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Survey on Gesture Recognition for Sign Language

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Abstract: From the total world population, more than 5% of the population has problems with speaking and hearing, which creates a barrier in communication as they communicate only using sign language. This paper presents a survey on all components which are required to build a device that helps to reduce this barrier and has studied many inventions in this field, which include all the possible methods through which the device can be built. They include Vision-based methods, device-based methods, and many more. And survey on different hardware like flex sensor, accelerometer, IMU sensor, Arduino, and EMG sensors. An even survey is done on different algorithms used for processing data captured during gesture recognition.
Keywords: Hand Gesture Recognition, IMU sensor, Electromyography, Flex sensor, Arduino, CNN, DBN, ANN, FDN.

I. INTRODUCTION

Communication is a means of exchanging information or emotions between two people or a group of people. To make it successful all participants should know the common language. Communication can be verbal or nonverbal but not everyone can go the verbal way. There are specialized abled people who have problems with speaking and hearing i.e., deaf and mute. As they cannot use verbal ways, then the only way of communication is sign language for them. but not everyone cannot understand sign language which creates a barrier between 2 communities. It is the same problem that two people face when they do not know a common language. In that case, we need a translator. In between it can be a human or a device. Having a person everywhere is not convenient. So, there is a need to develop a device that will help to convert these gestures into text or voice. Our device works as a translator for these two communities. There are many devices that implement unique methods to achieve it. First, let us look into Vision based devices that basically take input from the camera and compare with an already existing dataset if the device finds the match it will be displayed in the form of text or voice. We have hardware-based methods like a smart glove which will capture the gestures through sensors like flex and accelerometer, gyroscope, IMU, and Electromyography, all inputs from sensors are collected and processed in the microprocessor. We can also use Leap Motion Controller and Kinect Motion detection sensor for gesture recognition, which gives more accuracy, hence they are comparatively costly. Then the output can be given in many forms, by using separate speakers or by using an android app that can give voice or text, the output can be given by pre-recording it or by using the TTS algorithm, prerecording creates a delay in giving the output so TTS algorithm gives better output and we can also use IR sensor band to detect the eye movement to give the output according to it but long usage of this band damages the eye nerves. We can classify the gestures into two categories, static and dynamic. The dynamic gesture involves continuous hand moments like hand waves, a moment in circular movements, and sign language sometimes involves the whole body to convey a message. Static does not involve any movement like alphabet input. For vision-based methods, we have done surveys on different algorithms that can be used to process data, like CNN, ANN, DBN, SVM, K-nearest, and many more. CNN is a deep learning algorithm that is used for image recognition and processes which include pixel data. The input taken from the camera in the form of video is segmented further and using CNN we can tag the image with its ID. In ANN we can develop a model which categorizes hand gestures by using the skin color detection method. ML approaches have 4 types namely. Among them, ANN gives better output. As said earlier gestures can be of two types subtle and large motions, SVM helps to divide the input into 2 categories. Further reduction and processing can be made using DBN.

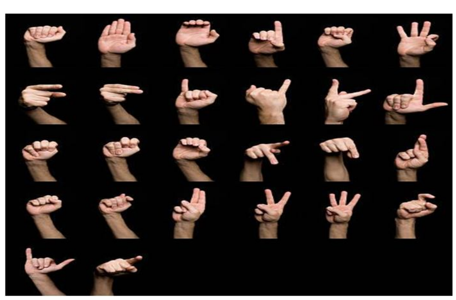

Fig.1 Sign Language Gestures

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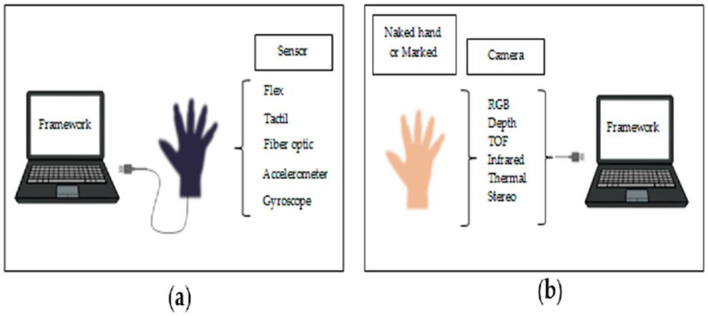

