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Sign Language Recognition Using Leap Motion Sensor

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Abstract - *A sign language recognition system is carried to bring the speech and the hearing impaired community closer to more regular and convenient forms of communication. Thus, this system requires recognizing the gesture from sign language and convert them to form that are understandable by hearing it. Sign languages are the only means to communicate with deaf and dumb people. Without this, they become isolated from the society. In this paper, we have reviewed about the need of sign language, myths about it, different types of sign languages, followed by steps required in a sign recognition system and different types of modeling by which we can achieve it. We have also discussed different types of techniques for sign language recognition system. Moreover, we are proposing sign language recognition using leap motion sensor which is more portable and economical and will overcome the limitations of previous systems with advantages of delivering accurate results and real-time response capability.*

***Key Words*: Sign Language, Leap Sensor, Kinect Sensor, ANN, HMM, Classification, Euclidian Distance.**

1. INTRODUCTION

Human beings interact with each other to convey their ideas, thoughts and experiences to people around them. But unfortunately this is not the case for deaf-mute people. They are not able to communicate with normal people properly and get isolated from society. This gap can be aided by using sign language. Sign language helps the impaired communicate with others. A sign language is composed of various gestures formed by different hand shapes, movements and orientation of hands or body, or facial expressions.it is possible only for those who have undergone special training to understand the language. However, the normal person cannot understand and never learns sign language .So a recognition system is must to express the words of the disabled to normal person and communication can take place between them. Sign language is a visual language consisting of 3 major components:

1. Finger–spelling: used to spell words letter by letter.
2. Word level sign vocabulary.
3. Non manual features: facial expressions, tongue, mouth, body positions.

Signs are mostly obtained using hand signs. There are 2 types of hand signs:

• **Static**: this includes only poses and configurations. The static gestures are called “hand postures”. Posture is a specific combination of hand position, orientation, and flexion observed at some instance of time. Posture or static gestures are not time varying signals, so they can be completely analyzed using only one or a set of images of the hand in a specific time.

• **Dynamic**: Dynamic gesture is a sequence of postures connected by motions over a short time span. A gesture can be thought of as a sequence of postures. In the video signals, the individual frames define the postures and the video sequence defines the gesture.

1.1 Myths about Sign Language

There are many myths about sign Languages that it is universal, all sign languages have same grammatical structure and people understand other countries sign language but the real facts are-

- Sign languages in each country have its own dialect. Many well-known sign languages are-
  - American Sign Language (ASL)
  - British Sign Language (BSL)
  - Spanish Sign Language
  - Israeli Sign Language
  - Indian Sign Language (ISL)
  - Pakistani Sign language
  - South Korean Sign Language
  - Taiwan Sign Language
  - Turkish Sign language
  - Arabic Sign Language and so on
- Sign language dialects of each country will differ from region to region.
- Sign languages will not be completely understood or clear to foreigners who use sign language.

2. Trends in Sign Recognition System

The recognition of sign language appeared almost 20 years behind speech recognition. Also, sign language processing is not yet completely explored. Understanding sign language requires better linguistic knowledge, but until now there are no general rules that define the signing from a linguistic point of view. The first scientific publications in the field of sign language recognition emerged in the beginning of the 90s. Most applications presented in previous works do not operate in real-time and need up to 20 seconds after the sign production to complete the processing. There is a scarcity of published work which provides details on camera hardware and resolution. Generally, most proposed approaches suggest the use of professional hardware, optimal camera placement, low noise and high resolution. Magnetic or optical markers on hands and face facilitate the determination of manual configuration and facial expression. However, this method is restrictive and unnatural for the user. Furthermore, data gloves, which measure the flexion of the finger joints, are undesirable for practical systems because of their high cost. Some existing systems process continuous production of signs but their vocabulary is not large. To improve the recognition rate, the exploitation of grammar and context is necessary.

