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A Glove Based Approach to Recognize Indian Sign Languages

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Abstract: ***Language is the first and foremost requirement for any human being in the world as communication would become impossible without its presence. Human beings with good hearing and speaking abilities would never find conversations difficult, whereas those with hearing and speaking impairments would rely on some special language mechanisms for making their conversations both simple and understandable. One such special mechanism is the so called Sign language. This language possesses a well-defined code gesture; a meaning would be incorporated in to the gesture to enable the persons involved in the communication to understand the essence of the conversation. In India, individuals with hearing impairment (dumb) make use of the Indian Sign Language (ISL) to communicate with others. Compared to the other natural languages with well defined grammar, syntax, phonetics, and morphology the Indian Sign Language has also been widely accepted all over the country. The quality and adequacy of the sign languages are comparatively lower than that of the other natural languages. Various techniques and mechanisms have been identified and incorporated in the communication realm of those with speaking and hearing impairments with an aim of achieving efficiency and adequacy with the advancements in the area of science and technology. Improvements in the sign languages would eventually reduce the communication gap. Interactions involving human beings and computers essentially make use of the glove based and vision based approaches for the purpose of illustrating the gestures appropriately. Compared to the vision based approach the glove based approach is quite expensive and hence difficult for everyday use. This work illustrates the vision based ideas incorporating a cost effective camera that essentially captures and analyses the signs of ISL and suitably converts the same to its corresponding text and speech formats.***

Index Terms: Indian sign language, Glove, Gesture, KNN

I. INTRODUCTION

Human beings with hearing and speaking impairments usually face a lot of difficulties even for obtaining their basic requirements as communication forms the backbone of human survival. Such difficulties would naturally corner that person and would make him feel low and isolated. This feeling would literally isolate him from the entire society thereby harming both his personal and professional life. Such effects would even trigger that person to take extreme decisions. One of the well known reliefs adopted for those with such impairments is the Sign Language; this is considered as the language of hearing for those with speaking disability incorporating the mechanisms of the advanced technologies. As per statistics it is seen that a total of around 360 millions of the world population have been identified with hearing and speaking impairments [6]. The percentage in India is around 2.78% of total population with speaking impairment (dumb) [4]. It is evident that those of them without such impairments are hardly aware of this sign language. Communication between an ordinary person and the one with impairments would usually incorporate a translator for the purpose of converting the expressions of the sign language to the other person's natural language and vice versa. Sign language recognition adopts two strategies in general, namely, the Glove based strategy and the vision based strategy. The glove based strategy makes use of flex sensors, the users here are insisted to make use of gloves essentially attached to the sensors. Users would usually find it heavy to carry. As far as this work is concerned the users need not rely on any sensors and gloves for their gestures. The components used in this approach is the webcam and the voice board, the gestures made by the person would be essentially captured by the webcam and would be suitably translated into their appropriate speech terms by means of the voice board. Wireless transmissions are usually preferred and hence the ZIGBEE protocol is adopted. With the help of this strategy a normal person can very well communicate with a dumb person. People with hearing impairments can also incorporate the webcam technique. The process here would be to first obtain the signs and then forward the same to the microcontrollers, which would convert the signs into text materials and display the same using the LCD display, followed by a speech board that would display the appropriate actions using the voice display.

II. LITERATURE REVIEW

Jinuk Kim et.al, extracts a sign language primitive (SLP) for sign recognition with the help of surface electromyography (SEMG) sensor and a motion sensor. Two parameters required for the construction of the sign language primitive is hand shape and motion direction vectors respectively. The function of the SLR is to understand the meaning of the language words, followed by which it would adopt four different steps to convert those words into an appropriate meaningful sentence. The attributes of the concerned signals can be analyzed by converting the raw data materials into usable materials by means of the data processing mechanism.

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The next step is to distinguish the concerned sentences as several words; this can be done by implementing the segmentation strategy which appears to be the most important task of the entire process. Based on the vectors the primitives can be classified. Classification of primitives is essential for estimating the words of the sign language. The final step is to suitably extract the words by combining the two classified primitives. This work exhibits the production of 12 hand shape primitive essentially made from the hand-shape vectors and 6 movements primitive from the motion direction vectors. The load inhibited in the sign language recognition is considered essential; this can be effectively minimized by the planned primitives. Performing various comparisons in the sign language can result in the extraction of the hand shape and movements. The SLP introduced in this work has been extracted in 5 different sentences comprising of 12 words continuously.

