CHAPTER 37
Sign Language into Text and Speech Translation in Real Time

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ABSTRACT

This project aims to develop a sign language translation system using an Arduino microcontroller, LCD display, two flex sensors, a speaker, and a power supply. The system will be designed to translate hand gestures made in sign language into text and speech in real-time. The project will utilize two flex sensors to detect the hand gestures made by the user. These sensors will be attached to a glove worn by the user. The flex sensors will measure the bending of the fingers and transmit this data to the Arduino microcontroller. The microcontroller will then process this data and interpret the gestures made by the user. The interpreted gestures will be displayed on an LCD screen, and the system will also produce speech output using a speaker. The system will be powered using a power supply. The proposed system will be particularly useful for individuals who are deaf or hard of hearing and rely on sign language to communicate. The system will enable them to communicate more easily with individuals who do not understand sign language, allowing for greater inclusion and accessibility. The project will involve designing and building the hardware components, programming the microcontroller, and testing the system's functionality. Overall, this project will contribute to the development of assistive technologies that can enhance communication and promote accessibility for individuals with disabilities.

Keywords: *sign language translation , sign language to communicate, assistive technologies etc*

INTRODUCTION

Sign language is a primary mode of communication for individuals with hearing impairments, and bridging the communication gap between deaf and hearing individuals is crucial for fostering inclusivity and accessibility. The Glove, equipped with advanced sensors and technology, enables the translation of sign language gestures into written text and spoken words, facilitating effective communication between deaf and hearing individuals. This project aims to harness the power of artificial intelligence and machine learning techniques to accurately recognize and interpret sign language gestures, providing real-time

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translation and improving accessibility for the deaf community. Through this report, we will delve into the project's objectives, methodology, challenges, and potential applications, highlighting the significance of sign language translation systems in promoting inclusive communication and equal opportunities for individuals with hearing impairments.

Sign language is a visual language used by individuals who are deaf or hard of hearing to communicate with others. It is a rich and complex language that employs hand gestures, facial expressions, and body language to convey meaning. However, communication barriers still exist between sign language users and those who do not understand sign language. To address this issue, this project proposes the development of a sign language translation system using an Arduino microcontroller, LCD display, two flex sensors, a speaker, and a power supply. The system will enable real-time translation of sign language gestures into text and speech output, providing greater accessibility and inclusivity for individuals with disabilities. The system will use two flex sensors attached to a glove worn by the user to detect hand gestures. The microcontroller will process this data and interpret the gestures made by the user, displaying the results on an LCD screen and producing speech output using a speaker. The system's hardware components will be designed and built, and the microcontroller will be programmed to enable real-time translation. This project aims to contribute to the development of assistive technologies that can enhance communication and promote accessibility for individuals with disabilities. The proposed sign language translation system has the potential to improve the lives of many individuals who rely on sign language to communicate with others.

Fig 1 Hand signs.

In recent years, there has been a growing recognition of the importance of inclusivity and accessibility for individuals with hearing impairments. One significant aspect of this effort is facilitating effective communication between individuals who use sign language and those who rely on spoken or written language. Sign language, being a visual-gestural system, presents unique challenges for translation into text and speech. However, advancements in technology have opened up exciting possibilities for bridging this communication gap.

The aim of this project is to develop a sign language translation system using the "glove" approach. This system will enable real-time conversion of sign language gestures into understandable text and synthesized speech. The glove technology offers a promising solution by capturing and interpreting the intricate hand movements and gestures involved in sign language.

By creating an accurate and efficient translation system, we can significantly enhance the accessibility of sign language users to various domains, including education, healthcare, employment, and social interactions. This project seeks to empower individuals with hearing impairments, enabling them to engage more seamlessly with the hearing community and fostering a sense of inclusion and equality.

This report outlines the methodology, challenges, and anticipated outcomes of developing a sign language into text and speech translation system using the glove technology. We will delve into the technical aspects of the glove technology, its implementation in capturing sign language gestures, and the algorithms and models used for accurate translation. Additionally, we will discuss potential applications, user interface considerations, and future directions for expanding the capabilities of this system.

The successful implementation of this project holds the potential to revolutionize the way sign language users interact with the world around them. By providing an effective and efficient means of translation, we can empower individuals with hearing impairments to fully participate in society, breaking down communication barriers and fostering a more inclusive and accessible environment.

Through this report, we aim to shed light on the significance of sign language translation systems, highlight the merits of using glove technology, and provide insights into the development process. It is our hope that this work will contribute to the advancement of assistive technologies and ultimately improve the quality of life for individuals with hearing impairments.

EVOLUTION OF SIGN LANGUAGE

Sign language has evolved and developed over time, just like spoken languages. Here is an overview of the evolution of sign language:

1. Historical Origins: The use of sign language to communicate predates recorded history. Deaf communities throughout the world have independently developed sign languages within their cultural contexts. Some historical evidence suggests that early forms of sign language were used in ancient civilizations such as ancient Greece, Rome, and China.

