Accelerometer Based Trajectory Motion Recognition for an Intelligent Environment

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Abstract- In this paper an accelerometer based portable device for digit and gesture recognition is being presented. The recognized data will be displayed on the monitor. A speech module is also embedded. The system finds its application in assisting patients. Apart from its HCI and gaming applications, it can be incorporated to assist the communication of deaf and dump with the visually challenged people. The digital pen consists of a tri-axial accelerometer, a microcontroller and a display unit. The system operates with microcontroller as its heart. The system is capable of identifying the digits written on air, display it on PC and also give a voice corresponding to the digit written. Users can use the pen to write digits or make hand gestures, and the accelerations of hand motions measured by the accelerometer are transmitted to a computer for online trajectory recognition. The digital pen can also control the operation of other devices. Here a fan and light are made to turn on and off with the aid of gestures made by the digital pen. As a future application more devices can be controlled with its aid.

Index Terms- Accelerometer, gesture recognition, intelligent environment, microcontroller, trajectory motion recognition.

I. INTRODUCTION

There are a number of technologies thriving for human computer interaction or human machine interaction such as speech recognition, vision-based gesture recognition and tablet types of devices. These devices facilitate the intercommunication between humans and machine more freely and without the use of traditional keyboards or mouse or remote controls. Gesture or trajectory recognition based on inertial devices is an original, direct human-computer interacting way, because the motion of limbs is driven by the force from muscles and the inertial devices could detect the outcome of the force, say acceleration and angular velocity, directly, so people could even use them without any distraction all the time.

A significant advantage of inertial sensors for general motion sensing is that they can be operated without any external reference and limitation in working conditions. However, motion trajectory recognition is relatively complicated because different users have different speeds and styles to generate various motion trajectories. Thus, many researchers have tried to narrow down the problem domain for increasing the accuracy of handwriting recognition systems [1].

II. PROJECT DESCRIPTION

This paper presents a digital pen based system to find out the trajectory of the written digits and gestures. As a HMI application to this device, various gestures are used to turn on and off other devices.

Microcontroller is the heart of this system. AVR ATmega32 is the microcontroller used in this paper. Microcontroller is being programmed in embedded C language and is being simulated in AVR Studio 5. The input device to this microcontroller is a three axis accelerometer. The accelerometer is used to measure the acceleration signals with respect to x, y and z axis. The acceleration values are displayed on the LCD Display.

The working of the system is as follows. The entire working can be said to have two parts - Digit recognition part and the device control part. The digital pen can identify the digits from zero to seven and display it on a PC. Also a voice module and loud speaker is being attached to the system to give a voice output of the digits written and displayed. The single APR module can only store and output eight signals. So the recognition of only eight digits – zero to seven are only carried out in this paper. The trajectories of the digits are shown in Table 1. This system facilitates the communication between deaf, dumb and the blind.The device control part aims at giving a further application to this pen. So it aimed of a human machine interaction one. The digital pen can be used to control other machines like fan, light etc. Four gestures where used – up, down, right and left. Table 2 shows the various gestures used.

These gestures can turn on and off a light and fan respectively. In future further more devices can also be incorporated. This can thus find application in assisting disabled or physically challenged people to communicate easily with the surroundings. This device thus provides a tool for an intelligent environment.

