ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

GestIC based Mouse Control and Home Automation System

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ABSTRACT:A gesture based interface system for an operating system is designed that emulates the working of a mouse in terms of hover and left and right clicks. Additionally, gesture-controlled home automation is implemented. The sensor used for gesture tracking incorporates GestIC technology which is 3D motion tracking and gesture sensing controller working on the principle of capacitive proximity sensing detecting distortions in the electric field when a conductive object is placed in proximity. Proposed system comprises five functional units viz. sensor module, control unit, system application at the PC end, Zigbee for wireless transmission and home automation unit. Proposed system aims to enhance the ease of design and usability of hand gestures as medium of interaction in Human-Machine Interface (HMI) in comparison to existing gesture recognition technologies.

KEYWORDS: Gesture sensing, GestIC technology, HCI, home automation, zigbee.

I.INTRODUCTION

Gestures are natural medium of interaction among humans and recently in trend of being adopted in Human-computer Interaction(HCI), home automation, consumer electronics, robot control etc., Gesture based HCI provides touch-free alternative for conventional HCI devices majorly comprising of mechanical devices like mouse, keyboard, joystick etc., Currently trending gesture recognition techniques make use of camera modules, accelerometers, depth sensors etc., to track and identify gestures [2][3][4][6][7][8]. Gestures can be classified as either vision-based or sensor-based and in turn touch-based or touch-free [1].

Vision-based gesture recognition involves employing camera to capture the gesture image and process the image using extensive image processing algorithms in order to identify, track and decode the specific gesture and then associate it with a specific action. This technique is prone to limitations in terms of camera resolution, illumination, interference by other components in vicinity captured by the camera, and robust processing algorithms are to be applied so as to differentiate and specifically recognise a gesture.

The proposed technology employs gesture recognition sensor that employs 3D gesture recognition and motion tracking controller that works on proximity and touch sensing with respect to change in electric fields across the sensor electrodes.

They have an advantage of being robust to external factors like light, temperature variations etc, no crosstalks and accurate sensing but cons being limited area of interaction and limited information[5]. The controller assists free hand movement since it is touch-free interaction and is not attached to the hands unlike other available sensors. The gesture/position tracking processing is done within the chip hence no processing is required at the host-end eliminating lengthy processing algorithms hence less developing time.

When the hand is placed in proximity to the sensing region, it causes change in the electric field distribution. The field lines are then compressed and hence the potential of receiving electrode is in turn lowered which is then processed by the signal processing unit within the controller.

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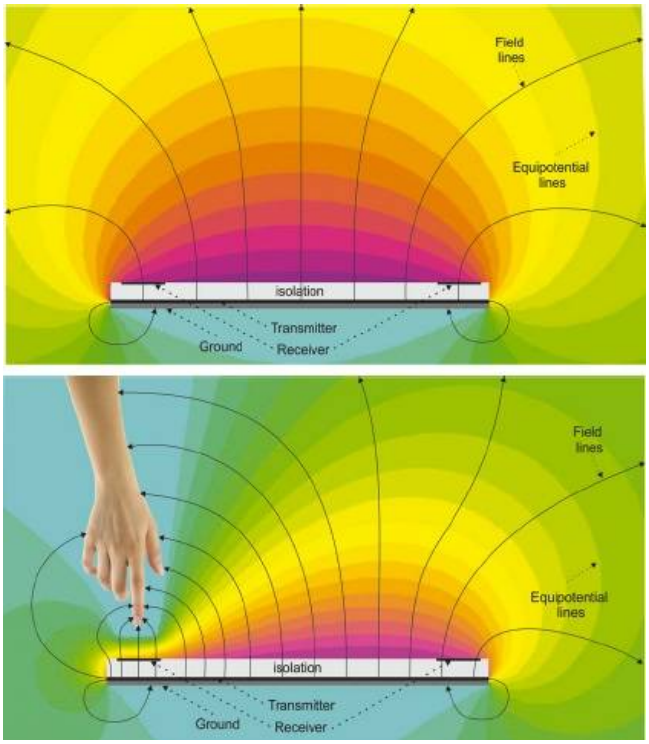

Fig 1. Influence of earth grounded body to the electric field

Home automation is another field of application wherein gestures are widely used to remotely regulate switching and monitoring of the home appliances and consumer electronics. Zigbee is a prominent RF communication technology which is flexible, low-cost, low-power and also easy to setup and hence extensively used as a wireless communication protocol in home automation.

II.SYSTEM ARCHITECTURE

The control flow of the proposed system design is as shown in the figure.

