SIGN SEQUENCE BASED GESTURE RECOGNITION USING MEMS ACCELEROMETER FOR AUGMENTED REALITY APPLICATIONS

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Abstract- The Increase in Human Machine Interactions in our daily life is getting important day by day. Physical gesture will greatly ease the interaction process and enable humans to more naturally command the machinery like computers. In this hand gestures are mostly used as the control mechanism in virtual reality. To ease these physical gestures MEMS accelerometer can be used which can recognize the several hand gestures. In the real world the physical gesture machinery control is already in existence such as vision system or data glow but these are relatively expensive. By the usage of MEMS, the cost can be reduced and method can be implemented more effectively.

This project deals with an accelerometer-based gesture recognition application. This application consists of a tri-axial accelerometer and same is connected to raspberry pi through wire. The tri-axial accelerometer measures the acceleration signals generated by a users hand motions to identify the character. The code for application program in raspberry pi is written using python programming language. The text is displayed on the monitor of the PC.

Keywords: Raspberry pi, Mems accelerometer, Accuracy, gesture recognition, python. Etc
1. INTRODUCTION

Technology has played a very significant role in improving the quality of life. The simplification of work can be done by automating several tasks using complex logic. Much attention from many research communities such as human computer interaction and image processing has been given to gesture recognition. More importance has been given to the interface technology due to the increasing human machine interactions in our daily life. Physical gestures will greatly ease the interaction process and enable humans to more naturally command computers or machines. To convey information a system is created using the primary goal gesture recognition. Vision based and accelerometer based are the two existing types of gesture recognition method. The limitations that we have, while using vision based method are slower dynamic response, unexpected ambient optical noise and relatively large data collections. To overcome these limitations we are using Mems accelerometer [1]. AVR Microcontroller is used in real time hand gesture recognition. In order to get the output object is needed to be presented in front of camera. It limits mobility and cannot use camera in dark area as well as cost is very high [2]. Inertial MEMS present in smartphones are used to tackle the task of symbolic gestures, But Inertial MEMS are more sensitive to feeble movements [3]. First a class of finite state machines (FSM) for gesture recognition were constructed in first phase and then tuned for higher accuracy with the help of some training data and a suitable optimization method in the second phase. In this the power consumption is very high [5]. Unsupervised network self-organising map is applied for character recognition and to classify the characters [6].

2. DIFFERENT METHODOLOGIES OF EXISTING

There are three methods in the existing system. They are 1) sign sequence and Hopfield based gesture recognition model 2) velocity increment based gesture recognition model and 3) sign sequence and template matching based gesture recognition mode.

A. Sign sequence and Hopfield based gesture recognition model.

There are two types of gestures one is which has only motions on one axis (up, down, left, right) and the other one is which has 2-D motions (circle, tick, cross). These two are stored separately. Minimum value and maximum value of the accelerations are used to write the coding and find the gestures. We get eight numbered coding by combining the x and z axis sign sequences. But the input for Hopfield network can be only 1 or -1. So we will use positive sign, negative sign and zero. We use following rules to get these signs,“1 1” represents positive sign, “-1 -1” represents negative sign, “1 -1” represents zero. Standard patterns for the seven gestures will be pre given and will be compared to get the output. [1]

B. Velocity increment based gesture recognition model

Identification of gestures will be done based on velocity increment. An area sequence should be normalized before stored as training data or compared with templates. Normalization is implemented using

\[ \text{Anorm} = \frac{A_{\text{original}}}{A_{\text{max}}} \]

Where \( A_{\text{original}} \) is the original area, \( A_{\text{max}} \) is maximum area and \( A_{\text{normal}} \) is normalized area in a sequence. The final step is to compare the velocity increment sequence by subtracting two area sequence vectors. The gesture which has minimum value by comparing one area sequence with the training sample can be recognized. [1]
C. Sign sequence and template matching based gesture recognition mode.

