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Gestures in air based home appliance control system

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Abstract: Our paper is based on developing applications and demonstrating the advance use of accelerometer, till now various applications of accelerometer using tilt has been developed. We start with the design of hand motion sensor using 3 axis accelerometer and I2C protocol based ADC, we will also provide wireless interface so we will have complete freedom to move our hand in air to make various shapes. Various shapes will be associated with different devices. We design device/appliance control system using shapes produced by hand motion in air.

Keywords: accelerometer, I2C protocol, gestures, ADC, wireless interface.

I. INTRODUCTION

MEMS technology has promised human kind with great potentials in near future, not only that currently we have various technologies in hand which uses extensively MEMS technology. One such technology is MEMS based 3 axis accelerometer. These sensors have tremendous application in various aspects of life and engineering; but till now accelerometer was used only for tilt sense and shock sense; various application of accelerometer using tilt has been developed like head controlled mouse or wheel chair. Glove based gesture control system for differently challenged people[1] which uses accelerometer.

In this system, the sensors attached to the glove capture the movement of the hand and finger and also the rotation. Many efforts have been made to interpret hand gestures, particularly the signals that are changing over time Hidden Markov Model(HMM) is employed as an effective tool in. This control system is based on Zigbee network technology for transmission of finger bending data from sender to receiver. Gesture data sending and receiving is used for ubiquitous access of appliances and allowing breach control at home.

Another system is Automatic hand gesture based remote control for home appliances[2] which presents an accelerometer mostly based on hand gesture recognition algorithm which is used to control electronic/electrical devices. The hardware module consists of an accelerometer, microcontroller, infrared transmission module for sensing and collecting accelerations of hand motions. Users can use this hardware module to control the infrared devices by making hand gestures which transmitted wirelessly to a target device.

There is a computer application designed in Java processing[3] to have real time image processing. An infrared camera is giving images in infrared vision to the computer application. After processing the images and recognizing the hand gesture, decision data is sent to a microcontroller hardware based on Arduino environment. This hardware sends the data to the gadgets in same way as a remote control does for general use. We propose an advance use of accelerometer in our paper where we will not use tilt sense feature of accelerometer instead of that we are going to digitize raw acceleration values and with the help of signal processing we will deduce hand motions from the accelerations and transmit it wirelessly, these hand motions which will be used appliance control receiver and processes to form correct shape and match it with shapes in database.

With our system the control of devices will be possible just by making special predefined gesture in air for example just make L shape in air to turn on/off lights. Our aim is not only to design a appliance control system with new method, but implement in a low cost microcontroller with limited code memory and RAM.

II. HARDWARE DESIGN

A. HAND MOTION SENSOR

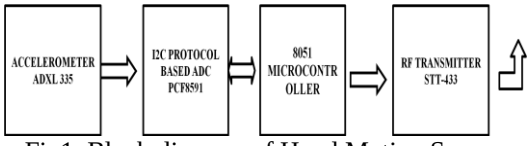

Fig1. Block diagram of Hand Motion Sensor

This module is divided into three parts: Acquisition, Hand Motion Detection and Transmission. Acquisition is done with use of Accelerometer and ADC. Detection/recognition is done using software algorithm and transmission is done using RFTx module. Mounting of accelerometer is very important for acquiring correct accelerations during hand movements. It is mounted for getting up down movement in Y-axis[values are taken in Z-axis of accelerometer but for convenience it is taken as Y-axis] of accelerometer frame and left right hand movement in X-axis. These are analog voltages we digitize them using ADC PCF8591 this is I2C based ADC,

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it has four channel out of which we are using two channels one for Y axis(up-down) measure and other for X-axis(left-right).To read axes values we use I2C protocol to select the channel and get the digital value. We are applying low pass filter on data by performing rolling average and final data is put in two arrays, for left and right motion it goes to X array and for up down motion it goes to Y array. Initially for designing hand motion detection algorithm we need to analyze the accelerometer data for that we have provided provision to download data to PC using RS232 interface and HyperTerminal. Once x y is downloaded to PC using HyperTerminal we can plot the x-y using excel some plots are shown and samples for one is shown below. Here X-axis data is corresponds to left right hand motions and Y axis data corresponds to up down hand motion data.