Fig.2 (a) hardware-based (b) vision-based Hand Gesture Recognition Method

Techniques	Components	Algorithm	Advantages	Limitation
Vision based	Camera sensor, IR sensors	Convolutional Neural Network (CNN), Deep Belief Network (DBN), Support Vector Machine (SVM), K-Nearest Neighbour, Leap Motion	No need to wear any device at all the time,	Portability, Change in light intensity can give a wrong output.
Hardware based	Flex sensors, Gyroscope, Accelerometer,	Artificial Neural Network (ANN), Hidden Markov Model (HMM), Random Projection (RP), Naive Bayes	High accuracy, Real-time Portable, cost-effective,	Data pre-processing is required, Ambiguity while comparing input data and original data.

Table(1) Techniques used for Hand Gesture Recognition System

II. RELATED WORK

In [1] they have designed hand gesture recognition based on the data collected from a 3-axis accelerometer and multi-channel EMG signals from the Electromyography (EMG) sensors. Here the system automatically detects the start and end point of a meaningful gesture by using the intensity of the EMG signals collected from the EMG sensor. Here they have used a dataset containing 72 Chinese Sign Language words and 40 CSL sentences. For the classification of these gestures, they used machine learning techniques like the hidden Markov model and decision tree classification algorithm. This system achieves 98.7% accuracy for word segment detection for both subjects. It also achieves an accuracy of 72.5% for sentences. They have used this system for building a real-time interactive system as a virtual Rubik's cube game using 18 hand gestures as control commands.

This system[2] uses a single 3-axis accelerometer to recognize sign language. It contains 2 stages: The training stage and the testing stage. For the training stage, it uses a Dynamic-time-warping algorithm. For the testing stage, this system estimates all the unknown and candidate traces onto a lower (linear) dimensional subspace. This system also addresses the hand gesture recognition problem using Random projection. It formulates the whole problem into a minimization problem. It uses the 18 hand gestures defined in the dataset. It also uses 7 subjects to create a database of over 3700 traces, on which the system is tested and the results are evaluated. Using this, the system achieves 98.71% accuracy for mixed-user recognition for the dictionary of 18 gestures. It also achieves accuracies of 96.84 and 94.6 for the dictionary containing 8 gestures and 18 gestures, respectively.

In[3] They developed an accelerometer-based pen-type sensing device. This system is user-independent which means that users can hold this pen-type device and perform hand gestures with their choice of handheld style. These gestures are classified as basic and complex gestures. Complex gestures can be represented as a basic gesture sequence. They have defined 24 hand gestures, which contain 8 basic gestures and 16 complex gestures. This uses an effective segmentation algorithm to classify the accuracy of the performed hand gesture. With the help of the segmentation algorithm, each complex gesture is segmented or divided into several basic gestures. 25 features are extracted using the kinematic characteristics of the basic gestures. These features can be used to train the FNN (Feed Forward Neural Network) model. Input gestures for basic gesture recognition are classified directly by the FNN (Feed Forward Neural Network) classification model. Complex gestures are classified by using a similarity matching procedure, which identifies the most similar sequences of the gestures. For both basic gestures and complex gestures, this system achieves 99.88% accuracy for user-independent and user-dependent gesture recognition. They collected data from 5 subjects. The effectiveness of the FNN (Feed Forward Neural Network) and similarity matching algorithms are validated using 1600 trajectories.

