
HAND GESTURE RECOGNITION

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Abstract

In the growing world of technology, communication plays a major role in conveying ideas and information to one another. However, in today's smart and automated world, more and more emphasis is being placed on non-verbal communication rather than the verbal one. This is because non-verbal communication in its own way helps to interpret things better. Nonverbal communication encompasses numerous modes of expression. This includes gestures, eye contact, touch, physiological responses and manner of movement. Of all the non-verbal communications, gesture, is one of the most easiest and interesting way of communicating ideas to one another. The mere actions, hand movements and/or expressions have so much to express.

Gesture-Based interaction is being used in every field today but not in the education domain. This paper explains what is Gesture-Based Interaction and explains the Gesture Recognition Technology in detail. It also puts an emphasis on how Gesture-Based Interaction can be used in the field of education and thus in literal sense make it interesting. To demonstrate the same, we have created an android application to explain the use of gestures in android. Two supporting diagrams are also included which illustrate the functioning of gestures in android. The diagrams explain the flow of the gesture based application as well as it illustrates the gesture detection mechanism of android. This paper also proposes the creation of an application to find which gesture-based interaction can be used by the verbally impaired.

Key words- Kinesics, Gesture Detection, Gesture Recognition, Gesture Correctness

INTRODUCTION

As it is rightly said, 'Actions speak louder than words', gestures in its own way can have a catastrophic impact on people. An appropriate Gesture Recognition technique is thus required so as to interpret gestures properly and correctly. Gesture Recognition is one of the most advanced techniques in augmented reality based applications too. This is because, apart from its simplicity, gestures have an ease in understanding and interpreting what a gesture is actually meant to be. Gesture Recognition can have a wide impact and implications in the context of technology too. Various Gesture Recognition techniques and tools have also been implemented, yet, there is much more still left to reinvent in the same. Gesture Recognition is the next big thing in technology. Its wide implementation in medicines, automobiles and industries will be seen in the near future.

In almost every field, the implications of gesture based techniques has been seen. However, Gesture Recognition

techniques is not widely used in the field of education. Owing to its technical advances, if gesture recognition techniques are used in education field, it will encompass more and more participation of students in schools, colleges etc. The interactive techniques of gesture based interaction in its own way will increase the participation of students in classrooms and lectures.

Gesture cannot be termed as a mere action, it is much more than that. A gesture can sum up all the verbal communication in its own way. A gesture based system is something which is not bizarre these days. Owing to the advances in computer science, a gesture based recognition system has been developed widely. Such systems work on the concept of 'Kinesics'. Kinesics was first used in 1952 by a person named Ray Birdwhistell who was an anthropologist by profession. He wished to study how people communicate through postures and gestures. He was a pioneer in the study of non-verbal communication. Kinesics is the scientific study of body

movement involved in communication. This includes gestures in its major forms. Kinesics are used so as to convey special meaning that are interpretable. Gestures is a non-verbal behavior related to movement of any part of the body or the body as a whole. For Gesture based systems- Both 'Gesture Detection' and 'Recognition', along with 'correctness' is very important.. Gesture Based systems include the following-

1. Gesture Detection.
2. Gesture Segmentation.
3. Gesture Prediction & Recognition.

Systems present these days are able to provide a gesture based interaction system. However, an important criteria in this aspect is the number of gestures that a given gesture recognition system is able to recognize accurately.

Thus, the focus should be on how the gesture based interaction techniques can be used in the field of education. However for this, first we need to understand how the gesture based interaction systems work. A gesture recognition system must first detect the gesture. Once the gesture is detected only then can it be processed in order for it to be recognized.

GESTURE CHARACTERIZATION

In order for the gestures to be recognized, they are characterized into various types. Gestures mainly involves communicating via body , arms ,eyes , facial expressions and moreover are hands which includes fingers mainly. Kinesics which are used to convey specific meaning can also be misinterpreted. In order to avoid misinterpretation it is very important to create awareness of the meanings of the different kinesics movements. Awareness of the meanings of these various ways of Kinesics movements was thus considered a very important aspect of gesture recognition.