2. Early Education and Formalization: The establishment of formal education for deaf individuals in the 18th and 19th centuries played a significant role in the evolution of sign languages. Educators, such as Charles-Michel de l'Épée and Thomas Hopkins Gallaudet, developed methods to teach sign language to deaf students, leading to the formalization and standardization of sign languages.

3. Regional Variation: Sign languages have regional variations and dialects, similar to spoken languages. These variations arise due to factors such as geographic isolation, cultural influences, and the formation of deaf communities. For example, American Sign Language (ASL) in North America, British

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Sign Language (BSL) in the United Kingdom, and Auslan in Australia all have distinct features and vocabulary.

4. Influence of Spoken Languages: Sign languages have been influenced by the surrounding spoken languages in their respective regions. This influence can be observed in the incorporation of grammatical structures, idiomatic expressions, and borrowed vocabulary. However, sign languages are not mere translations of spoken languages but have their own linguistic systems with unique grammar and syntax.

5. Research and Linguistic Studies: The recognition of sign languages as fully- fledged languages and the subsequent linguistic studies have contributed to a deeper understanding of their structure and evolution. Linguists have explored the phonology, morphology, syntax, and semantics of sign languages, further establishing them as natural languages.

6. Technology and Innovation: Advances in technology have had a significant impact on sign language. Video recording and distribution have made it easier to document and analyze sign languages, facilitating linguistic research. Furthermore, technological developments have enabled the creation of sign language translation systems and educational resources to enhance accessibility and communication.

7. Evolution within Deaf Communities: Sign languages continue to evolve within deaf communities. New signs are created to express new concepts or adapt to changing cultural and societal contexts. These linguistic innovations can be driven by factors such as technological advancements, social trends, and the need for inclusive and accessible communication.

8. Recognition and Official Status: Sign languages have gained recognition as official languages in many countries. Governments and educational institutions have acknowledged the importance of sign languages in deaf individuals' lives and have taken steps to protect and promote their use. This recognition has further contributed to the development and preservation of sign languages.

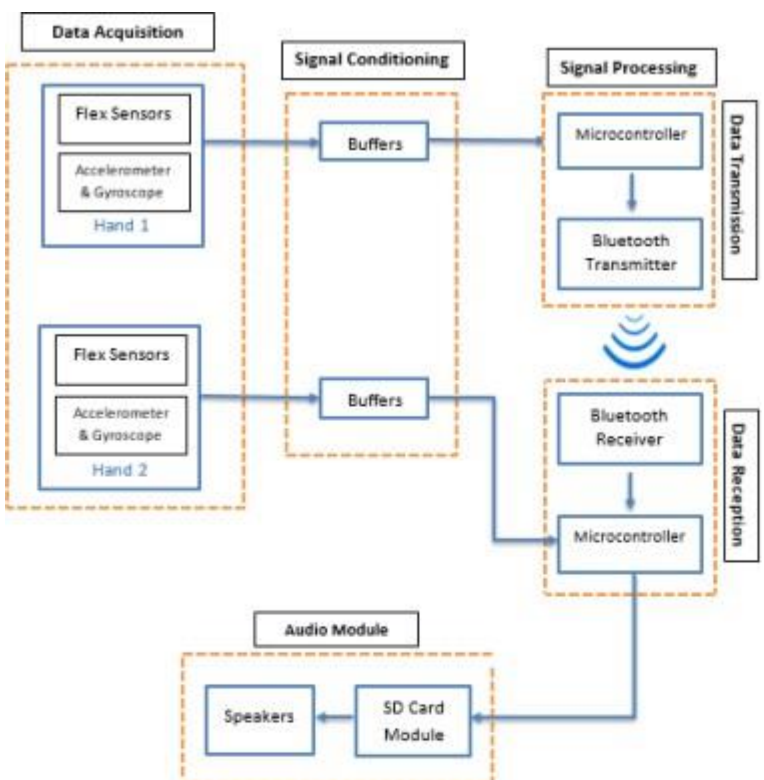

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Fig 2 : Flow Chart

The evolution of sign language is ongoing, shaped by the interactions, experiences, and cultural contexts of deaf communities. It continues to adapt and thrive as a rich and expressive means of communication for deaf individuals worldwide.

CLASSIFICATIONS

Although sign languages have emerged naturally in deaf communities alongside or among spoken languages, they are unrelated to spoken languages and have different grammatical structures at their core.

Sign languages may be classified by how they arise.

- BSL, Auslan and NZSL are usually considered to be a language known as BANZSL. Maritime Sign Language and South African Sign Language are also related to BSL.[71]

- Danish Sign Language and its descendants Norwegian Sign Language and Icelandic Sign Language are largely mutually intelligible with Swedish Sign Language. Finnish Sign Language and Portuguese Sign Language derive from Swedish SL, though with local admixture in the case of mutually unintelligible Finnish SL.[clarification needed] Danish SL has French SL influence and Wittmann (1991) places them in that family,[70] though he proposes that Swedish, Finnish, and Portuguese SL are instead related to British Sign Language.