[4] presents the different techniques used for developing a hand gesture recognition system for sign language recognition. Here they have defined two types of techniques, vision-based hand gesture recognition technique, and data glove-based technique. These two techniques use MATLAB for processing the input data, which can be image or data from the sensors. Vision-based gestures can be performed using two types, one is a static hand gesture technique and the other one is a real-time algorithm. This real-time algorithm technique takes video as input. The data glove-based technique uses sensors to collect the data. It consists of 5 flex sensors, whenever the user bends the fingers, data is collected based on the bending degree or the pressure on the sensor. Here based on changes in the resistance value of each flex sensor a unique hand gesture is recognized. This technique is performed on 10 subjects, which is then compared with the dataset to find the most accurate technique for recognizing hand gestures.

In [5], they addressed the problem of real-time EMG-based hand gesture recognition, and it also gives the embedded solution for this problem. It mainly concentrated on the system design, and also on integrating the software and hardware components to build a wearable device, which is capable of collecting the data from EMG signals in real-time, and it also focuses on processing the EMG signals collected from the sensors. For onboard processing of data, this system combines the analog front end with the data from the microcontroller. From the 4 different users, 7 types of hand gestures are collected to create a dataset. This system uses an SVM classification algorithm, to determine the accuracy of the hand gesture recognition. This classification technique using SVM achieves 90% of accuracy. It consumes an overall 29.7mW of power with a 400 mAh battery, this system can operate continuously for up to 44 hours.

[6] presents the implementation of a wearable hand gesture recognition system for American Sign Language Recognition, to build this system, data from inertial and surface-myography sensors are collected. To select the subset of features from the well-established features, this system uses a feature selection scheme, in this system information-gain-based feature selection scheme is used. This system uses four classification algorithms to evaluate the accuracy of the hand gestures performed, with a selected feature subset and, by the use of the SVM classification algorithm this system obtains overall average accuracies of 96.16% and 85.24% for intra-subject evaluation and intra-subject cross-session evaluation respectively.

[7] constructs a dynamic hand gesture recognition system using PNN (probabilistic Neural Network). This system is mainly focused on developing hand gesture recognition devices for the practical usage of dynamic gestures in day-to-day life. In this system, 10 gesture patterns are generated by using data-glove, and each gesture in this system is trained for generating 360 input vectors using the PNN classification model. The output of this system can be given via speakers. This system is tested on 23 disabled people, and based on the data, the performance of the proposed system is evaluated. This system also results in problems while detecting the gestures, for gestures 7 and 10 this system doesn't detect the accuracy correctly. 92.7% of accuracy is obtained from this device.

In[8] the system is developed using Arduino UNO and a flex sensor for recognizing hand gestures. In this system data collected from flex sensors are analyzed using different machine learning techniques, these data were categorized on the basis of 4 labels, which contain class labels 0, 1, 2, and 3. This system collects the data in the form of integer values, for each interval of 0.25 seconds, a new value from the sensor will be obtained based on changes made in the bending degree of each flex sensor, these two data are labeled as A and B, these labels represent the value which is obtained by the flex sensor. This system extracts the features from the pre-existing data, here it collects a total of 6 features, which can be then used to analyze the data using a machine learning model. The technique used in this system achieves 88.32% accuracy, 81.77%, and 84.37% of precision accuracy, and it also achieves an 82.78% of F1-score.

The authors of [9] developed a useful double-handed transportable glove system for people who cannot speak and/or hear. This system was developed specifically for Taiwanese sign language with the help of flex sensors and inertial sensors to capture the record of finger bending and hand orientations respectively.

The speech output was taken through a smartphone. For the identification of signs, they had taken the help of three registers. One was to match the previous gesture with the present, the second one for palm orientation, and the last one is to track the motion of the hand. They considered signs for five different emotions with only 5 subjects (for training). More than 94% of efficacy was gained by this proposed system considering the parameter of sensitivity.

In [10] paper, the author introduced a special kind of glove system for deaf-mute people to convert their sign language to human understandable words or speech. They developed gloves for both hands containing flex sensors and an accelerometer connected with a gyroscope, thus they had done data collection through them. Adding to it, contact sensors were also used to eliminate the mismatch of input signals. Signal conditioning was done for flex sensors to make sure that they will give the proper output. Using a microcontroller, signals from each hand were processed and they were combined using a Bluetooth transmitter. Speech output was taken through speakers. Author of [10] gained an efficacy of about 93% for alphanumerics.