Fausto Acuna et.al, analyses the communication pattern between the children with speaking disability and the humanoid robots. Play cards are adopted here, where the concerned child would portray a play card with a specific sign to the robot, after viewing the card the robot would narrate a story relevant to the sign in the card. The components incorporated in this process include a robot, a personal computer and an arduino microcontroller, the pc and the robot are eventually controlled here by the controller. Another model that was considered here is the torso model, the modifications and constructions of this model was essentially done by the CAD/CAM/CAE tools. Evaluation of this humanoid was performed by the children of an Educational Specialized Unit Cotopaxi, where two different teaching approaches were considered, one was the conventional approach where a teacher would teach the essentials to the students. Essentials here correspond to the interpretation of the signs by the students. The next approach incorporated a robot which would portray the signs as instructed by the system, here the child would observe the actions and would self educate itself. This method was found to minimize the learning times to around 25% when compared with that of the conventional systems.

Sergio Bessa Carneiro et.al, made use of sensors called as the kinect sensors, essentially meant for determining signs. The fundamental task performed here was the extraction of skeletal structures, for this purpose the method adopted three different sensors. The sensors used here include the RGB color sensor, the IR emitter and the IR depth sensor. The RGB sensor is used for capturing the colors, the IR emitter and the IR depth sensor are incorporated for obtaining the information's related to the distance between the object and the sensor, simply termed as the depth information. The strategy adopted here is to subtract the pixels at the background and to identify the hand signs suitably. Presence of noise and sharp edges is another common problem here, this can alleviated by introducing the mean filters. Eigen classifier is one of the well known algorithms used for the classification purposes, this is then incorporated into the system for the matching task which is to be done with the predefined template, followed by which the output in the text format would be displayed. Gesture recognition demonstrates the use of kinect sensors. In general applications and features have been developed by this strategy for the Brazilian Sign Language, which relies mainly on the static hand gestures considering voice generation as its major element with the help of the kinect sensors. This is a visual type of language as its meaning can be captured only by observing the hand movements and gestures hence vision is mandatory. One of the prime factors of consideration here is the lighting factor as this can greatly influence the identification of the gestures. Hence it becomes mandatory to check into the lighting conditions prior to the process and thereby apply some normalization in the prevailing condition so as to make the environment conducive for the identification procedure. Samples of specific properties were considered here, application of the above mentioned procedures on those samples revealed 89% of accuracy. One of the major drawbacks of this strategy is the cost incurred in the sensors, which is considerably higher than that of the other normal sensors.

Sushmita Mitra et.al analyses gesture identifications in a much more detailed manner, here movement of the person on the whole is considered, where gestures related to hands, arms, face, head, and/or body is taken into account. Design of a human-computer interface is not an easy task, as it involves varies features to be considered both within and outside the surface. Designing an efficient and effective system is the foremost requirement for implementing a new invention. Only an efficient system can produce the desired results of the invention. Gesture identification today is considered as an essential procedure in various applications such as in the medical field, in virtual realities etc. This paper deals with the gesture identification procedure involving hand and facial expressions. From the conventional gesture identification procedures to the current identification procedure various strategies have been adopted, this survey paper would essentially discuss on the same. Physical movements are usually considered as gestures, this would include movements of the fingers, hands, arms, head, face, or body with the aim of: 1) portraying meaningful or useful messages or 2) communicating with the outside world. Any human movement would convey a message; identification of the same is the aim of the adopted technique. Gestures may usually include both static and dynamic movements, when a person stands in a place firmly and portrays his messages through hand and face expressions then it falls under the static gesture type. On the other hand messages portrayed by movements on the whole would fall into the dynamic gesture type. Sign languages would sometimes incorporate both the static and the dynamic type of gestures to convey its messages. Hand, arm and face gestures are considered as the basic and conventional type of gestures. Various algorithms have been developed for the purpose of identifying such gestures. Hidden Markov Model (HMM), Finite State Machine (FSM) and KNN algorithms are some of them.