MICROCONTROLLERS

1. LPC2148:The arm7 based high performance 32-bit microcontroller. It is used to interface the gesture sensor to the relay circuit as well as the laptop for mouse application. ARM7 receives the digital data from the gesture sensor output through the zigbee interface, interprets the data received and then serially transmits relevant data to the laptop using an USB to RS232 TTL UART interface.

2. W78E052D: This is an 8-bit CISC microcontroller optimised for control applications. It is used to receive serial data from the LPC2148 received using zigbee receiver module, interpret it and then in turn control the relay circuitry to which the home appliances are connected.

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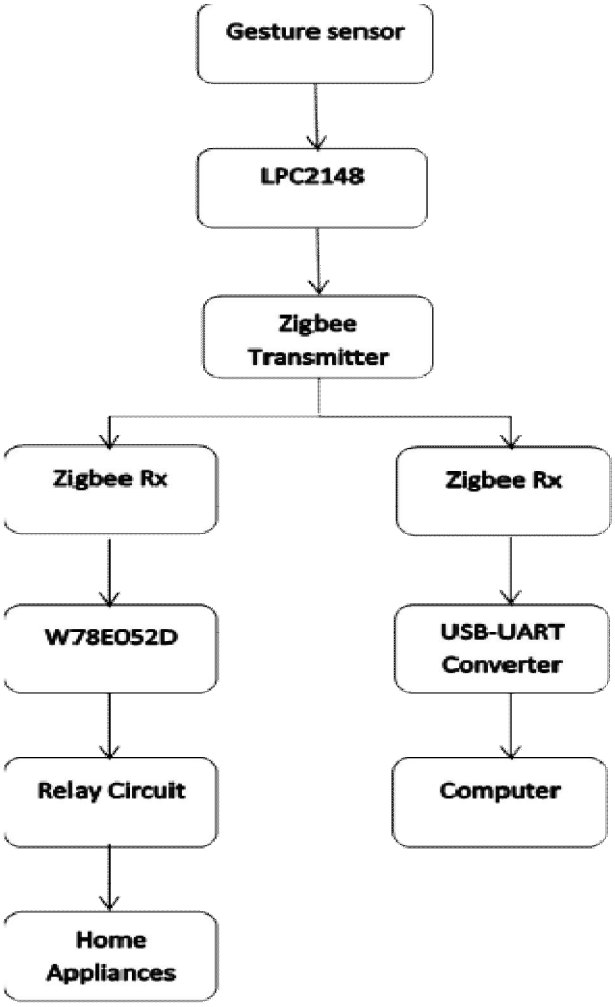

Fig2. Control flow of the system

ZIGBEE MODULE

Zigbee is a reliable, low-cost, flexible self-healing protocol used in the home automation system. It is a RF communication standard following IEEE standard 802.15.4. It operates with 2.4 GHz ISM band with 250 kbps data rate and since it is wireless, easy to install and also scalable.

USB TO SERIAL UART CONVERTER

The module allows connecting the computer/laptop through the USB port to a microcontroller board providing a serial COM port at the computer end. Applications interacting with the COM port are converted to USB and to UART at the target end.

RELAY CIRCUIT

Relay circuits are used to provide switching applications for the home automation. Relays enable switching high voltages/currents using low power circuits. The 5V provided by the W78E0528 is used to drive the home appliances and the motor controlling the door using the relay circuit.

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The relay working principle is as shown in the figure 3.

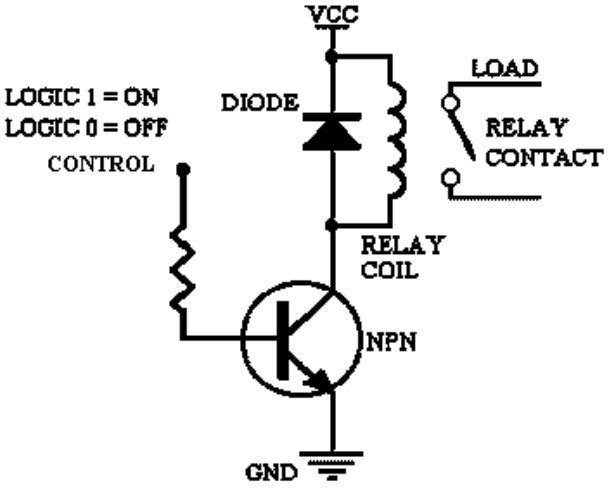


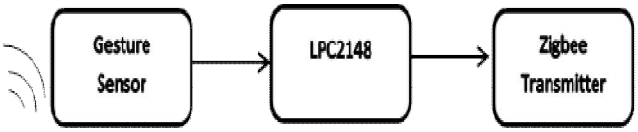
Fig 3. Simple Relay Circuit

When control signal goes high, the transistor is turned on hence it acts as a closed switch. The DC voltage is then applied across the relay coil and the relay contact in turn is closed.
When control signal goes low, the transistor turns off and the relay contact is pulled back to the open condition.
COMPUTER
The PC is interfaced to the microcontroller LPC2148 using zigbee and the USB-UART converter, wherein the mouse driver application written within the PC interprets the signal received and performs the intended operation of hovering in a particular direction and the clicking operations.