The author of [11] paper introduced a special kind of gesture-recognizing sensor called a Leap Motion controller(LMC). Using LMC, a system was developed for deaf or mute people around the world and they can communicate easily with normal people through their sign language. Firstly, LMC captures the gestures performed by them. From those, palm & finger-related data were extracted through LMC. They were normalized as feature sets, then they were passed into a multilayer perceptron neural network(MLP) to perform the process of classification. After that, processed signals were handed to artificial neural networks from which output units that specify alphabets or numbers of the performed gestures were produced. An algorithm was also used to reduce the possible error by propagating backwardly. The proposed system was able to attain above 95% of accuracy in identifying 26 letters of American Sign Language(ASL). The author of [11] paper also suggested enhancing their system for sentences or words in the future.

The author of [12] paper demonstrated a system by using 5 flex sensors, 5 force sensors, an accelerometer, and a contact sensor for people who cannot speak or hear. Through the sensors mentioned, required data of palm and finger orientations are collected. Gathered analog data was processed and digitized using Microcontroller. The output is presented through a wired LCD display as well as on smartphones through Bluetooth. The proposed system has attained an efficacy of 96% by being able to identify 20 out of 26 letters of ASL. In the [13] paper, authors developed a system for still gestures of several sign languages. Here gloves for two hands were developed with the help of flex sensors (inner and outer) and contact sensors which collect the data of movement of fingers and hands. Then the input signals were passed into two supporting hardware. Those two microcontrollers operate the values, distinguish the gestures and present them on the LCD. The proposed system works in the Default Operating Model for which it gained an accuracy of more than 83% and an Intelligent Operating Model for which it gained an efficiency of 60%. The performed gestures were fractionated into 3 blocks and they were compared with the table containing all the gestures. Only the proper match of blocks with the performed gesture is perceived using DOM & IOM models.

In the paper [14], the authors discussed the sign language conversion system using a special device called the Kinect motion sensor device. The proposed system contains information about how the training and translation method is done using the device mentioned above. In the training phase, the subject has to perform each gesture 5 times in front of the device. Then the mean of each gesture's 5 inputs is calculated and stored in the database. In the translation process, once the subject performs a gesture it checks with the database, and it gives the word output stored in that database. Otherwise, it shows the message saying that the gesture isn’t available and suggests training the model for that unidentified sign. Even this device has some faults like it can give a wrong output when it fails to capture real-time data. Here is the current work of this paper speech conversion of the words is not done. In [15] paper, authors developed a suit consisting of several inertial measurement unit (IMU) sensors fitted on the upper body of the participant. The system was developed to know about the participant's capacity to persuade the decisions for basketball with the help of official referee signals(ORS). Basically, it's a training system where two types of tests were given to participants before and after training them with ORS, to compare their results respectively. Firstly participants were made to make decisions by watching the 10 pre-recorded videos and the correct decisions were stored. Then the second test will be conducted through three steps. In the first 2 steps, the participant was made to look at the ORS names and perform those gestures along with them. In the last step, he or she has to judge 10 more scenarios. The correct decisions of both tests are tallied to know about participants' judgment skills. There are a few drawbacks of this suit as it requires time to wear properly and it can also get affected by the presence of other electronics. In [16] paper they developed a glove for a single hand to convert the sign language for deaf-mute people with the help of 5 accelerometers. Each accelerometer has three input components, thus this hand glove will have 15 inputs which were processed by a microcontroller. Then this analog data is fed to a smartphone through Bluetooth. An Android application is also included in this system to have speech or letter output of word or phrase as letter or voice however the user wishes to have.This system could also be enhanced for other Sign languages.