- Indian Sign Language ISL is similar to Pakistani Sign Language. (ISL fingerspelling uses both hands, similarly to British Sign Language.).

- Japanese Sign Language, Taiwanese Sign Language and Korean Sign Language are thought to be members of a Japanese Sign Language family.[72]

- French Sign Language family. There are a number of sign languages that emerged from French Sign Language (LSF), or are the result of language contact between local community sign languages and LSF. These include: French Sign Language, Italian Sign Language, Quebec Sign Language, American Sign Language, Irish Sign Language, Russian Sign Language, Dutch Sign Language (NGT), Spanish Sign Language, Mexican Sign Language, Brazilian Sign Language (LIBRAS), Catalan Sign Language, Ukrainian Sign Language, Austrian Sign Language (along with its twin Hungarian Sign Language and its offspring Czech Sign Language) and others.

- German Sign Language (DGS) gave rise to Polish Sign Language; it also at least strongly influenced Israeli Sign Language, though it is unclear whether the latter derives from DGS or from Austrian Sign Language, which is in the French family.

- The southern dialect of Chinese Sign Language gave rise to Hong Kong Sign Language, spoken in Hong Kong and Macau

- Lyons Sign Language may be the source of Flemish Sign Language (VGT) though this is unclear.

- Sign languages of Jordan, Lebanon, Syria, Palestine, and Iraq (and possibly Saudi Arabia) may be part of a sprachbund, or may be one dialect of a larger Eastern Arabic Sign Language.

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- Known isolates include Nicaraguan Sign Language, Turkish Sign Language, Armenian Sign Language, Kata Kolok, Al-Sayyid Bedouin Sign Language and Providence Island Sign Language.

INDO-PAKISTANI SIGN LANGUAGE

Indo-Pakistani Sign Language (IPSL) is the predominant sign language in the subcontinent of South Asia, used by at least 15 million deaf signers.[1][2] As with many sign languages, it is difficult to estimate numbers with any certainty, as the Census of India does not list sign languages and most studies have focused on the north and urban areas.[3][4] As of 2021, it is the most used sign language in the world, and Ethnologue ranks it as the 151st most "spoken" language in the world.

In 2005, the National Curricular Framework (NCF) gave some degree of legitimacy to sign language education, by hinting that sign languages may qualify as an optional third language choice for hearing students. NCERT in March 2006 published a chapter on sign language in a class III textbook, emphasising the fact that it is a language like any other and is "yet another mode of communication." The aim was to create healthy attitudes towards the disabled.[citation needed]

Strenuous efforts have been made by Deaf communities, NGO's, researchers and other organisations working for people with hearing disabilities , including the All India Federation of Deaf (AIFD), National association of the Deaf (NAD) in the direction of encouraging ISL. Until 2001, no formal classes for teaching ISL were conducted in India. During this period, Ali Yavar Jung National Institute of Hearing and the Handicapped (AYJNIHH), Mumbai, established an ISL cell. It started a course called "Diploma in India Sign Language Interpreter Course". The curriculum designed for the course aims to develop professional communication in Sign language and ability to interpret professionally. It also focused on the basic understanding of the Deaf community and Deaf culture. Later, the course was offered in the regional centers, in Hyderabad, Bhuvaneshwar, Kolkata and Delhi.[citation needed] Besides AYJNIHH, organisations like the Mook Badhir Sangathan in Indore and several other organisations offer ISL classes. Many NGOs all over the India use ISL to teach English and various academic and vocational courses.

These NGOs include ISHARA (Mumbai), Deaf Way Foundation (Delhi), the Noida Deaf Society and Leadership Education Empowerment of the Deaf (LEED) (Pune), Speaking Hands Institute for the Deaf (Punjab), etc. (Randhawa, 2014). The associations like the Association of Sign Language Interpreters (ASLI) and the Indian Sign Language Interpreters Association (ISLIA) were established in 2006 and 2008 respectively for the professional development of Interpreters in India. Two schools have been established in India which follow bilingual approach to teach deaf students. The schools are the Bajaj Institute of Learning (BIL) in Dehradun and Mook Badhir Sangathan in Indore. Apart from the establishment of organisations working for Deaf people there has been a spurt in research on sign language in India. Recent research developments include the studies by research scholars of the Jawaharlal Nehru University (JNU) and the University of Delhi including Wallang, 2007; Sinha, 2003,2008/2013; Hidam, 2010; Kulsheshtra, 2013. There is also work on problems and awareness of IPSL and typology of IPSL verbs (Morgan 2009,2010). Apart from these there have been continued works by scholars on linguistic aspects of IPSL as well as on varieties of IPSL (Bhattacharya and Hidam 2010, Aboh, Pfau, and Zeshan 2005, Zeshan and Panda 2011, Panda 2011, Panda 2012). Steps taken by the Government of India to promote sign language include the establishment of the ISLRTC. However, currently the autonomy of the Research centre is a contentious issue, which is yet to be resolved.