Two Professors, Paul Ekman and his colleague Wallace V Friesen did a study of Kinesics and derived onto the conclusion that they can be categorized into five types

- 1) Emblems.
- 2) Illustrators.
- 3) Affective Displays.
- 4) Regulators.
- 5) Adaptors.

Emblems : Emblems are easy to understand gestures which are used in context to a particular thing. Though they are non-verbal signals they can be used in the context of verbal communication. Emblems are considered to be direct replacements of words.

Example : A thumbs up gesture .

A thumbs up gesture is a direct replacement of wishing all the best or good-luck.

Illustrators : In order to interpret what is being said appropriately, illustrations are used. This is what is the focus of Illustrators. Illustrators are used to create a visual picture of what is being said. Moreover it used to shape the words that are actually put forth.

Example : Rising Your Feet above the Ground.

When one rises his/her feet above the ground it illustrates that one is trying to convey the height of a particular thing

Affective Displays : Affective Displays is a kind of Kinesics movement that occurs quite less. It is used to display emotions and are usually accompanied by facial gestures.

Example : Facial Expressions.

A lot of Facial Expressions can be used to express love, hatred, anger, frustration etc.

Regulators : Regulators are used so as to control the flow of a conversation. They are a kind of complementary action used to depict the understanding involved in a particular discussion. They are usually used to give a feedback of a particular conversation.

Example : Nodding, Raised Eyebrows.

A head nod depicts a yes and a raised eyebrows is used to express exclamation with regards to something.

Adaptors : Adaptors play a very important role in order to understand what someone actually thinks. Adaptors are body movements or adjustments made in order to make oneself comfortable. A person is usually unaware of such movement and so Adaptors play a major role in understanding the persons thinking at the home.

Example : Small movements done during lectures and Interviews.

During an interview, even your smallest movement is considered as an evaluation technique to judge one's personality. Also movements done during lectures, can give the lecturer a perfect understanding whether the students are really interested in the lecture or no.

DATA COLLECTION FOR GESTURE DETECTION

Gesture is motion which is made to express or help express a thought or to put an emphasis to speech. For a gesture based interaction system to work, firstly we need to collect data so as for it to be processed as gestures. Data Collection forms a basis of Gesture based System. There are two ways to collect gesture data :

- a) Data-Glove based method.
- b) Vision Based method.

Below is the comparison between the two techniques:

A) Data-Glove based method

It is an early form of data collection method whereby which the data was collected with the help of a device which was accompanied by sensors which was connected to the computer via an electric line. The user with the glove just had to stand in front of the screen and move his/her hand. Although it gave accurate results, it was a very infeasible in terms of cost. It was also a very unappealing way for users as it had limitations in terms of size and user's consecutively suffered from problems such as restricted hand movements.

B) Vision-Based Method

The system using visual based method gets visual input. Unlike the former method, this method does not need the user to wear any external device. The user is free to make a gesture which the system recognizes using a camera without the need of any extra device.

Data-Glove Method V/s Vision-Based Method

The Vision-Based Method overcomes the limitations of the data glove method. User feels totally free to make a gesture without the use of any external device such as a hand-glove. The interaction via gestures becomes even more natural. Due to its ease of use, the Vision-based

Method has attracted researchers and this method has become the focus of researchers attention in the development of various Human Computer Interfaces.

A yet another approach to gather data for gestures in android is to collect it as a raw data. The data is first fed into the system manually, that is, all the possible gestures to be used are fed into the application which is saved as 'raw' data in a folder. In the next step, the application which is using the concept of gesture recognition analyzes this 'raw' data to extract meaning or related context from the data in order to perform tasks.