III.SYSTEM IMPLEMENTATION

The system design consists of gesture sensor, computer and a home automation system which in turn involves light bulb, fan and a door controlled using servo motor. The relay circuit is used for switching on/off the light bulb and the fan. The output of the gesture sensor is wirelessly transmitted using the zigbee module. A push button monitors whether the application is mouse emulation or home automation. When the switch goes high, the application of home automation is implemented. An LCD is used to display the status of the appliances connected at the home automation unit.

TRANSMITTER SECTION:



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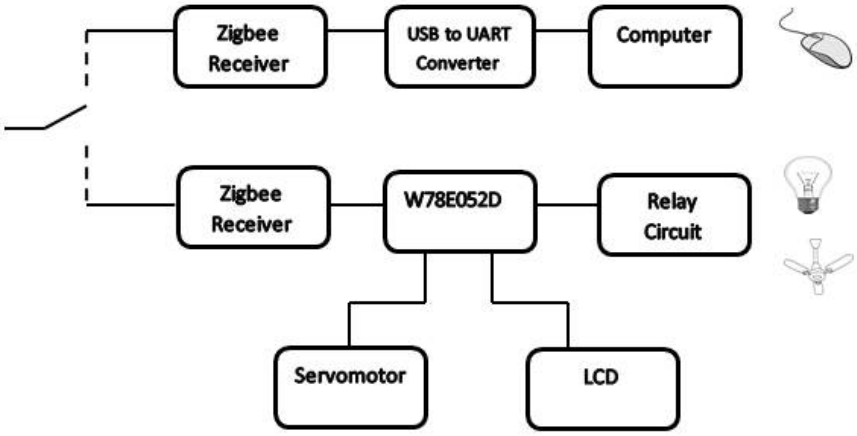
RECEIVER SECTION:



1. W78E052D:
W78E052D is an 8-bit microcontroller with instruction set compatible to 8052. It has 8 KB of programmable flash memory and 256 bytes of RAM and designed for low power consumption.
2. LPC2148:
LPC2148 is a 32-bit ARM7TDMI-S microcontroller with 40 KB on-chip static RAM and 512 KB on-chip flash program memory. It is widely used in embedded system applications because of its tiny size, highly optimised power consumption and high performance.

GESTURE SENSOR
Gesture sensor detects and tracks the gestures within its inbuilt signal processing module and is interfaced to the LPC2148. Gesture sensor is comprised of MGC3130 which is 3D gesture sensing and motion tracking controller working on the principle of near field sensing.

ZIGBEE
Zigbee is an RF communication protocol operating on IEEE 802.15.4 standard operating in 2.4 GHz frequency band. The zigbee system consists of Coordinator, router and end devices. Coordinator is the root of the network tree and is concerned with initiating the network. Routers are intermediate nodes that relay data. End devices collect the information transmitted by the adjacent router which would be the switch/sensor data.

SOFTWARE TOOLS

1. KEIL MICROVISION:
The µVision IDE provides easy-to-use environment to create projects, source code editing, build the projects and debug them to verify the code.

2.FLASH MAGIC:
Flash Magic is a PC tool for programming flash based microcontrollers from NXP using a serial or Ethernet protocol while in the target hardware.

3. JAVA:
Java is a high-level programming language used to develop software applications in the computer. It is object- oriented and platform independent, also simple and secure and hence widely used in embedded applications.

HOME AUTOMATION CIRCUIT
For the system designed, a specific gesture should regulate that either of the home appliances i.e. bulb or fan is to be

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turned on/off and also the door has to open/close. The status of the appliances is then displayed onto the LCD.

IV.RESULTS AND DISCUSSION

The proposed technique utilises the gesture recognising mechanism incorporating GestIC technology for implementing applications of mouse functionality control and also home automation making use of zigbee 802.15.4 standard for wireless communication between the gesture sensor and the PC and also with that of home automation module. Wireless communication helps to reduce hardware costs(cable cost).