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The native language of Pakistan's Deaf community is Pakistan Sign Language (PSL). Similar to spoken languages, PSL has a variety of dialects in different regions of the country. PSL Resources: For the first time in Pakistan, FESF has developed Pakistan Sign Language (PSL) Learning Resources to bridge the existing gap in educational materials for the Deaf. The resources include:

- PSL Dictionary containing 6,500+ words –available via web portal, DVD and phone app (both Android and Ios)

- 1,000 Basic PSL Signs in 7 languages: English, Urdu, Punjabi, Sindhi, Pashto, Balochi, and PSL

- PSL Learning Unit, a mini computer mounted on 22" HDMI Monitor with built in speakers, keyboard, and mouse.

Contents include: PSL Dictionary, PSL Animated Stories, Teacher Training Tutorials, Primary Level Tutorials, The IQRA Literacy Program, and more. These open-access PSL resources are now available countrywide to assist the Deaf in gaining literacy skills, and to enhance their opportunities for education, employment and social inclusion. They have proven to be a key resource for those working in Deaf education, as well as for parents, families and employers.

RESIDENTIAL DEAF SCHOOLS

A few students who were unable to learn via the oralist method were taught with signs, many students preferred to communicate with each other via sign language, sometimes to the frustration of their teachers. The first study of the sign language of these children, which is almost certainly related to modern IPSL, was in 1928 by British teacher H. C. Banerjee.

LITERATURE SURVEY

The literature survey also takes into account the approaches considered by researchers across different sign languages like American Sign Language, Taiwanese Sign Language, etc. Which will help to develop a perspective for sign languages.

MEXICAN SIGN LANGUAGE RECOGNITION USING MOVEMENT SENSOR

Sign languages as hand gestures play an important role nowadays between people to try to communicate which others. The aim of the Sign Language Recognition (SLR) is providing a mechanism to transcribe sign gestures into meaningful speech so that communication between deaf and hearing society can be made. People with hearing and speech problems sometimes aren't taken into account by the society. For many years, they were considered unable to think and communicate those ideas. However, from the above premises and the ability to communicate with human beings, it was achieved to promote the study of sign language. Perceiving the above, it's more important to study this type of language, were able to observe that people with oral and hearing impairment were understood using sign, sight, his hands, his body, his facial expressions and the space around them to interact with their neighbors.

Given the difficulty of deaf and dumb people to communicate with others who have no knowledge of sign language, mechanisms and systems that enable understanding between these people have been developed, however, today technology usage is advancing and thus it has given way to the implementation of new systems that achieve facilitate interaction between people of different

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capacities. In particular, this work aims to facilitate communication with people who uses Mexican Sign Language (MSL) with others one that don´t understand it, making use of new technologies that emerged in our environment. Thus, it was made by one of the devices for movement recognition, the Kinect, and with help of developed libraries for its data manipulation, the use of pattern recognition, neural networks, it was developed a system capable of reproducing sound by the sign language translation to spoken language in Spanish-Mexican.

METHODOLOGY

The proposed system consists of the following modules: capture input data, hand segmentation, feature extraction in depth images, hand signs recognition and presentation of the translation result.

CAPTURE INPUT DATA

The Kinect sensor is used as an input device for capturing depth images, RGB images and obtaining information from the skeleton of the human body. The data coming from the Kinect are then processed with classification and pattern recognition algorithms for sign language translation.

HAND SEGMENTATION.

This is a depth-based segmentation using information provided by the Skeleton Data of the Kinect (SDK). The segmentation is performed in the following steps:

1. First depth images are obtained from the information of the skeleton.

2. After the coordinates are obtained in three dimensions (x, y, z) on the right hand according to the coordinate system of the Kinect.

3. Once obtained the position of the right hand, it proceeds to map its 3D coordinates to its corresponding in depth.

FEATURE EXTRACTION

The features are extracted from the segmented hand image consist of the phalanges of the fingers and the center of the palm. Random Forests algorithm performs a pixel classification to group them into different classes defined as regions of the hand, then the joints are located using a local modes search approach based on Mean Shift algorithm [13].

COLLECTION AND LABELING OF TRAINING DATA

The collection of data that was used for the training stage consists of a set of images captured with the RGB and depth cameras from Kinect sensor. Images stored different MSL signs in different positions and angles of the hand.