Sachin Bhat et.al involves the use of sensing gloves for the gesture identification task. Sensing glove comprises of various components, the first component is the sensor, the next portion includes ten flex sensors, an accelerometer is present in the system, finally it includes a processing system for the data and communication related processing's. Twisting of fingers would intrude a change in the sensors that are constantly located at specified points. A small board is adopted for the purpose of configuring the accelerometer and the processing system. This setup can be tied around the wrist of the concerned person; it is a powerless system in general. The initial step would be to identify the hand position. The sign language is classified into three classes based on the hand posture, posture may be considered in terms of directions, preferably the vertical and horizontal directions together with the motion of the gestures. Classification procedure focuses on the alphabets of the sign language. Out of the three classes if the concerned gesture belongs to the first or the second class then the letter identification here would take place with the help of a matching algorithm. On the other hand if it is found to belong to the third class then a special algorithm called as the dynamic time warping algorithm (DTW) can be used in the identification process. The processing unit incorporated in the system would process the data contents from the sensors and then would forward the same to the personal computer via the USB ports.

Matheesha Fernando et.al analyzed the possibilities of identifying the signs that are meant to be translated into their respective text and speech formats with the assistance of an appearance oriented approach incorporating a low cost webcam. Beginners usually find the sign language difficult; this strategy would make it easier for them. The research process here involves in the determination of the postures accompanied by the identification of the related interactions between the user and the machine. In this procedure the hand gestures would be captured and stored by the webcam, following which the recorded images would be divided into frames of suitable sizes, processing is done on the individual frames rather than on the entire image. By means of setting up a controlled background with appropriate lighting conditions an accuracy percentage of around 76 can be obtained by this procedure. Preprocessing would always encounter immediately after capturing the entire image. An image on the whole is not required for the processing procedures, therefore only the required relevant areas of the image would be filtered out, further the noise contents in the image can be separated by means of adopting the dilation and erosion functions. The ultimate aim of the research is to identify a best algorithm for sign language posture recognition.

Purva A. Nanivadekar et.al, A new sign language with special features has been designed. Any language would require a database hence the initial procedure is to create a suitable one. Databases can be prepared by means of capturing the recorded videos, containing the hand gestures performed by various signers. Tracking of hand gestures and further segmenting the same would be the next subsequent procedures to be adopted. Tracking procedure would essentially recover the relevant features required by the language from a particular gesture. Quality of the tracking and the segmentation procedures can be enhanced by incorporating a three step algorithm. The responsibility of this algorithm is to track the motions and to identify the edges and the skin color. The first phase of this method is to obtain the image. This can be achieved by incorporating a digital camera. A digital camera essentially records and renders the images as and when required. Once the images are recorded there arises a need for preprocessing the images. These videos would be later transformed into frames of suitable sizes. Naming of these frames is done sequentially. Two adjacent frames are considered here, the variation among these two would give rise to the tracking ability. Once the tracking process is completed the next step would be to obtain specific boundaries of the concerned hand movements prescribed conditions would be displayed.

Noor Tubaiz et.al, A wide variety of hand motions and facial expressions referring to different words were identified, a collection of these words constituted the sign language. This type of communication usually involved people with hearing impairments. This paper introduces a new sign language based on the Arabic interpretation pattern meant for aligning the data contents in a sequential order. 80 different words were selected and organized in various patterns into order to produce meaningful sentences, 40 such sentences were framed. DG5-VHand data gloves were used for obtaining the hand movements in the dataset. A camera was incorporated for the purpose of Data labeling which was performed in such a way so as to coordinate with the relevant hand motions. For the purpose of classification a Modified k-Nearest Neighbor (MKNN) approach was used. In order to achieve perfect classifications MKNN made use of the context of feature vectors. This method was found to achieve an accuracy rate of 98.9% in terms of sentence recognitions. The strategies adopted in the vision based procedures were compared with this method using the same set of sentences. This proposed method was found to achieve better accuracy rates in terms of classification.