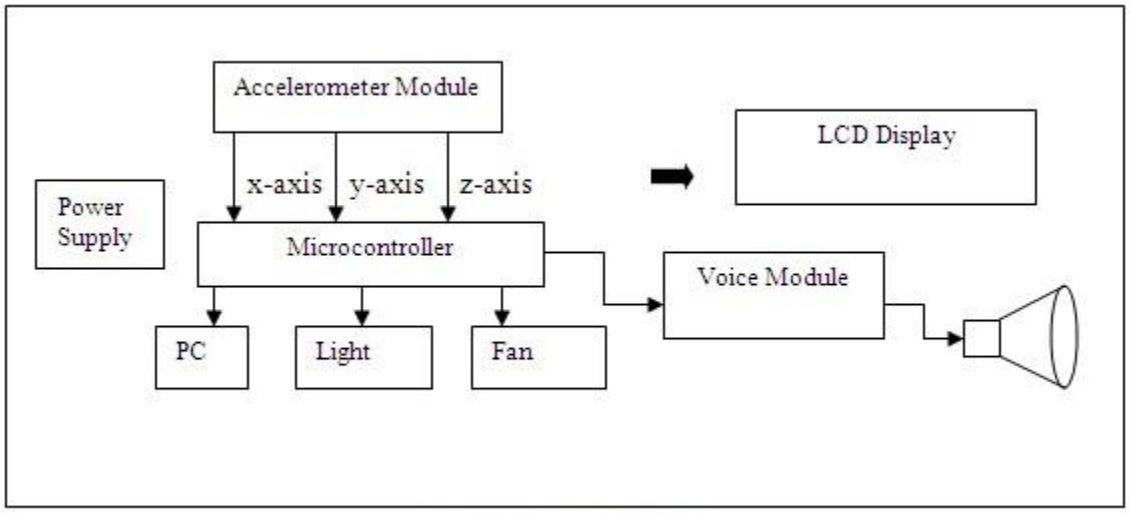

Figure 1 Block Diagram

Table 1 Trajectory of digits

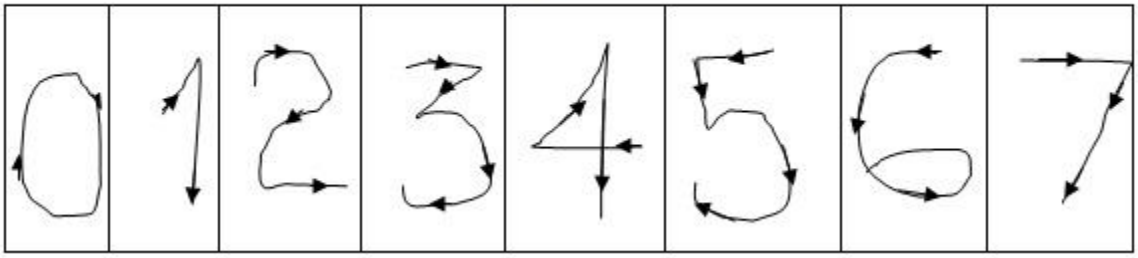

Table 2 Trajectory of Gestures

Up	Down	Right	Left
↑	↓	→	←

III. RESULTS

The programming language used in this project is Embedded C. The code was written and simulated in AVR Studio 5. The code was loaded to the microcontroller. The device successfully recognized digits zero to seven. The digits were displayed on the PC. The four gestures used in this project turned on and off the light and the fan. A survey was conducted among 20 people (10 male and 10 female) to check the efficiency and accuracy of the system. Table 3 and 4 gives the survey report and the accuracy rates.

Table 3 Survey Report

Digit/Gesture	Male	Female	Total
0	9	10	19
1	10	8	18
2	8	9	17
3	8	9	17
4	7	8	15
5	8	8	16
6	8	10	18
7	8	9	17
→	10	10	20
←	10	10	20
↑	10	10	20
↓	10	10	20

Table 4 Accuracy Rates

Digit/Gesture	Accuracy (%)
0	95
1	90
2	85
3	85
4	75
5	80
6	90
7	85
→	100
←	100
↑	100
↓	100

IV. CONCLUSION

This paper has presented an accelerometer based framework that can that can be utilized for acceleration-based handwriting and gesture recognition. The proposed system is utilized for digit and gesture recognition and thus it is an effective tool for HCI applications.

Users can use the pen to write digits or make hand gestures as shown in Table 1 and 2, and the accelerations of hand motions are measured by the accelerometer. The recognized digits are displayed on a computer for further applications. So, by changing the position of accelerometer users can show the numerical characters on the PC. The voice recognition system identifies the digits that are being identified. The voice recognition module and the loud speaker output the digit that is being recognized.

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