GESTURE SEGMENTATION

Once the data has been collected, the next step is the ability for it to be detected so as for it to be recognized. Gesture Segmentation helps in the same. The concept of Gesture Segmentation looks for changes over time with raw data values. Gesture Segmentation plays a very important role in feature extraction of gestures. From initial to the final posture everything can be tracked using the concept of gesture segmentation. When hands are not moving in detects it as end of a particular gesture. Such techniques involved in Gesture Segmentation prove a bane to the Gesture Recognition concept.

TECHNIQUES TO RECOGNIZE GESTURES.

Gesture Recognition involves basically two techniques :-

- a) Extracting Features.
- b) Template Matching.

A) Extracting Features.

In order to match the gestures appropriately the features of the gestures must be properly extracted and analyzed. In feature extraction, even the lowest level of information collected from the raw data is analyzed so as to produce higher-level information. The cosine and sine of the initial gesture made, the speed with which the gesture is made and also the distance between the first point and the last point etc. all of these help in extracting features. With the help of these features, the system is able to recognize gestures. Even though Feature Extraction and Analysis is a robust way to recognize gestures, it becomes computationally inexpensive for the system to differentiate between gestures if a large number of features are extracted.

B) Template Matching

Template Matching is a very simple and easy technique in recognizing gestures. Both Data-Glove Method and Vision-Based Method make use of Template Matching Technique to recognize gestures. In Data-Glove based, the templates are a sequence of sensor values whereas in Vision-Based the template is a static and a small set of images.

Similarly in android too, the template matching is done by comparing the predictions made by the user with the gestures already stored as 'raw' data.

APPLICATION AREAS OF GESTURES.

Gesture based interactions due to its simplicity and ease of use has various scopes. It can be used in a wide variety of Application areas such as :

A) Sign Language

Gestures and sign language go hand-in hand. Sign language like seen is much more prominent among the deaf and dumb. Sign language is one of the intuitive technique which is used to express words. Various Systems have been developed to understand sign languages.

B) Gesture-to-Speech

Gestures follow an easy-difficult paradigm sometimes. That is, sometimes the gestures are easy to make but difficult to be interpreted in a particular context. In order to avoid misinterpretation of gestures, Gesture-to-Speech applications have been developed in order to translate gestures into speech. Such systems can have hearing-impaired people to convey their thoughts and ideas to a great extent. It can also bring about a transformation in the lives of visually challenged people.

C) Presentations.

An application has been developed by Baudel and Beaudouin-Lafon which makes use of gestures to give presentations. This system made by them is called Charade, it gives the user the ability to control a computer-aided presentation. It uses the concept of 'active-zone'. Active-zone is the zone in which gestures are made so as to be recognized. If a gesture is made outside this zone it isn't recognized by the application.

Charade gives the user the freedom to control the presentation within the active-zone. For example. The user can move to the next or the previous just by the movement of his hand which is recognized as a gesture by the application.

D) Human/Robot Manipulation and Instruction

A yet another field where gestures can prove its worth is in the field of instructions and manipulations of robots/humans. Humans can demonstrate appropriate Hand-Gestures which can be used to teach commands to robots in order to instruct them. Hand-Gestures can act as an effective tool to train robots.

E) Device monitoring

Another application area of gestures is its use in monitoring audio and video devices. Nowadays, various systems have been developed such as smart TV's, tablets that work on the concept of gesture recognition. User can make use of his hand to turn on/off the television or to move to the next channel altogether.

V. PROPOSITION

Gesture recognition has reached great advances in technology in almost every field. However, there are still various scopes of improvements. Gesture Recognition need to be precise so as to distinguish between each gesture significantly.

For this, the gesture prediction mechanism of gesture recognition technology must be made very strong. Gesture Recognition Systems revolve around three things namely, Gesture Detection, Gesture Prediction and lastly the correct Gesture Recognition.

Each of these steps is very important for Gesture-Based Interaction Systems to work profoundly.

The smart and automated world nowadays has given rise to so many new smart devices and tools. From a small mobile phone to high-interactive smart phones, refrigerators, televisions, PC's, tablets everything demands so much of interaction with the users using them.