III. EXISTING SYSTEM

Image processing and data gloves are considered to be the two topmost research areas in sign language. As far as the image processing techniques are concerned, a simple camera module is sufficient for capturing and storing the relevant images and videos. The vision based sign language makes use of various algorithms for the purpose of identifying the inbuilt data in the static images, only after the identification process suitable and appropriate sentences with exact meanings can be displayed. For this purpose the vision based approach makes use of the following algorithms, namely, the Hidden Markov Mode (HMM), Artificial Neural Networks (ANN) and Sum of Absolute Difference (SAD) Algorithm for the purpose of extracting the images and thereby eliminating the unintended background noise. The interactions or conversations between the human beings and the machine interfaces can take place through keyboards, mouse and remote infrared controls.

The glove based method incorporates a sensor glove integrated with around ten flex sensors and one accelerometer. Sensors are used for the purpose of determining the curvature of the fingers and the accelerometer is used for the purpose of detecting hand movements. As seen earlier hand movements would usually determine the alphabets of the corresponding sign language. Based on this determination classification is performed, three different categories named as 1, 2 and 3 is found to be the result of the classification process. The initial step of this procedure is to identify the hand movement. Matching algorithms would be incorporated if the posture is found to belong to either category 1 or category 2. This introduction of the algorithm is to identify the letters. A dynamic time wrapping algorithm would be introduced if postures belong to category 3. Automatic gesture identification is the specialty of this technique. Sensors utilized in this system are found to be expensive; if a single sensor encounters damage or fails to produce the desired results then the entire system would crash. As sensors are considered as the major source of components in this system, meant for effectively identifying the hand postures. Another drawback is the continuous dependence on the glove materials, whenever a user wants to express a thought or an opinion then wearing that gloves would become mandatory. Hence the vision based approach can be utilized for sign language recognition.

Fig. 1 Existing system

Figure 1 illustrates the existing system. A person with speaking disability is considered here, the posture exhibited by the person is eventually captured by the webcam. Once the capturing is done, the relevant signs are subjected to a preprocessing procedure, for this purpose various techniques such as that of the HOG (Histogram Oriented Gradient) and LBP (Local Binary Pattern) mechanisms are incorporated. After the preprocessing step the signs would be compared with the signs in the template, if a match is found then those signs would be marked as identified signs, it is these signs that would be finally transformed into its matching text.

IV. PROPOSED SYSTEM

Fig. 2 Proposed systems

Figure 2 illustrates the proposed system. The proposed system's objective is to transform the set of identified signs into text and speech outputs correspondingly. As usual the signs would be obtained and recorded by a webcam, after which the signs would be subjected to various levels of preprocessing procedures. The mechanism adopted in the preprocessing procedure is to remove the skin pixels and perform suitable morphological filtering. The foreground images embedded inside the background images are usually required, in order to separate out those images skin pixel extraction is performed. One of the common problems in images is the presence of noise factors; functions such as erosion and dilation performed by the Morphological filtering process effectively remove those noise factors. From the obtained images, edge pixels are extracted, this is done by the segmentation process. Another function performed by the segmentation process is the extraction of signs from their backgrounds. Signs should be extracted along with their characteristics in order to provide relevant meanings, this extraction can be done after the segmentation of the corresponding image and feature extraction procedure helps in this extraction process. The complexities involved in the pixel evaluation process can be considerably reduced by adopting the feature extraction strategy; another observed benefit of this strategy is the removal of appropriate gestures of the concerned sign. Two features adopted for this aspect are the Histogram Oriented Gradient (HOG) and the Local Binary Pattern (LBP). These features assist in the matching processes performed among the obtained signs and those present in the template. Those signs perfectly resembling the original signs would be thus marked as the identified signs.A zigbee transmitter is used here, to which the identified signs are forwarded. The transmission range of the zigbee transmitter is found to be at a range of around 100-150m radius at a high transfer speed. A zigbee receiver o the other side would suitably receive the signs from the transmitter. The LCD display and the voice boards are effectively controlled by a microcontroller. Transmission of signs to the display unit is done by the microcontroller.