3. Steps of Gesture Recognition

Different trials have been performed towards building a reliable sign language translator but most of them do not exceed the lab boundary. In general, The gesture recognition system for sign language recognizer consists of the following described in fig 1

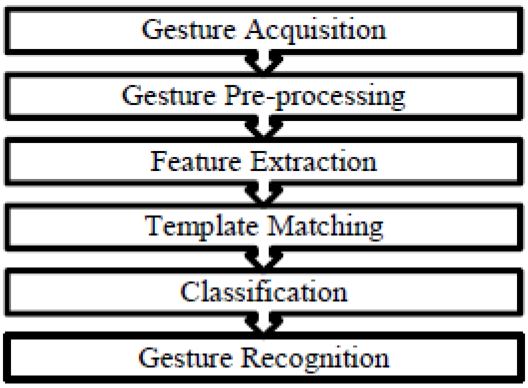

Fig -1: Steps in generalized gesture recognition system

- **Gesture Acquisition Block:** It is a sensing device which is responsible for capturing the gesture. In case of vision based approaches it is a camera and in case of sensor based approaches it is a data glove, or motion tracker or marker.
- **Gesture Pre-processing Block:** This block is mainly responsible to make gestural information useful information in feature extraction point of view. This block will enhance the useful data and get rid of unwanted data.
- **Feature Extraction Block:** It is the block that collects all the feature components of the gesture and stores them in a code vector.
- **Template Matching:** In this block, the code vector is compared with the existing codebook vectors that are reference vectors in database.
- **Classification:** Based on the output of template matching, a classification of gestures will be done. This block will classify the gesture as per the nearest match found in template matching.
- **Gesture Recognition Block**: The terminal block will recognize the gesture completely and produce an appropriate output.

4. Types of Modelling

Modeling refers to using models- physical, mathematical or otherwise logical representation of a system, entity, phenomenon, or process as a basis for simulations. There are 2 types of modeling present.

I. 2D Modeling

In this, 2D image data is captured from a single camera's point of view. Image segmentation and manipulation algorithms are used to extract information from the image. This information is used to classify the gesture. This has led to development of colored markers or colored gloves on hands which directly record the gesture and ignore the background. 2D modeling techniques rely on computer vision algorithms to extract information of a gesture, rather than using specialized equipment. ***The wearing of extra equipment and restricting the background of the video are widely acknowledged limitations of computer vision based techniques.***

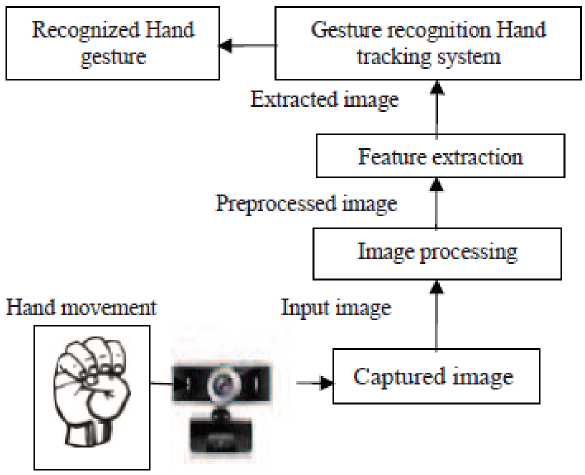

Fig -2: vision based system based on 2D modeling

II. 3D Modeling

3D modeling entails capturing a gesture or sign in a three dimensional space. Sensor based gesture recognition system which uses flex sensors for sensing the hand movements. Flex sensor changes its resistance value depending upon the amount of bend applied on the sensor. By measuring the resistance, we determine how much the sensor is being bent. Accelerometer used within the gesture recognition system is employed as a tilt sensing element, used for finding the hand movement and orientation. In this system the deaf-mute people wear the gloves (with the resistors and sensors attached to it) to perform hand gesture. First the system will convert the gesture to the corresponding text and then the speech is synthesized for the corresponding text by using the text-to speech synthesizer. The system consumes very low power and it is portable. The sensor glove design along with the tactile sensor helps in reducing the ambiguity in gestures and shows improved accuracy.***but it is very costly and flex sensors often break after a period of time***

4.2 Microsoft Kinect Sensor

Microsoft released Kinect in November 2010, it was mainly targeted at consumers owning a Microsoft Xbox 360 console. However, developers found a way to develop it for the deaf-mute people. The device itself features an RGB camera, a depth sensor and a multi-array microphone, and is capable of tracking the users' body movement. It was incorporated into many sign language systems and gave better results than Traditional single cameras having drawbacks on environmental conditions.***However, it did not support hand shape recognition and since sign language generally features different hand-shapes, similar signs cannot be distinguished. Also using depth cameras to generate depth map can't give the signer the privilege of camera pose-invariance; the user must stand against the camera in a predetermined position. Thus, the system was unpractical.***