Gesture Recognition technology has its imprints in almost every field but not education. However, the ongoing change in technology demands its use in the field of education too. But, the concern lies in answering the question how can gestures or gesture-based interactions be used in the field of education. The answer to this is very simple, a mobile-application must be created for the same. Here an application means an educational application which will encompass the features of gestures as well have an interactive approach to bind the students towards studies.

As the usage of mobile phone is utmost these days amongst the people of various age groups, a gesture-based application will definitely act as a boon for students. It will also help the teachers gather the attention of the students easily. As seen in many movies, even Embodied Interaction Technology works on gesture-based interaction. Embodied interaction allows sharing of ideas through constant interaction with artifacts. Such an interaction, makes exchange of ideas interesting thus encouraging people's participation. The focus of this research paper is on encompassing the use of Gesture Recognition Technology to a greater extent.

GESTURE-BASED APPLICATION

In order to implement the use of gestures in education, we created one android application. The main motive of this application was to demonstrate the use of gestures, its simplicity and its ease of use.

The flow of the application is explained below :

The application's name is Guess and Match, it is an educational game mainly made for children. However, it can be played by people of various age groups.

The flow of the game is : the application on start-up has the name of the game written along with the necessary instructions. When the user hits the button to play the game, randomly images appear on the screen. The images are pictures of animals. The user has to guess a letter of the image as mentioned in the instruction before. The user now makes a gesture on the application games using his/her finger to input the letter say for example. "A". If the guess is right, the game continues else it will redirect on the first page again.

Theory : Android supports Gesture Recognition. The Gesture Builder file is present in android in the android-sdk's – platform tools – samples – Gesture Builder folder.

The folder needs to be imported in the workspace and the project is to be run as an android application project on any android compatible device (say mobile phone or emulator). The gestures are then fed manually on the device which will be used to match the user input's in the game.

In the File Explorer View of android within the storage/emulated folder, the gestures apk is saved. The apk needs to be saved inside the folder named "raw" inside the "layout" named folder of the game. This apk is the "heart" of the game. This is because it will be used to match the user's inputs with the ones that are fed in the "raw" folder.

Concept : The Gesture Recognition application works on the concept of Predictions. If the prediction the user made is correct, the Gesture Library recognizes the user's inputs as a gesture matches it with the "raw" data already saved and if a match is found, the score is incremented by one and the game move forwards.

Also if the user does not input the gesture within the specified time limit (Time limit as set in The Timer), the timer expires and the game is over.

Thesis : The application exits incase the user's input does not match with the one's that are fed. This is because the prediction mechanism of gestures is not very strong. The gesture detection also depends on how the gestures are fed inside the application. So, in order to make the utmost of this technology, the prediction mechanism of gestures must be made strong enough to distinguish between gestures.

This can be done by correctly feeding gestures in the "raw" folder and by capturing the pixels and strokes of the user input whereby which the flaw can be reduced to a greater extent.

A diagrammatic view of the flow of the application is as follows :

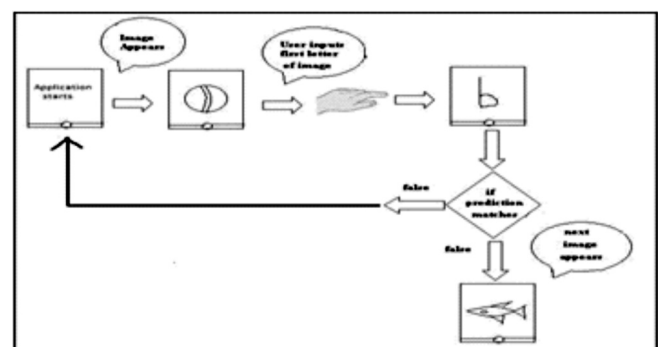
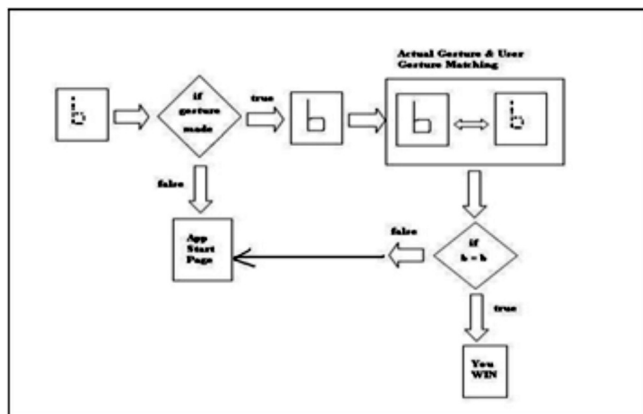