V. SYSTEM DESIGN

Figure 3 illustrates the architecture of the proposed system

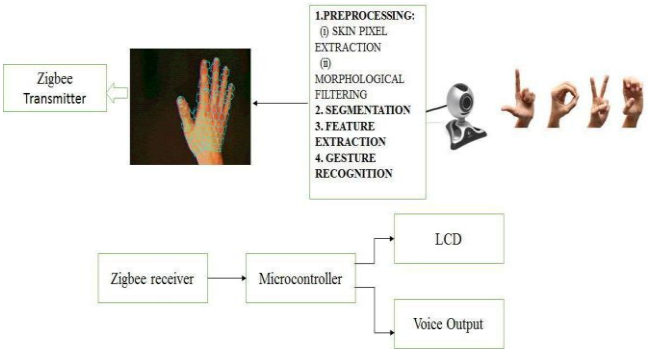

Fig. 3 Architecture Diagram

Various signs received by the webcam are subjected to different levels of preprocessing. In the initial preprocessing procedure the skin pixels are extracted and the signs are morphologically filtered.

The skin pixel removal process effectively recovers the foreground image from its background. Further the noise sources are removed by the Morphological filtering process. The next encountering step would be the segmentation procedure, which is done to remove the edge pixels.

With the help of the feature extraction step the features of the concerned image is removed after the segmentation of the image. The task of minimizing the complexity of pixel computation and removal of exact gestures is performed by the Feature extraction procedure, for this purpose it adopts two features, they are the Histogram Oriented Gradient (HOG) and the Local Binary Pattern features. By this way the exact matching signs are thus identified and termed as the recognized signs.

A specialized zigbee transmitter receives these recognized signs. The transmitter is thus found to exhibit a transmission range of 100-150m; high forwarding speed is its additional ability. The zigbee receiver is incorporated for the purpose of receiving the processed signs by the transmitter. The output display units such as the LCD and the voice boards are maintained and operated by a microcontroller.

VI. METHODOLOGIES

IMAGE ACQUISITION AND PREPROCESSING MODULE

Flow diagram representing the image acquisition and preprocessing modules:

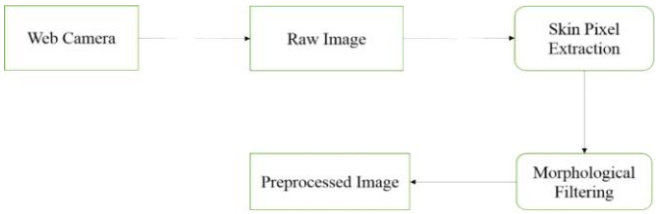

Fig.4 Image Acquisitions and Preprocessing Module

Figure 4 represents the image acquirement and the preprocessing modules. Image processing mechanisms are usually employed for the purpose of enhancing the quality of the images. Once the signs are captured by the webcam, preprocessing mechanisms would be applied on those signs. The hand postures must be confined to small spaces in order to make it appear accurate; the next step would be to remove the image from its concerned background. The above mentioned confinements would make the detection process easier. One of the features possessing advantages in terms of computational complexity and freedom from hand orientations is the color feature. The removal strategies adopted here essentially make use of the rule based model of the skin-color pixels distribution.

Two different color pigments were selected here, they are the red and blue pigments, the difference between them was observed to be larger than 25 in terms of the skin pixels, whereas the original difference between them was observed to be larger than 20. For the purpose of obtaining clear and perfect hand images morphological conversions were considered. The functions of the morphological converter include erosion, dilation and removal of noise, other specialized tasks would be to separate out individual components and to integrate various components of an image. The skin recognized image was processed with both dilation and erosion to get a clear image. Dilation and erosion functions tend to produce clear images.

FEATURE EXTRACTION MODULE

Figure 5 illustrates the Flow diagram for the Feature Extraction module:

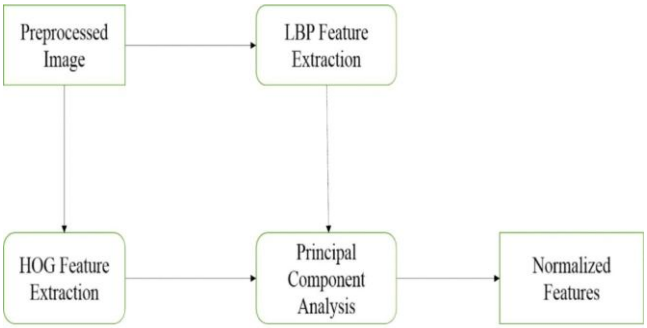

Fig.5 Feature Extraction Modules

Figure 5.2 illustrates the Flow diagram for the Feature Extraction module. Sign language adopts the Feature extraction procedure, it is considered as one of the most essential procedure, classifiers used in this technique require inputs in the form of feature vectors and it is in this step that the feature vectors are produced. Preprocessing procedures on the images gives rise to the Histogram Oriented Gradient (HOG) and Local Binary Pattern (LBP) features. Feature removal can result in the establishment of parameters, like palm position, joint angles etc. Variations in the lighting conditions should not appear as a hindrance in the accurate identification of the shapes and sizes of the concerned objects in a particular audio/video module. Pixels make up an object. Properties of the pixels that make up an object must be determined accurately in order to recognize the object exactly. Such properties of the pixels can be obtained by incorporating the following techniques: wavelet decomposition, Haar wavelets, Haar-like features, texture features, orientation histogram, and scale invariant feature transform Fourier descriptors etc.

In certain places where the dimensions are reduced by means of the Principal Component Analysis (PCA) technique the ROI are used as the feature vector. Training to the classifier is provided by the feature vectors obtained from the feature extraction methods.

CLASSIFICATION AND GESTURE RECOGNITION MODULE

Flow diagram for the Classification and Gesture Recognition module:

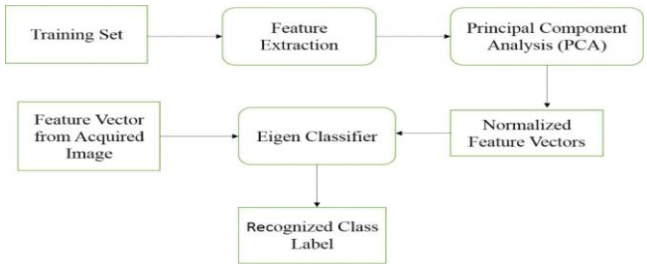

Fig.6 Classification and Gesture Recognition Module

In Figure 6 illustrates the Classification and the gesture recognition module. In order to achieve enhanced accuracy percentage the Classification algorithms usually rely on the preprocessing stages. Camera position and its distance from the concerned object usually decide the exact shape and meaning of the proposed gesture, this also takes into account the distance of the concerned signer from the camera. Real time performances depend on several other additional features when compared with that of the non real time performances, one such is the constant balance between the accuracy and the computational complexities. Signs must be classified into various classes based on their properties; a classifier performs this task efficiently. One of the best known classifier adopted for this purpose is the Eigen Classifier. A special type of dataset called as the Eigenvector transform analysis dataset which is considered to be a collection of various observations made on the classification procedures. Feature vectors from the dataset can be utilized for the purpose of training the classifier. In this way the classifier would be in a position to identify the class to which the sign belongs by means of proper training. After this identification procedure the corresponding outputs would be displayed. The inputs used for the test purposes can be either an image or a video. Some of the commonly used classifiers are listed below, Hidden Markov Models (HMM), Artificial Neural Networks (ANN), Multiclass Support Vector Machines (SVM), Fuzzy systems, K Nearest Neighbor (KNN) etc. The recognition rate of a classifier would portray its efficiency.

WIRELESS TRANSMISSION MODULE

Recognized signs are usually forwarded from the personal computer to the microcontroller, this forwarding mechanism is controlled by the ZigBee wireless transmission standard. ZigBee is an IEEE 802.15.4 standard, this is considered to be a high-level communication protocol that is incorporated for the purpose of generating personal area networks encompassing small, low-power digital radios, such as those adopted for the home automation mechanisms, medical device data collection, and other low-power low-bandwidth requirements, specifically designed for small scale projects which rely on wireless connections. Certain limitation such as its low power consumption, with respect to the environmental conditions limits its transmission range to 10 –100 meters line-of-sight. These devices are capable of forwarding data packets to longer distances when incorporated in a mesh network. Networks possessing low data rate applications rely on zigbee so as to maintain its battery life and ensure security. 250 Kbits/sec is the defined data rate of ZigBee. It is specifically suitable for transmissions incorporating alternate routing mechanisms. The other end of the microcontroller is connected to the ZigBee transmitter. To another microcontroller the ZigBee receiver is connected. Figure 7 portrays the wireless transmission module.