HAND SIGNS RECOGNITION

Hand signs recognition is obtained by an artificial neural network, whose topology consists of three layers (one input, one output and one hidden layer). The number of neurons in the input and output layers are 14 and 7 respectively. The 14 input neurons represent the normalized Euclidean distances between the different phalanges of the fingers to the center of the palm, and 7 output neurons represent the 5 vowels and two consonants of the alphabet. To classify an input pattern, the values enter the neural network according to

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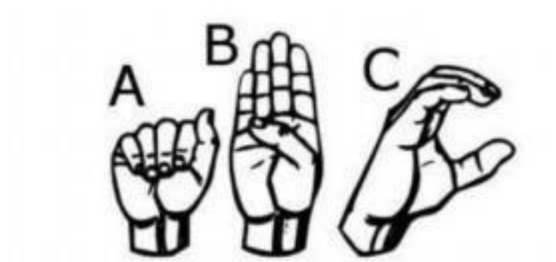
the weights and thresholds obtained in the training stage, using sigmoidal transfer functions spread, the neural network provides its output layer; numerical values in the range of zero to one. The winning neuron is one whose output value is greater.

To demonstrate the effectiveness of the algorithm and its outcome to recognize really possible locals trends to predict some position of the articulation were used some training images for this training and algorithm test, the results indicated over the images to perceive prediction correct of the hand´s articulations. Fig. 6 shows recognition of each region that distingue some part of the hand; it has inside middle point, which allows knowing how to get the articulation position.

In order to report more information, in this evaluation were realized tests with images taken of the Kinect interface in real time to verify the develop algorithm. Fig. 7 shows the articulation and its prediction in real time, color dots in the image are the projection of the (x, y, z) coordinates into two plane dimension (RGB images plane), it mean each hand region.

In this paper, it is presented the design of a system to recognize Mexican sign language. To recognize the alphabet in the MSL was accomplishment by training a set of hand gestures in real time using the interface Kinect. The system recognizes five of MSL than represent vowels (A, E, I, O, U) and two equivalents sign consonants (B, L) of the MLS. This method is advantageous because it is used in real time and the users immediately can interact with it; also using the Kinect infrared camera device eliminates the need for suitable lighting. In the hands sign recognition phase the neural network can provide the center of the palm of the hand, to proceed to map its 3D coordinates to its corresponding in depth in color. The system provides benefits than include the following: gloves, special clothing or accessories are not required; it is not necessary a special background color to work the system; the system can be adapted to other available depth sensors on the market, for example, Leap- motion, PMD (VISION), Asus Wavixtion pro



TALKING GLOVES: LOW-COST GESTURE RECOGNITION SYSTEM FOR SIGN LANGUAGE TRANSLATION

Deafness or hearing-impairment is the loss of ability to hear normally whether permanent or unstable. It can be caused by environmental and genetic factors as well [1]. According to WHO estimates, 360 million people worldwide are suffering from hearing loss and this could increase to 900 million by 2025[2]. The deaf population in Pakistan is over 0.2 million [3] and is usually under-reported due to the societal factors. The disabilities in household members are considered as stigma and threat to family’s social status. In a study conducted [4], it was found that hearing impairment students have a hard time adjusting with the other hearing classmates. They don’t feel belongingness and hence get admissions in special education institutions while lack of sign language interpreters in schools is one of the15 reasons for frustration observed in students.

LITERATURE REVIEW

Gesture recognition is a complicated field. It is mostly being achieved through computer vision (web camera and depth sensors [5], [6]). Gesture recognition using sensor gloves has been done through various methods. Their applications are vast ranging from Biomedical, Design and Manufacturing, Virtual Reality, Robotics to Sign language translating. A survey paper for the applications of sensor gloves and their classification is presented in [7]. A gesture recognition- based Human-Computer Interaction control system is developed [8] via LabVIEW to control a robot wirelessly through hand gestures. An improved PSO-SVM (Particle Swarm Optimization) classification algorithm of hand-gesture recognition is proposed to increase the precision and efficiency of gesture recognition. The gesture sample data is collected using sensor gloves which has

five bending sensors and then processed and optimized using PSO algorithm. Inertial motion sensing glove [9] was designed to detect movement of the entire limb. 3 axis accelerometer sensors were used on each finger, wrist, and arm. Precise hand gesture modeling was done by using the sensor gloves with RGB camera for vision-based gesture recognition. The approaches of Hidden Markov Model (HMM) [10] and parallel HMM were used for sensor fusion modeling. Another sensor-computer based hybrid Inertial sensor glove system was developed [11]. The system tracks hand movements using inertial measurements and the real-time data is fed to a machine learning algorithm for gesture recognition based on LDA (Linear Discriminant Analysis) to reduce classification complexities. In [12] the data was captured using a camera mounted on the hat to give the vision-based system a mobility factor and accelerometers on the wristbands. Accelerometer data provides additional information to the camera captured data. However, the results were too noisy because of the webcam used in order to make the whole system relatively cheap.