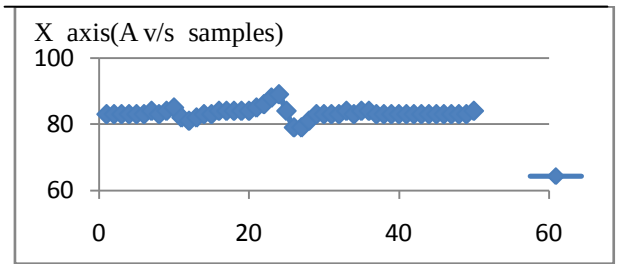

Fig2. Plot for X axis of UP RIGHT gesture

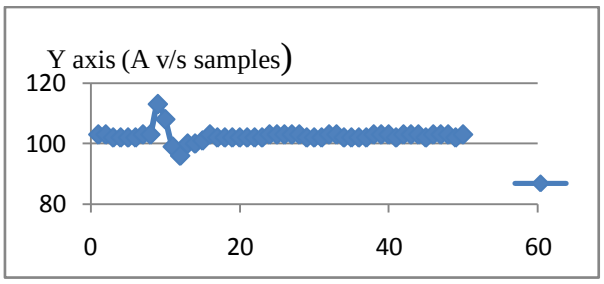

Fig3. Plot for Y axis of UP RIGHT gesture

To transmit this hand motions to control part, we are using transmitter module [STT-433] for better noise performance and to avoid erroneous data reception we use encoder and decoders. Both four bit (HT12E and HT12D) and 8bit (HT640 & HT648) can be used as data is of very small volume. The working of Hand motion sensor transmitter is shown in the form of flow diagram in fig4.

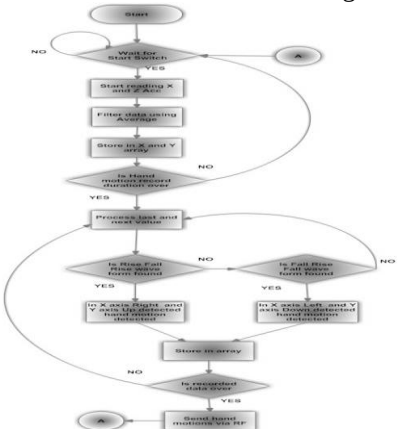

Fig4. Flow chart for hand motion sensor

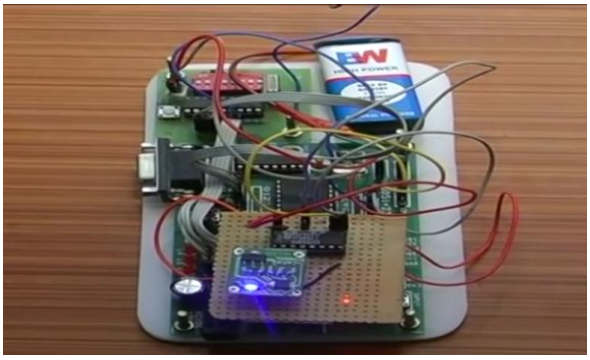

Fig5. Hand motion sensor transmitter

B. APPLIANCE CONTROL SYSTEM

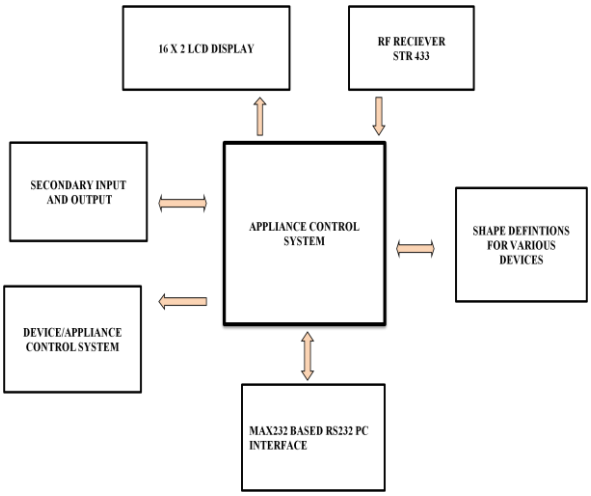

Fig6. Block diagram for Appliance Control System

The receiver module is STR-433 which requires no external RF components except for the antenna. The data transmitted by the transmitter module is received by this module and is sent to the microcontroller where the data is processed to deduce the gestures received. That is when any shape is made using hand motions in air, it converts gesture movements in the partial hand motions and these are transmitted wirelessly by the hand motion sensor. These broken hand motions are received by control system and it compares theses motions with motions stored in EEPROM memory to find the definition of shapes associated to any device. If shape match is found the corresponding device is activated using interfacing circuit.