Fig. 5.1 Gesture Prediction Mechanism.**Technique Of Detection:****Fig. 5.2 Gesture Detection Mechanism.****GESTURE BASED INTERACTION FOR THE VERBALLY CHALLENGED**

Gesture has its genre ranging in every field. We will see its implications in almost every field in the near future. However, it is very important that we should extend the scope of gesture based interaction for the verbally challenged too. If thought about, of the use of gestures for the same, we could definitely extend its use for the verbally challenged too. This could be done by creating a Gesture Based Mobile application.

As we all know, each of us have a own way of communicating. The people who are devoid of speech also communicate through gestures which they are taught right from childhood. They symbolize speech through various gestures made by their hands. Each hand gesture has a different meaning altogether. Using this concept of hand gesture recognition for the verbally challenged, we could create a mobile application for the same.

Concept : The concept of this application lies in capturing the hand gestures made by the verbally challenged people with the help of the front camera of an android mobile phone. The application will work with the help of an android library know as Open CV (CV stands for Computer Vision). This library detects the hand gestures made. It recognizes each gesture and then the mapping of the gesture with the appropriate letter can be done. For. example. The hand gesture made for „A“ will be recognized and mapped as „A“ in its backend.

For the application to respond correctly, all the user needs to do is to hold the mobile phone with one hand and needs to make the gesture with the other. As soon as the application starts, the camera will open. We need to write a piece of code to translate the hand gesture into the correct alphabet and map it with the one detected with Open CV. It uses depth threshold concept of image processing to classify the fingers and then tracks the fingers. Prior, via coding each alphabet will be fed into the applications' database. The main task however is to detect the correct hand gesture. This is done by the Open CV library. After the mapping of the gestures is done, the next step is to translate it into speech. For this we can use the android's speech recognition library.

This speech recognition library will speak out the gestures made by the person which was mapped previously. The speaker of the mobile phone will thus say it, out loud, what a person actually wished to say via gestures.

Let's say a person wants to say "I see you". She/he will then make the first gesture of the alphabet "I" and so on. The applications camera has the Open CV library with the help of which the gesture of the letter "I" is captured , recognized and saved at the back-end. The speech recognition library will then speak out the words. A delay of some seconds will also be set so as to differentiate between words. This is a very important step to enhance the proper functionality of the application.

Thus, a simple and easy to use application can be made with the help of which the verbally challenged can communicate ideas and words better.

CONCLUSION

In this paper, we have gone through a discussion on Gesture-Based Technology and its use. This ever rising technology has its footprints in almost every field today. The motive of this paper was thus to have a walk-through about gesture recognition and understand that it has its scope in the field of education too. We proposed the use of gesture recognition in two applications. First as a game and the second which will act as "voice" for the verbally impaired.

The application demonstrates the simplicity and ease of use of gestures. Also the functionality of the application throws limelight on the concept of gestures.

We have seen both the pros and cons of gesture during its implementation. We also suggested that if the gestures are properly saved, the gesture prediction mechanism can be made strong and we can thus overcome the limitations of gestures.

If implemented successfully surely we can derive onto a conclusion that with gestures we can have the future in our hands thus making the world a much more smaller place to live in. - “technologically”.

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