Wearable Device for Sign Language and Speech Translation, Compatible with Android Operating System, Created Specifically for Special Education Institutions in the Philippines

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ABSTRACT
With the goal of helping students who are both deaf and hard of hearing communicate, the Sign Language and Speech Translation System using Smartphone with Android Application (SignSpeak) employing a Wearable Device was created. This was done to address the shortage of Hawaii-based instructors with expertise in Special Education (SPED). Once the wearable gadget (glove) is paired via Bluetooth with a smartphone running the appropriate software, the wearer's sign language gestures will be translated into spoken language for the hearing-impaired learner. Speech from a SPED instructor or other able-bodied people will also be transcribed and shown on the mobile device. This method was piloted and surveyed among HI and non-impaired students and staff at a public SPED school in the Philippines. The obtained findings demonstrated the accuracy and reliability of the translation system for various sign language gestures and talks. This would be a cutting-edge means of communication for the deaf and hard of hearing.

Keywords: Android Application, Sign Language Translation, Wearable Device

INTRODUCTION
People who are speech and hearing impaired (HI) often rely on sign language as their primary means of communicating with the able-bodied. To communicate with HI persons, non-impaired individuals need first get familiar with the various sign language movements used in the process. Given the huge variety of conceivable forms that a human hand is capable of making, our grasp of the complexities of these shapes is just the beginning. Besides the 26 hand forms used to represent the letters of the alphabet in written form, there are only a small number of hand shapes used in sign language. Moreover, American Sign Language (ASL) is a full, intricate language that uses signals generated by moving the hands in addition to facial emotions and body postures. Those living in North America and Asia who have HI both utilise it as a means of communication [1]. Smartphones running Android OS are widely used as transmitters and receivers in the 21st century.

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signals from a microcontroller unit-based system or device, especially a wearable device, via Bluetooth connectivity and the Android OS's API (Application Program Interface) to carry out various operations and generate output data in accordance with the application or given instructions uploaded on an MCU. There is a constant evolution of wearable technologies or gadgets with numerous sensors that determine various characteristics of the users' health status [2] and other applications that benefit persons in their day-to-day lives.

The varied resistance levels of the resistive carbon components used to make the flex sensors on each finger of a glove (wearable device) allow for a wide variety of input data combinations to be generated. The flex sensor's changeable printed resistor construction allows it to have a small footprint on a thin, flexible substrate. As the substrate is bent, the sensor's output resistance increases or decreases depending on the bend radius [3]. Utilizing a wearable device and an Android application, it is possible to translate sign language motions into audio talks by using the resistance values provided by flex sensors as the foundation for aural feedback.

The approach has the potential to assist public and private SPED schools in the Philippines, which are struggling owing to a shortage of SPED instructors trained to work with students who have hearing or speech impairments. Developers of Android apps and wearable gadgets might potentially utilise the findings of this research to fine-tune the parameters of a communication support system they're building, such as sensor values for discriminating between different types of gestures and audible voice input data. Technology advancements in the field of communication support are one viable option for enabling those who are hard of hearing or have trouble expressing themselves verbally to communicate with others on an equal footing.

Conceptual Model

Sign language movements and audible talks are used as input data during the system's operation, which is then processed by the translation algorithms conducted by the Android app. The created wearable gadget (glove) allowed the HI user to transform their sign language movements into auditory speech. The last step was displaying the translated speech and sign language motions on the smartphone of HI users.

Problem Statement

The goal of this research was to create a wearable, two-way communication device for children with speech and hearing impairments that would be both practical and easy to use. This was done to address the shortage of SPED educators with expertise in working with students who have aural impairments. The following questions were targeted for resolution by this research project:

For example: "How accurate is the established system in translating the various American Sign Language gestures?"

Second, how accurate is the technology in converting ASL hand motions into spoken English?

When compared to conventional sign language gesture communication, how much more reliable is the new system?

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Defined Areas of Responsibility and Their Boundaries

The created system primarily served to convert sign language movements into audible speeches and convert audible speeches into readable texts utilising a wearable device linked through an Android software placed on a smartphone. The app's database, powered by SQLite, allowed users to save, retrieve, search, and remove sign language movements reported by hearing-impaired students, special education instructors, and researchers.

The system included an Android app, a stretchy, custom-made glove equipped with sensors and resistors, a dedicated switch, and a Bluetooth Module that could be wirelessly associated with a smartphone. The MCU coordinated all of the system's components, including hardware and software. To provide for the increased need for inputs from the flex sensors, we used a Multiplexer Breakout - 8 Channel (74HC4051). These sensors will provide values that may be interpreted as a sign language gesture. The Android app on the user's phone was used to provide aural feedback.

The Android app may also be used to record and play back the person's voice who is speaking to the student who has hearing loss. The app's listening mode feature also transcribed the normal student's or SPED teacher's audible remarks into text for the speech and hearing-impaired student to read and comprehend. The app's listening mode may be toggled on and off, recording the user's voice so that it can be translated into text and shown on the user's smartphone.

Disturbances to the Bluetooth signal or the power supply are two examples of the kinds of disruptions that should be taken into account while drawing boundaries. The gadget was thin and flexible enough for the visually impaired learner to wear. An independent power supply and a Light Emitting Diode (LED) serve as status indicators.

hooking up a smartphone. As long as the translated text is correct, there was no restriction on the display size. The translated texts may be viewed on your smartphone in three different display sizes thanks to this app. Accurate translation of sign language gestures will take time and rely on the strength of the Bluetooth signal, while the accuracy of translation of audible speech will need a sufficient volume and an Internet connection (through mobile data or Wi-Fi). In order to work, the system was designed just for Android smartphones.