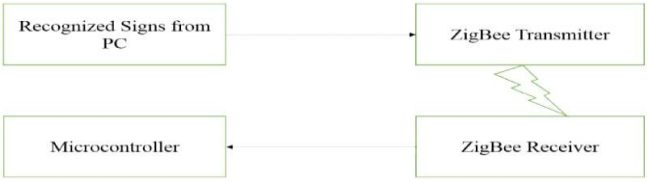

Fig.7 Wireless Transmission Modules

TEXT AND AUDIO PLAYBACK MODULE

The obtained signs are forwarded to the microcontroller from the Zigbee receiver. The display units such as the LCD and voice boards are connected to the microcontroller. The output in the form of recognized signs would then be displayed in the output unit, namely the LCD display and the speech contents would be played using the voice board.

In Figure 8 illustrates the Text and audio playback module.

Fig.8 Text and Audio Playback Module

VII. RESULTS AND DISCUSSION

Image processing and data gloves are considered to be the two topmost research areas in sign language. As far as the image processing techniques

PREPROCESSING

The sign obtained by the webcam is preprocessed in its initial raw stage. Confinement of the image takes happens in a small place, after which the foreground image would be extracted from its background. Morphological filtering mechanisms are adopted for the extraction purpose, where additional features such as dilation and erosion mechanisms would help in eliminating the noise sources completely. The results of preprocessing shown in Figure 9.

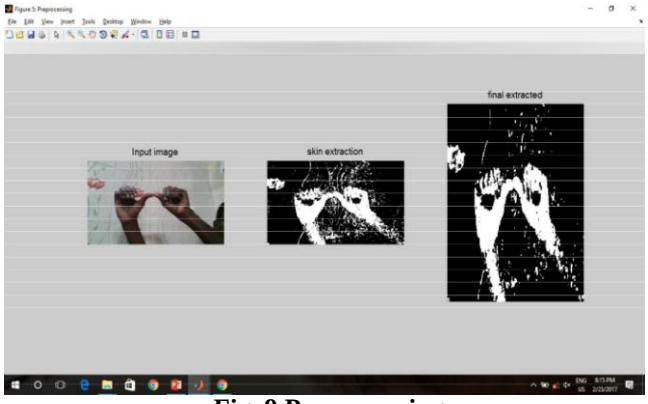

Fig. 9 Preprocessing

CLASSIFICATION AND RECOGNITION

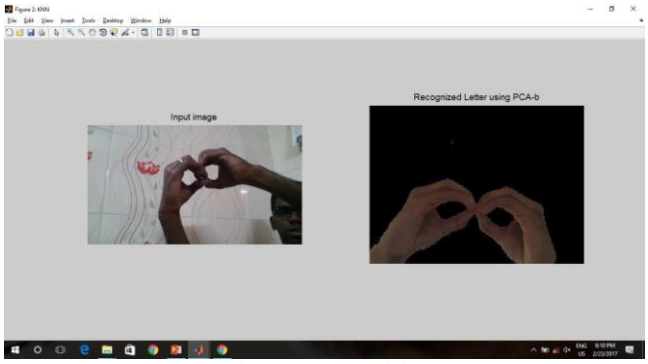

Fig.10 Recognition

The preprocessing stage is observed as the platform for deciding the accuracy levels by the classification algorithm. Various factors such as the distance of the signer from the webcam, position of the camera etc, decides the recognition accuracy of the concerned gesture. For any real time performance a balance between the accuracy and the computational complexity parameters must be maintained. The images obtained from the zigbee receiver is compared with the images in the template, only after appropriate preprocessing procedures the images are forwarded from the transmitter, the images thus obtained must possess similarities corresponding to the recognized images. The result of classification and recognition is shown in Figure10.

VIII. CONCLUSION

The Indian sign language recognition system is most useful to the people to make comfortable communication which is similar like normal people. The proposed system is developed based on glove based approach. This system is designed to support dumb people. Normal peoples unaware the Indian sign languages, so the same has been implemented and used it for gesture recognition. The accuracy of the system is achieved over 98% when comparing with all other exiting methods. In future it is planning to adopt soft computing algorithm to improve the performance of the detection.

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