This paper [17] says why we choose Arduino, there are many other boards in the market there are a few reasons which We need to consider it already has many active users there is a community working on it, it supports many operating systems, and easily programmable, quite inexpensive as well, In Arduino itself we have many come with built-in Bluetooth, Ethernet, and many other options. This paper also gives an insight into all the parts of Arduino, hardware parts and software how we can code, the tiny details available in Arduino IDE all the things are explained in detail, and about few real-time applications which were built using Arduino like an open-source satellite for research purpose and wearable device many other highly developed projects are explained in the paper.

This paper [18] is mainly focused on the application of flex sensors in different fields and their working in detail, here can see flex sensors can be found in 3 types, optical flex sensors here a light source, and a photodetector is kept on another side to major light passing when the flex is bent similarly other flex sensors are explained. they are capacitated and conductive based. Then author goes on explaining how flex sensor is not specified to single field, it does have its application in many fields like, the first application was a Goniometer a glow which can help to detect finger moments and here on a plastic carbon resistance material was placed to produce resistance and a circuit was designed to collect data ADC convertor, in early days this work was done by mechanical Goniometer which used to a lot of times for processing Another glove was developed to interact with 3D virtual objects by Giovanni Saggio et al using flex sensor ,An obstacle detecting device is quite important in a vehicle but infrared ultrasonic sensor are expensive flex provides affordable object detection which can be placed on 4 sides of vehicle ,an application was designed to detect landslides using flex sensor , a device was developed to detect intrusion by considering the status of door , author explains how flex sensors can be used as musical instruments then author specifically focuses on how flex sensor can be used to detect dent on vehicle ,for this purpose earlier signal vibrations were used but metal do have a nature vibration so results can be wrong many times so it is important to detect shape change of surface which is done using flex sensors.

Here [19] has developed a simple device to translate all the alphabets of sign language to audio and they have focused on creating their own flex sensors to take the output, here they have constructed 2 flex sensors one with copper and another with aluminum, they have placed a resistive material inside 2 strips of copper foil and that sandwich is laminated here they have done an experiment to detect the signal with copper and aluminum and came with a conclusion that copper gives promising result In this project author has used 9 flex sensors and 3 accelerometers which are connected to the simple microcontroller where the processing of data takes place this result is sent to a mobile app for audio by a Bluetooth device, here every alphabet has to be spelled out with 10-sec gap which will not be a practical way of communication and the delay can be reduced with better algorithm implementation and we need a sensor to detect hand moments of other parts not just fingers and analyze the result.

[20] is quite simple yet impressive work, it is a device that converts 9 signs into text. Here they have used 3 flex sensors and one accelerometer which are used to detect finger moments and tilt moments, the continued input from the flex and accelerometer is sent to a microprocessor where they calculate the resistance change by flex and compare it with already present data then it was sent to LCD where they displayed the output from the microprocessor, but the drawback which we can see here is the device is capable of detecting only 9 gestures and it's not portable as LCD is mounted a breadboard it can not be carried everywhere, and in the country, like India where we have many languages not everyone is familiar with English and reading it so the device fails to help an individual in communicating And output which they have taken considered only 3 fingers but if we take real-time sign language communication it involves all five fingers some time even arm so this project lacks this that particular area, these all drawbacks are covered in our project.

[21] has proposed to help mute people to communicate through gestures, first it explains how devices can be used in many sectors like education, medical, public areas, industries, and many other places. The first author goes on to explain how the present dataset takes a long time to process and is limited to only a few gesture identification and author also explains how grammar in SL is important and should be considered while developing an SLR (sign language recognition) system. Next section covers on all the methods which are available SLR recognition it can be sensor based or vision based, there few drawbacks in the present systems which can identify only few moment to solve this problem we need to add few more sensors in arm and shoulder area and in vision based it is necessary to add extra filter to recognise words like U and V, further author has explained mainly 2 categories hardware based and software based, software based method usually include usage of algorithms like CNN which takes input from computer and processes and gives out output on screen, Hardware based methods have many subdivisions first one is smart glove method which uses sensors like flex and accelerometer and take reading from hand movements based on change in resistance second subdivision is IR sensing eye band which has few IR sensors attached to band and based on eye movements digital bits are generated, long usage of this band effects eye and last subdivision is Hybrid method which uses both hardware and software methods to recognize the gesture . Then the author explained how text can be converted into voice.