The LCD module is used to display the information indicating which home appliance is being controlled and it also displays if there is any error in transmitted gestures. There is an option to update shapes or redefine them using PC interface.

Few switches are provided for user interface and for selecting different modes of operations, status output is used for audio visual indications of shape registration, identification or rejection. Finally for utility device control a relay board is used through which devices are controlled for direct interfacing of devices with high current drivers is also possible. The working of the appliance control system is shown in the following figure 7.

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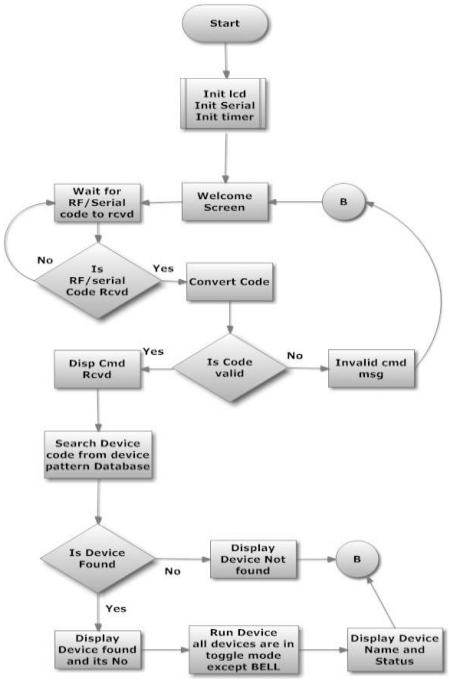

Fig7. Flow chart for appliance control system

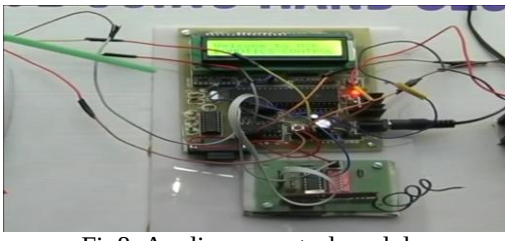

Fig8. Appliance control module

Fig9. Appliances control system with appliances connected

III. EXPERIMENTAL RESULTS

Acceleration variations due to hand motions are captured and processed in controller and hand motions are recognized and transmitted wirelessly. This is the main part of the paper and we prove that gesture in air system can exist even with very tight budget. We develop a dedicated application part in which GIA based home appliance control module is implemented. In this system the accelerations are converted into the form of commands that is right[R], left[L], up[U], down[D] in the sensor. The combinations of these commands are transmitted wirelessly. The receiver upon receiving these commands will verify the combination with the predefined set of commands. If the match is found then the corresponding device will turn on or turn off accordingly. The LCD module will display the received command combination as shown in fig10 and indicates the device which is controlled as in fig11.

Fig10. Commands received on appliance control module

Fig11. Indicating the controlled device

IV. CONCLUSION

This system is useful in home and office automations as it allows you to make any gesture and which can be used to control appliances or some industrial devices. It can be used by blinds in smart homes. This can be made as integral part of remote one can control with buttons or gesture whatever user feels more comfortable. Mentally challenged and users with cognitive disorders can be trained to use this systems for better learn of hand motion co-relation. With better algorithms high speed ADC the accuracy and speed both can increase and one or more dimension can be added. Conversion of Circuit from DIP to SMD will save lots of space and low power components can be used to save power as this is portable battery operated system. This was only to demonstrate one advance application of accelerometer except tilt sensing, Apart from this it has myriad of applications in entertainment, education, medical and high end gamming. Gesture in air can be used for text entry with multi tilt and orientation sense.

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