Sign language translation through gesture detection can be achieved using various tools [13], [14], [15]. A tremendous amount of work has been done in computer- based image/video gesture recognition but there are differences in tools and environment used between implementations [16], [17], [18]. Many Hybrid approaches have also been used for solving this problem. An approach of translating Indian Sign Language is proposed in [5] using leap motion controller. It is a small device consisting of a 3D noninvasive sensor which allows the user to capture their hand gestures and finger motion on the computer. It can report discrete position and motion of fingers and hand. Multilayer Perceptron Neural Network (MPNN) was used for gesture recognition and classification. An ARM9 processor-based Chinese sign language translation system [19] was designed consisting of sensor modules, voice and text display modules. The data from modules are processed in ARM9 processor and the gesture is recognized by matching the characteristic value of the hand. The system is portable, scalable and of high efficiency but the only negative is the cost and size of ARM9 which makes the system not feasible to carry all the time. Another system [20] was made using a 7-sensor glove of 5DT company. This glove had 5 optical fibers for each finger and thumb to measure the flexion by detecting the light loss due to the bending of a finger and another sensor for tilt and rotation of the hand. Artificial neural networks were used to recognize the data from sensor gloves and converted into text and speech. But this system is overall expensive. Arabic Sign Language translation system was developed [21] using the two Cyber Gloves, two trackers and support vector machine to translate Arabic Sign language. Implementing the system through Principal Component Analysis (PCA), the recognition rate of 99.6% is obtained but the whole system costs more than 30K$.

SYSTEM DESIGN AND IMPLEMENTATION

A. Hardware Design The block diagram of the proposed system. It comprises of following four major modules:

1) Data Acquisition Module

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2) Signal Conditioning and Processing Module

3) Data Transmission and Reception Module

4) Audio Module

DATA ACQUISITION:

The system is comprised of both hand sensor gloves that is the gloves will be able to translate both single and double-handed gestures. The gloves will track angular position, rotation of hands and bending of fingers. These motions are read through the use of multiple sensors stitched within the gloves.

EXPERIMENTAL SETUP

Experimental Setup Ten volunteers were hired from the university campus in order to collect the sensors data variations according to the various hand sizes and shapes. The participants did not possess any muscular disorder that could affect the gestures. The volunteers were requested to perform each sign, for approximately 20 seconds and the neutral position is also observed regardless of the hand orientation.

All the data were recorded using Data Acquisition application PLX-DAQ. Values of flex sensors from F1 to F5 and rotation of hands were recorded during the experiment. The data were saved in text MS Excel Sheet for the processing and easy visualization through the graph.

METHODOLOGY FLEXION

As stated in the sections above, flex sensors and accelerometer are used to record the bending of fingers and orientation of hand respectively. Flex sensors change its resistance when it bends. This variation is changed into voltages through voltage divider configuration and further digitized with the ADC of the microcontroller. The ADC is of 10bit resolution. It will map input voltage from 0 to 3.3 volts into integer 1 to 1023. The increase and decrease in the 10bit value points depend on the increase and decrease in the resistance of flex sensor. By doing a simple calculation, the integer value can be converted into the actual voltage

Movement of hand is defined as the clockwise, counterclockwise and Still position. This movement is detected by the Gyro values.

GESTURE MAPPING

Sensors' data from both hands are multiplexed through Bluetooth modules. All the flex sensors data are converted into decimal values according to each gesture. For the similar values of both hands, data from accelerometer and gyroscope are used for differentiating the gestures. Average values of each sensor are computed and matched with the gesture made. For similar values, accelerometer and gyroscope values are taken into the account. Gesture recognition is performed via lookup data.

It contains initialization, analog to digital conversion, recognition via lookup process and matching with an audio database stored in the SD Card. When no sign is made for 5 minutes, it is detected as a neutral condition and then the system goes into the sleep mode enabling its power saving mode and can be activated again by reset switch.

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RESULTS AND DISCUSSION

The system was implemented and tested with the sample gestures as depicted in Fig 8. It depicts the sign for Alphabets from A to E. The proposed system has a short initialization time to set up the Bluetooth connection which is 2s approx and is able to process a recognition in approximately 0.4s. To detecting alphabets with dynamic motions such as 'J' and 'Z', the angle of rotation and flexion values are observed while due to the higher similarity in 'V' and 'U', their mismatch rate was high as compared to other signs. In order to rectify this problem, a contact sensor comprising of simple copper foil is attached to the side of fingers which enabled the system to easily differentiate between both alphabets.

The proposed system translates the Pakistan Sign Language to speech with the help of various sensors such that the flex sensors, accelerometer, gyroscope and contact sensor. The system achieved the efficiency of 93.4% with alphabets and numbers and is expected to vary with more gestures and database. The wireless communication and small size modules make it an autonomous, portable and a user-friendly system. Keeping in view, the economic condition of deaf community in Pakistan, the system is made from cheap and inexpensive modules without compromising the system performance. It can be modified to the extensive vocabulary of Sign Language so that the deaf community can easily communicate with other people. The system also aims to use in various fields such as biomedical, controlling mechanisms in industries and virtual reality..