There are quite a few methods for it using preloaded voice and using the TTS algorithm both have their own pros and cons; Deep Belief networks are proven to be best among all other methods for conversion. This project is implemented using raspberry pie, which is expensive hardware, and here it is not needed. We can work with less expensive devices like Arduino which will give us the same results.

[22] has developed gloves that can recognize Indian sign language (ISL) gestures, ISL actually includes 3000 words, here they have used 8 flex sensors input from the sensors is given to Arduino where they have created 2 algorithms to calculate the aggregated value of all 8 flex sensors and second algorithm to compare the aggregated value to already given threshold, this value is, microcontroller recognizes the alphabet, makes the decision and sends the signal to give the audio output, here they have used pre-recorded method, which creates a bit delay and puts a constraint to very few gesture recognition. Then the author goes on to explain different algorithms present for gesture Sign Language Interpretation, total of 3 algorithms have been explained here SVM, ANN, and HMM.

[23] explains that sign language has 2 types of gestures static and dynamic, dynamic gesture involves continuous hand moments like hand waves, and moments in circular movements, and sign language sometimes involves the whole body to convey a message, to identify these Here they have applied two different methods for both gestures, for the static method they have shown 4 steps first normalization of data then comes skin color detection followed by skin color model at last hand gesture recognition. Normalization is changing pixel intensity value near users' images for better results, skin color model helps to put a label on objects in an image by dividing them into frames For the dynamic method they have considered 3 steps first skin color detection then training and testing phases, In the training phase, simple dynamic hand gestures are taken into consideration like high five, fisting and Gesture ID is given for hand gesture recognition, In the testing phase, each image is given s subspace each subspace represents a shape gesture recognition and movement gradient will give gesture movement pair which will be output, they have used MATLAB for the implementation, the drawback is you always need a computer to get the output a person cannot carry it around just to communicate with a person so it won't use full in day to day life and complex background can mess up with the output.

[24] mainly focuses on developing a cost-effective device for Speech Impaired People. So for gesture recognition, they have considered both image processing and sensor-based devices. Since Gesture detection was better in sensor-based systems, they implemented their device using flex sensors, an accelerometer, and an onboard gyroscope. Here the principle of flex sensor is understood. Flex has features like lightness, cheapness, and robustness but they also have problems, due to changes in resistance over time which can cause changes in value, so we need to change all the flex sensors implemented. Hence to make it cost-effective they have suggested a fabrication method for the flex sensors.

[25] This paper mainly focuses on developing light weighted, real-time portable assistance for speech-impaired people. This is done by taking a specific hand sign and assigning it to whole meaningful sentences which are used regularly. They have divided their system into two different parts, transmitter and receiver, which helps them to reduce the load on the processing of the data. The transmitter contains a flex sensor to gather the inputs.It will then be forwarded to the microcontroller through Bluetooth. In the transmitter, the input data is checked for its correctness, and the receiver consists of an Arduino board embedded with an SD card where the voices of the specific gesture are stored. It then matches the input with the corresponding data set and produces output in the text that is LCD display and voice through Speaker. This device reduces bulkiness and has high accuracy. It has a good sound quality, and just one sign provides a complete sentence. Users can customize the system. Accuracy is calculated by iterating the same message 50 times and has slightly higher accuracy than other works. Users can even increase the input gestures with unique sentences for each hand sign.