The proposed methodology has been preferred because of the following reasons:
1. Ease of access:Since the methodology used in proposed system does not require complicated lengthy algorithms to be designed at the receiving end by the user hence it reduces module design cost for a specific functionality and hence higher reliability, shortdevelopment period and lower NRE costs.
2. Less fluctuations with respect to external factors such as temperature, illumination etc.,

GUI developed for serial port connection for mouse implementation developed in java is as shown in figure4 below:

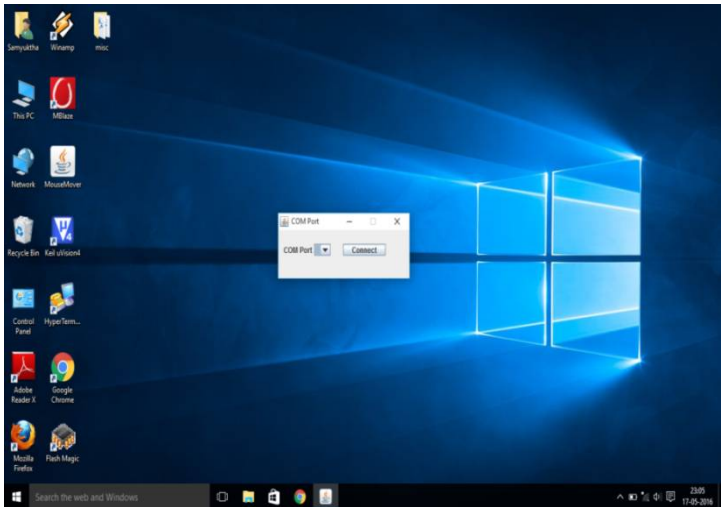

Fig. 4 Screenshot of GUI for serial port connection of PC with gesture controller

GUI consists of a dialog box implementing drop down menu that lists out any of the available serial COM ports and a button that enables connecting to that particular COM port. The zoomed in image of GUI is as shown in the figure5 below.

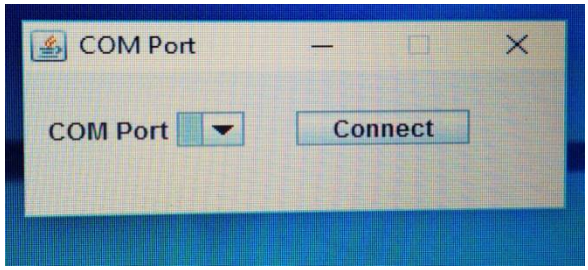

Fig.5 GUI for serial communication at PC end

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Zigbee receiver receives data transmitted by Zigbee transmitter connected to the gesture sensor. The sensed data now is received by the Zigbee receiver. Zigbee receiver is connected to USB to UART converter for compatible connection with the PC/Laptop and to establish a serial port at the PC end. The interfacing of Zigbee receiver to the PC using USB to UART converter is as shown in figure6below.

Fig. 6 Zigbee receiver interface to PC using USB-UART converter

Once the COM port is connected at the PC end, the data is continuously received which is then interpreted to specific mouse applications using java code embedded and executed in the PC.

The data sensed by the gesture sensor is then transmitted using Zigbee transmitter. A Zigbee receiver at the receiver end is placed at PC for mouse emulation and at Home automation end for HA application.

HAS consists of a Zigbee receiver which is interfaced to 8052 that in turn controls an LCD display displaying the status of the different appliances connected within the HAS; relays for light and fan and a servomotor which is used for controlling opening and closing of the door. Connection to servomotor is done making use of the driver for the motor, using H-bridge. 8052 is responsible for providing appropriate voltage levels for respective applications.

An experimental setup for Home automation system based on hand gestures is as shown in the figure 7 below.

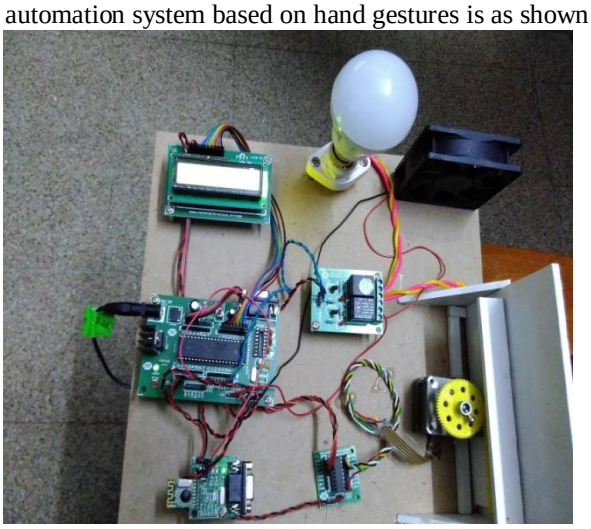

Fig.7 Experimental setup for gesture-based home automation system using zigbee

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V.CONCLUSION

The paper deals with successful design and implementation of GestIC technology based touchless mouse emulation and home automation control driven by the hand gestures. The robustness and ease of access at the user end with no computational burden provided by the gesture sensors enables it to be used for wider range of applications related to gesture tracking and control.

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