WEARABLE GLOVE THAT TRANSLATES SIGN LANGUAGE INTO TEXT AND SPEECH

Dumb and deaf persons make up a large portion of India's population. As a result, the system is developing a glove-based device for converting ASL to speech. The basic system is divided into 2 parts recognition of sign language and conversion to text, followed by voice. The sign language glove is made up of a pair of basic hand gloves with flex sensors that detect how much the fingers bend. The sensors that increase resistance based on the degree of bend on the sensor are known as flex sensors. Data from the sensors is sent to the Arduino Nano control unit, where the analogue signals are digitally transformed and compared to the recorded value for sign detection, and then displayed as text on the mobile display. Also, the text output is wirelessly transferred to a mobile phone. Persons who are deaf or hard of hearing communicate with society using sign languages that are difficult to interpret by non-deaf or hard of hearing people. As a result, communication between deaf-mutes and non-mutes has always been a challenge. Everywhere in the world, there are difficult tasks.

INTRODUCTION

Sign language is a natural way for normal and deaf individuals to communicate. The majority of sign language is based on hand gesture recognition. It might be difficult for ordinary people to notice signals and knowledge what they are trying to express. As a result, the gloves' purpose is to make the lives of the deaf and dumb people easier. The gloves convert hand gestures to text and then speech, allowing ordinary people to read the recognised gesture, hear the voice, and know what the person is trying to say, resulting in more effective communication. Physical and non-physical communication are both part of the system. The sign language varies from nation to country and is not universal. The United States created American Sign Language (ASL), the United Kingdom created British Sign Language, and so on. The American Sign Language is used in the majority of countries, and our method is no different. Using Arduino as the system's brain, the gloves transform precise movements to text and ultimately to speech. The system, which is attached to the gloves, uses flex sensors to turn gestures into resistance, which is then converted to text using an Arduino Nano. The flex sensors are a type of flexible sensor. For accurate output, flex sensors are

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combined with accelerometers and touch sensors. The accelerometer is used to track hand motion, while contact sensors are developed to track finger touch. The sensors are chosen based on the following criteria. The sensors' output is processed on an Arduino Nano to produce text for display on a mobile device. Additionally, the data is translated to voice using text-to-speech systems. There is no commercial method for converting sign language to speech on the market. However, work is underway to translate sign language to speech that is portable, efficient, and extremely accurate.

A variety of studies and research projects have been conducted on the issue of smart communication for visually and hearing-impaired persons. In addition to writing and drawing, sign language is the most efficient medium for fluent communication between regular people and these specially challenged people, according to this. Several patents have been filed in this subject with various ways to handle this challenge.

1. “Deaf-Mute Communication Interpreter” uses sensor-based technique comprising of flex sensor, tactile sensors and accelerometer to translate American Sign Language gestures to both text and auditory voice. Although, they were only able to translate thirteen signs into their respective alphabets namely letters ‘A’ ‘B’ ‘C’ ‘D’ ‘F’ ‘I’ ‘L’ ‘O’ ‘M’ ‘N’ ‘T’ ‘S’ ‘W’ and tactile sensor were used to improve the accuracy of three letters M, N and T.

2. Aslant provided a system for employing gloves to understand sign language. The framework consists of five flex sensors, a microprocessor that analyses sensor data, an LCD that displays individual findings, and a speaker that listens to the output. It generated both a visual display on an LCD and auditory output through the speaker. This strategy has the disadvantage of restricting the user's freedom of choice.

DESIGN METHODOLOGY BLOCK DIAGRAM

HARDWARE AND SOFTWARE

A. Hardware Use

1. Arduino Nano

2. Flex Sensor

3. Adxl 335 Accelerometer

4. Bluetooth Module

B. Software Use

Arduino IDE:

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

EXPERIMENTAL RESULT

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The movement in the fingers is measured using an accelerometer. Flex sensors allow the movement of each finger and the thumbs of the gloves. The flex sensors send out a flow of data that varies depending on at which you bend. A glove has five bend sensors, four for the fingers and one for the thumb. The flex sensors will be connected through resistors and the resistors will be of 1Kohms. This helps us know the resistance of the flex sensors according to movements of the user's fingers. The resistors will change values on flexing of the sensors and this way we receive the output of values. These sensors measure the bend in the fingers, thumb, and palm, and the Arduino Nano microcontroller determines which set of values represent which symbol based on the bend angle value, and sends the appropriate result value to the Android app via Bluetooth, which displays and speaks the generated symbol.

The output of the alphabet "A" is represented in figure "1," and the following movement identifies the letter "A". The bend of the fingers is measured by sensors." When these requirements are fulfilled, the alphabet is the single selection. "A" will be displayed on mobile screen and then speech output is obtained.