In [26] they used three sensors for better results and accuracy. They have used sensors for reading American sign language (ASL), but they have mainly focused on the sensor position and protecting them for long time use. Data is collected from all three sensors due to their difference in voltages, caused by hand signs, and processed in the microcontroller. Then data is converted into digital values from the analog input. This value is used for the decision-making process and the output is in text format as well as audio with the use of a text-to-sound converter IC. All sensors are positioned on gloves in such a way that it increases their working and they get high accuracy for each sign. Gloves flexibility was reduced to decrease its fluctuation chances. Dynamic gesture recognition was successful with an accuracy of 100%. An average success rate of more than 90% was achieved. They have achieved the protection of sensitive sensors by wrapping them with plastic which prevents them from contamination. The drawbacks of this proposed system are that it has a difficulty in sorting fixed letters from each other and the active letters within a given time frame. They also want their system to further identify an ASL word or sentence and make the system go wireless.

In paper [27] they have implemented a hand sign converter for Indian sign language(ISL) which is a little unique because it requires the use of both hands. In the sense, they have captured the movements of all ten fingers including their wrist movements. They have used flex sensors and accelerometers to capture the hand gestures like rotation, direction change, and angle tilts.

These are fitted over data gloves to get different voltages for different gestures. Voltage is then processed by a microcontroller and a voice module is used in which different voices are stored for different voltage gestures. The data from the microcontroller is passed to the voice module to match it with stored data to produce voice by the speaker and an LCD display for text output. This project helps in developing devices for Indian sign language which is really helpful since India has a very vast language diversity. It does not only capture wrist and finger movement but also elbow movement which increases accuracy. Even though this system was made for daily use by speech-impaired people, this is quite bulky which will make it difficult to be portable. It has only a few distinct outputs for each bent, like 8 voice outputs for eight gestures of the hand. They only captured one hand movement and they want to extend it to both hands with increasing the number of outputs produced.

In [28] using simple flex, tilt, and contact sensors they have developed a basic gesture recognition algorithm and converted American Sign Language(ASL) to text. They have developed an application that converts texts to gestures, and a translator which helps in two-way communication. The application will have an option that will allow the user to choose actions like either sign-to-text or text-to-sign. This project is made cost-effective with the use of only a flex sensor, an Arduino UNO board, a 3-Axis accelerometer to capture the wrist movement, and a glove for implementing these sensors. Initially, they faced many ambiguity problems but later they added contact sensors which helped in distinguishing the letter. System stability was low and Letters are less adaptive for the sensor’s threshold. They have a future idea of implementing software at the user end which will be easier to use as a translator.

In [29] they have developed an assistive tool that can be used by specially-abled people through the integration of both software and hardware. This paper mainly focuses on software that is helpful in running the interpreter at the user end. Hardware is made up of nine-axis motion tracking sensors which help to read the orientation of the hand and gather the input sign. The motion is captured by gloves and this signal is processed using a processing unit and mobile application which acts as an interpreter. The device is trained in a learning environment with the support of a backend server. Then the processing of the gesture descriptor stream from gloves is done by the interpreter to produce the output, in the form of audio and understandable text. Interpreters consist of algorithms that help in processing and correcting the input. Since the output is in loud audio format this device can be used to establish communication in public places. This paper targets only deaf people, they want to advance it to speech-impaired and physically disabled people like stroke patients during rehabilitation.In [30], Data is collected through data gloves in which 5 flex sensors are attached to it and processed in a microcontroller where a database of multiple gestures is stored. There are two parts: transmitter and receiver. At the receiver end, they have the option to change the mode to either Home-automation or speech generation. One of the advantages is that only one hand sign can be used either for a Gesture to Voice Synthesis Mode or to device control mode. It is difficult to be portable since it is implemented on a breadboard.

III. CONCLUSION

Here we have done a survey on the techniques, algorithms and components used for SL gesture detection. The survey reviewed the benefits of hardware-based gesture recognition systems over vision-based systems. Many proposed systems which used flex sensors and accelerometers are able to attain higher accuracy. Vision-based systems have used ML algorithms like CNN, ANN, K-nearest, and many more algorithms that could recognize many static gestures with more efficiency but for dynamic gestures, their efficiency is comparatively reduced. Flex sensor-based hand gloves are portable and also can give text and/or speech outputs in their preferred languages. Even hardware-based systems are required to have a predefined dataset but it will give more accurate results for both methods still and active gestures.