This is very similar to model one. All sign sequences are represented by -1,1 and 0 unlike model one. This method is not limited to specific users. In this the algorithm is based on feature of acceleration sign changes. [1]

![Signs](image)

Fig. 1 Motion of Seven Gestures [1]

D. Comparison of gesture recognition accuracy of above three Methods.

| Method   | Up  | Down | Left | Right | Tick | Circle | Cross | Mean |
|----------|-----|------|------|-------|------|--------|-------|------|
| Method I | 95.0| 86.0 | 91.0 | 84.0  | 64.0 | 75.0   | 61.0  | 79.0 |
| Method II| 87.0| 19.0 | 63.0 | 94.0  | 25.0 | 0.0    | 88.0  | 54.0 |
| Method III| 94.8| 91.1 | 96.70| 100   | 94.4 | 97.7   | 94.4  | 95.6 |

Table 1 Comparison of Gesture Recognition Accuracy (%) of Three Methods [1]

3. PROPOSED SYSTEM

LOT measures the similarity between a candidate and the target using locally order less matching, and HSV colour space is used to describe the appearance of each pixel. MEEM uses features extracted in the LAB colour space. In the most recent work, CSK is extended with colour names, and to speed up, the dimension of the original colour names is reduced with an adaptive dimensionality reduction technique.

![Diagram](image)

Fig 2 Block diagram of proposed system.
A. Micro-Electro-Mechanical-System (MEMS)

MEMS technology consists of microelectronic elements, actuators, sensors, and mechanical structures built onto a substrate, which is usually silicon. They are developed using micro fabrication techniques deposition, patterning, and etching. The most common forms of production for MEMS are bulk micromachining, surface micromachining, and HAR fabrication. The benefits on this small scale integration bring the technology to a vast number and variety of devices.

![MEMS accelerometer]

**Fig 3 MEMS accelerometer**

B. Raspberry pi

In this project we are dealing with raspberry pi, which has ARM 11 core architecture with Broadcom BCM2837 Soc chip. It has 1 GB SDRAM with video and audio outputs. Audio output has 3.5mm jack and HDMI. It has 4 USB 2.0 connectors. It has micro SD slot to store the memory by placing a memory card. Linux operating system is used in this. It has general purpose input output connector (GPIO).

![Raspberry pie]

**Fig 4. Raspberry pie**

C. Accelerometer Sensor

It is an electromechanical device which measures acceleration forces. These forces maybe static which are constant force of gravity pulling at your feet, or they could be dynamic which are caused by moving or vibrating the accelerometer. By moving the MEMS accelerometer gesture will be drawn on the monitor. The drawn shape will be recognized according to the pre given code which has been written using python language. Three switches will be provided for the given functions. First one is for start and stop of the gesture drawing. Second one is to clear the screen and the third one is for getting the output. In this we can get two modes of output. One is in the text form, which is already given in the program for particular gestures and the other one is audio form, where the displayed output text will be read out. There are two ways to get the audio output, one is through HDMI and the other is from audio jack which is present in raspberry pi.
1. RESULT AND DISCUSSION

Fig. 5 Gesture Recognition of Alphabet “Y type”

Fig. 6 Gesture Recognition of Alphabet “W type”

Fig. 7 Gesture Recognition of Alphabet “L type”

Fig. 8 Gesture Recognition of Alphabet “H type”
Above figures is the output of some alphabetic gestures such as “W, H, L, O and P”. In this method we have used angles to differentiate the gestures. So the accuracy is more, when compared to the existing methods. By using MEMS accelerometer the cost can be reduced.

2. CONCLUSION

The gesture can be recognized by MEMS accelerometer sensor. The sensor analog outputs have sent to the ATmega8 microcontroller. In microcontroller, already stored data can compare the input data of gesture and also transmitted to the PC. On running in a PC, the power point presentation has been manipulated. The gesture values are found out for 85 experiments and found that gesture recognition based on sign sequence and template matching gives high (96%) accuracy when compared to other models. The future work will be
done with the speech output using the speaker with hand gesture input, and also more recognition methods will be investigated.

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