This technique allows deaf, dumb, and blind persons to communicate with one another. Dumb people speak in their own language, which is difficult for blind and conventional people to understand. The sign language is also translated into a written format to help deaf people. This text appears on a computer screen. Deaf people must be recovered. We'll using it to observe the hand motions for the deaf and blind. Hand movements are converted to text and then to voice by the system. If a person cannot hear the sound made due to those difficulties, a provision has been implemented into the text system so that the person still read and understand what the other person is trying to say.

OVERVIWE OF PROJECT

Sign language translation into text and speech using gloves is an innovative approach to bridge the communication gap between sign language users and non-sign language users. The goal of this technology is to enable real-time translation of sign language gestures into written text or spoken language, facilitating effective communication and inclusivity for individuals who are deaf or hard of hearing.

The process typically involves the use of data gloves equipped with sensors or motion capture devices to capture the hand movements, gestures, and finger positions of the signer. The data gloves detect and record the intricate details of the signer's hand and finger motions, which are then processed and analysed by a computer system.

SIGN LANGUAGE INTO TEXT AND SPEECH TRANSLATION IN REAL TIME

Sign language is a visual language used by individuals who are deaf or hard of hearing to communicate with others. It is a rich and complex language that employs hand gestures, facial expressions, and body language to convey meaning. However, communication barriers still exist between sign language users and those who do not understand sign language. To address this issue, this project proposes the development of a sign language translation system using an Arduino microcontroller, LCD display, two flex sensors, a speaker, and a power supply. The system will enable real-time translation of sign language gestures into text and speech output, providing greater accessibility and inclusivity for individuals with disabilities. The system will use two flex sensors attached to a glove worn by the user to detect hand gestures. The microcontroller will process this data and interpret the gestures made by the user, displaying the results on an LCD screen and producing speech output using a speaker. The system's hardware components will be designed and built, and the microcontroller will be programmed to enable real-time translation. This project aims to contribute to the development of assistive technologies that can enhance communication and promote accessibility for individuals with disabilities. The proposed sign language translation system has

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the potential to improve the lives of many individuals who rely on sign language to communicate with others. The proposed sign language translation system aims to address the potential disadvantages of existing systems by utilizing low-cost components and real-time translation capabilities. The system will consist of the following components:

- Glove with Flex Sensors: The system will use a glove with two flex sensors attached to detect hand movements and gestures made in sign language.

- Arduino Microcontroller: The Arduino microcontroller will process the data from the flex sensors and interpret the sign language gestures made by the user.

- LCD Display: The system will use an LCD display to show the interpreted sign language gestures as text.

- Speaker: The system will produce speech output using a speaker to convey the interpreted sign language gestures.

- Power Supply: The system will require a power supply to operate.

The proposed system will utilize machine learning algorithms to improve its recognition of sign language gestures. The algorithms will be trained on a dataset of sign language gestures to enable the system to recognize a wide range of gestures accurately. The system will also have the ability to learn new gestures, which can be added to the dataset through user feedback. The proposed system aims to be an effective, affordable, and accessible tool for individuals who rely on sign language to communicate. By utilizing low-cost components and real-time translation capabilities, the system has the potential to improve communication and promote accessibility for individuals with disabilities.

SOFTWARE REQUIRED ARDUINO IDE

Arduino IDE stands for "Integrated Development Environment": it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go. In this article, we will introduce the Software, how we can install it, and make it ready for developing applications using Arduino modules.

ARDUINO IDE DEFINITION:

1. Arduino IDE is an open-source software that is mainly used for writing and compiling the code into the Arduino Module.

2. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.

3. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

4. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.

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5. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

6. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.

7. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and is used for compiling and uploading code into the given Arduino Module.

8. This environment supports both C and C++ languages.

Fig 4 : Hand signs

CONCLUSION

The proposed sign language translation system using a glove, flex sensors, Arduino microcontroller, LCD display, speaker, and power supply has the potential to be an effective, affordable, and accessible tool for individuals who rely on sign language to communicate. The system offers real-time translation, improved accuracy, and low-cost affordability, making it a valuable addition to the assistive technology available to individuals with disabilities. The system's development will require careful attention to the design, testing, and implementation of the system to ensure that it is effective, reliable, and usable for its intended users. The system's ability to learn new gestures will allow it to adapt to the needs of individual users and remain relevant in the face of changing sign language usage. The proposed sign language translation system has the potential to promote inclusivity and enhance communication for individuals with disabilities who rely on sign language to communicate. As such, the development of this system is a step towards greater accessibility and inclusivity in our society.

- Real-time translation of sign language to text and speech.

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- Improved accuracy in recognizing and translating sign language gestures.
- Low-cost affordability, making it accessible to individuals with disabilities who may have limited financial resources.
- Ability to learn new gestures, allowing it to adapt to the needs of individual users and remain relevant in the face of changing sign language usage.
- User-friendly interface with an LCD display for visual feedback.
- Lightweight and portable, allowing for ease of use and mobility.

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