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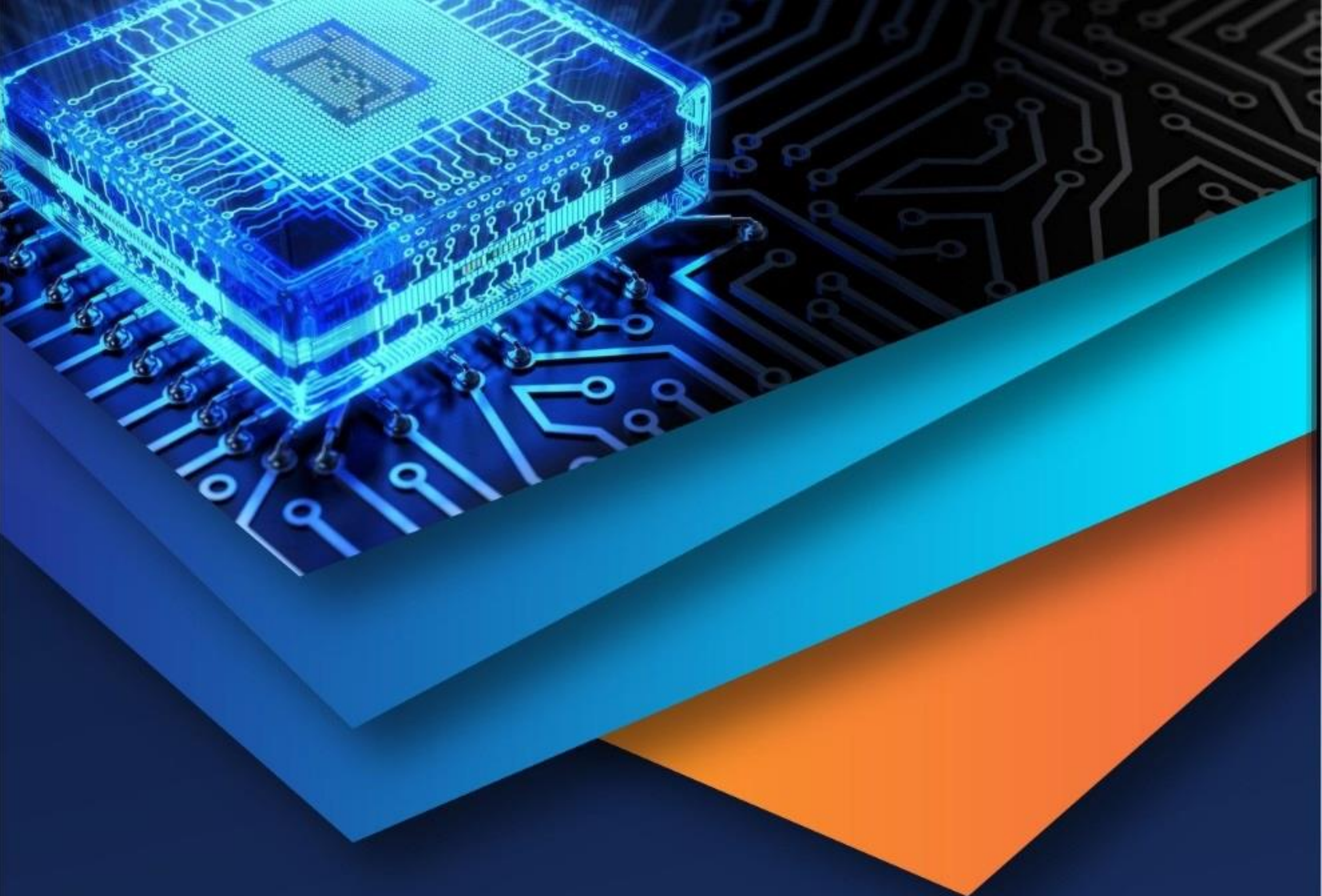

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