Fig -3: Kinect Sensor recognition

5. TECHNIQUES USED FOR SIGN LANGUAGE RECOGNITION

Different image processing, classification and machine learning techniques are applied for Sign language recognition. Hidden Marcov Model (HMM) is a statistical model in which the system is modeled as Marcov process with unobserved states. A Marcov process assumes the Marcov property that post events are only dependent on the current state. One of assumptions is, the system is stationary where transition states do not depend on time. Many recognition systems were developed using this model ,mostly glove based. Artificial Neural Network (ANN) is an adaptive system that teaches itself to perform a function from the data sets. It can be considered as a modeling for biological neural system. Errors from the actual and desired response are used to adapt the network's behavior through a set of iterations.

6. PROPOSED WORK

Traditional gesture recognition system consisted of Cyber Glove and two sensors on each wrist with a switch on the user's left hand to help the system identify the start of a gesture. This system was less accurate, and had significant problems. It was only accurate with a range of simple gestures, but was unable to recognize complex gestures. Further systems developed also had issues. The Microsoft Kinect platform was launched in 2010 with the ability to detect motions, and a software development kit was released 2011.Several projects have explored the use of the Kinect for sign language recognition, stating that system can recognize broad gestures and was not capable of recognizing smaller hand gestures. Moreover, Tracking and recognition must be handled as fast as possible, preferably at the same rate as images are displayed or obtained. Otherwise, the user could be easily confused or irritated and would not know whether he or she has already initiated an action. Previous developed systems suffered from the "controlled- environment" constraints also. All these limitations including the cost of hardware will be overcome by using leap motion sensor.

We are proposing sign language recognition using leap motion sensor. The palm-sized Leap Motion sensor provides a much more portable and economical solution than Cyber glove or Microsoft Kinect used in existing studies. Leap Motion controller is a compact and affordable commercialized sensor for hand and finger movements in 3D space of approximately 8 cubic feet above the device. The frame rate of data transmission is set at 15 frames per second in this study. So it's pretty fast and responsive. The controller comes with APIs supported by the maker. Via the API, the hand and finger data can be sent to user designed programs to use the sensor as an alternative computer-human interface. The best thing about it is that one can obtain features for fingers from the API. So, more accurate results can be obtained. The API recognizes one hand with five digits. This contrasts with other available 3D sensory input devices, such as Microsoft Kinect - where sensory data is returned in a raw format, which must then be cleaned up and interpreted. The benefit of strong API preprocessing is that error reduction can be abstracted away from client applications meaning client applications can be built faster and with consistently accurate data. The controller is also capable of tracking very small movements, another essential capacity for accurate sign language recognition.

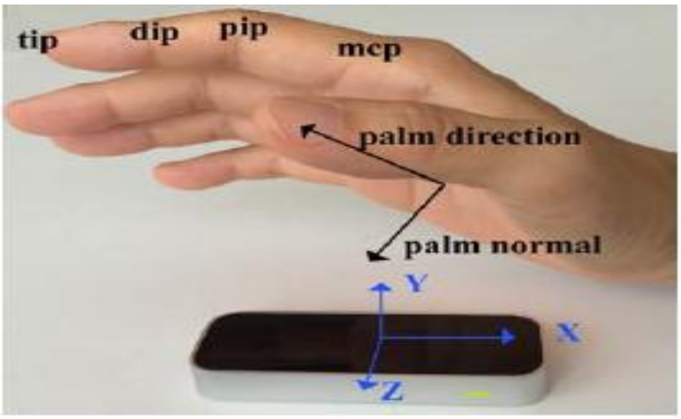

Fig -4: Leap Motion sensor measuring 3D coordinates of hand

7. CONCLUSIONS

Thus we conclude that Leap Motion Sensor will overcome the limitations of previous systems and will be an alternative to low cost hardware and real-time response property guaranteeing the system translation accuracy under different environmental factors.

8. FUTURE SCOPE

The future scope includes usage of GPUs instead of CPUs for faster processing of the signs. Mouth, body gestures and facial expressions may also be considered. Leap motion only considers static images for gesture recognition, dynamic images may be also be considered in future.

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