The method allowed for two nearby people to communicate with each other in a two-way fashion using American English. Both instructors and children with special needs might benefit from using the method in the classroom. Others in the HI community who are fluent in American Sign Language gestures may also benefit from this research. An alternative setting for this might be a meeting at home with the parents or guardians of HI students. Changes to this research will determine the specifics of future iterations of the app and wearable gadget.

LITERATURE REVIEW

Android is a mobile phone operating system that provides a robust software ecosystem for the development of a wide range of apps for different forms of communication [4],[5]. But the rapid development of mobile technology in recent years and its role in improving technology and

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providing people with access to a simple platform that meets all their fundamental requirements in [6]. There are three broad categories into which mobile applications that utilise a database, in particular SQLite, may be sorted; this is especially helpful when developing apps for wearable devices since it specifies the interface via which the software is displayed to the user [7],[8].

The primary components of this investigation were sensor technologies and microcontrollers, and the produced system generated voice and text as its output data. This was the secondary method of contact for the user, while the smartphone's Bluetooth connection and an Android software acted as the link between the raw sensors and the HI users [9]. During the process of developing this study, the researchers noticed a lack of prior work in the area of constructing helpful devices for people with disabilities using wearable technology. Furthermore, no regional studies have evaluated the precision and consistency of communication support for people with speech and hearing impairments [10]. Specifically for the fields of Special Education and assistive technologies, this study's integration of cutting-edge smartphone technology and wearable technology may bring a productive approach to the transformation of communicative signals across forms of technology.

METHODOLOGY

How to Do the Research

Our study was conducted using a descriptive approach, which aimed to provide a detailed account of the state of affairs so that it would serve as a basis for future improvement. The created system's accuracy and dependability, among other variables, were quantified via the application of quantitative research [11].

Model for System Development

The system and its accompanying interactive process were developed using a prototyping model as part of the systems development life cycle's analysis phase. The system's output phase was also directly implemented to solicit user input from the research community.

The Study's Sample

Because the main data came from 15 HI pupils, 15 non-impaired (regular) students, and 3 SPED instructors at Bian Elementary School (BES), a stratified sampling technique was employed to select the samples.

Elementary school kids of all abilities may enrol in BES, one of the public schools in Bian, Laguna City. Students at this institution were affected by a wide variety of disabilities, from ADHD and HI to Down syndrome and a speech impediment (DS).

Techniques of Data Collection

In order to assess the precision and dependability of the implemented system, researchers used closed-ended questionnaires based on a 5-point Likert scale and tested the system itself. Inquiries for verification and permission to the DepEd Division of Bian City Schools and the school's principal. The statistical procedures, including weighted mean, percentage, and t-test, used to verify the aforementioned instruments were performed by a research coordinator and statisticians.

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System testing and separate assessment were also performed to evaluate and validate its accuracy and reliability rates, in addition to direct observation of communication between HI kids, non-impaired students, and their instructors. The data obtained were crucial in fixing the performance issues that had been bothering the team and ultimately improved the system's efficiency and quality.

The system flow kicks off when the user activates the glove's sensors and the glove automatically establishes a Bluetooth connection with adjacent smartphones. By continually measuring the voltage across the flex sensors and MEMS (microelectromechanical system) accelerometer and gyro sensor, the MCU linked to the sensors gathers data, which is then sent over Bluetooth from the wearable device to the attached Android smartphone. The data is received from the wearable device, decoded by the app, and then used to search a database for recorded motions that match the data. When the app detects a gesture, it looks up the gesture by name and feeds that information into the Gesture-to-Speech engine if it exists. The app will notify the user through push when a gesture is not detected so that they may give it a name and add it to the database. However, activating the Android app's Text-to-Speech mode activates the Speech-to-Text module. When you hit "Start Recording," the system begins actively searching for voice data to add to a buffer. If the user taps the Stop Recording button, the Android app will send the audio to a Text-to-Speech engine and then show the results on the screen.

System Circuit Design

An expert American Sign Language interpreter checked each gesture translation to ensure it was accurate and reliable. The same number of tests (10 total) were run to assess the system's ability to translate between American Sign Language gestures and spoken language. An evaluation's reliability depends on how well it consistently and reliably measures the target variables. One definition of accuracy is the degree to which a measured value agrees with a reference value.

CONCLUSION

Without equal resistance and rotation value equivalent readings for each gesture, which send and save by the flex and gyro and accelerometer sensors to the microcontroller unit and Android application database, the developed system can accurately and reliably translate newly stored sign language gestures of any complexity. The accuracy of the system relied on the volume and clarity of the pronouncement of the speeches to be translated. A speech recording has to have a tone level between 40 and 60 dB, which is the usual range for a human voice, in order to be translated into text. Since there were always impediments to communication between HI and non-impaired individuals owing to the latter's unfamiliarity with ASL and other variants of sign language, the established approach was a substantial improvement over the former.

To further increase the system's dependability while dealing with a broad variety of input gestures, it may be useful to include a more robust and predictable method of gesture detection based on available sensor data. Improve the accuracy of the system's translation of sign language gestures and audible utterances by adding support for more sign language variants and localizations, as well as other spoken languages for the audible voice to readable text module. In order to improve and expand the capabilities of the current system, SPED schools in the Philippines are collecting data from other countries to create a centralised database of commonly used ASL gestures.

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