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Gesture in Air for Home Automation

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Abstract

Various electrical appliances have penetrated into people's daily life including televisions, video and audio equipment, and other household appliances. Many of them provide an infrared Remote Controller (RC) for appliance control. But as the number of controllers increased, it becomes not so convenient to access different controllers to control different devices, be specially for the senior citizens with diminished physical and mental ability. In this paper, a one-for-all gesture-based remote control system is proposed by which consumers can control different appliances in a nature and unified way. Firstly, two kinds of fundamental devices for the physical layer of the novel control method is presented, which including a compact wearable sensing device called transmitter node and its command receiver and executer called Domotics control system.

Keywords:*Accelerometer, Radio frequency,I^2C protocol, ADC, Domotics system.*

1. Introduction

Sensors allow detection, analysis, and recording of physical phenomenon that are difficult to otherwise measure by converting the phenomenon into a more convenient signal. Sensors convert physical measurements such as displacement, velocity, acceleration, force, pressure, chemical concentration, or flow into electrical signals. The value of the original physical parameter can be back-calculated from the appropriate characteristics of the electrical signal (amplitude, frequency, pulse-width, etc.). Electrical outputs are very convenient because there are well known methods (and often commercially available off-the-shelf solutions) for filtering and acquiring electrical signals for real-time or subsequent analysis. Sensor size is often important, and small sensors are desirable for many reasons including easier use, a higher sensor density, and lower material cost. A revolution in micro fabricated sensors occurred with the application of semiconductor fabrication technology to sensor construction. By etching and depositing electrically conductive and nonconductive layers on silicon wafers, the sensor is created with the electrical sensing elements already built into the sensor. The products created using these techniques are called micro electromechanical systems, or MEMS. Other examples of MEMS are the application elements of inkjet printers. The entire MEMS sensor is fabricated on a small section of a single silicon wafer or a stack of wafers bonded together. Reducing the area of the sensor layout both decreases the area of the sensor and increases the number of sensors produced on each wafer. The silicon dies are then packaged in chip carriers for use. Many types of inertial sensors have been fabricated as MEMS. The original MEMS sensors were pressure sensors using peso resistive sensing elements, include accelerometers (measuring either linear chemical concentration sensors, and gyroscopes. This project uses single-axis MEMS linear accelerometer sensors fabricated at MIT to create a three-dimensional accelerometer sensor system suitable for measuring the acceleration of human hand motion. With the advancements in technology various new sensor are introduced. One of the sensor is accelerometers, these sensors have tremendous application in various aspects of life and engineering. We use this sensor for designing a wireless hand motion/gesture. Till now accelerometer was used only in Tilt sensing and sensing of Shock or vibration. Very few or none have implemented application on continuous time varying signal output of accelerometer. As in tilt and shock sense only voltage thresholds need to be tested but in motion detection complete series of samples are required from point A to Point B and this data has to be processed for detection of motion type. We are not developing our project using Mat lab or similar costly tools. Our project is not miles stone towards futuristic Human machine interface but it can help blinds and other persons with other disabilities in interacting with their surrounding environments.

2. Existing system

Infrared wireless control is a dominant remote control method in that it can keep people stay comfortably in sofa and enjoy the service provided by various electrical appliances. But shortages are

obvious as well including one direction communication, one-for-one control, line-of-sight control, and handheld control. Gesture-based control, using vision or wearable sensors, is another important branch for remote control. Vision-based control is often based on CCD (Charge Coupled Device) and vision recognition, which is lightweight for the user since it requires no or only some marks to be attached onto the body. But it is generally heavy for the system, which includes a set of Devices to be deployed into target environment since in most of the cases the cameras need to be fixed in a location and difficult to be operated by users. Recently, some self-contained portable vision-based control system is proposed like sixth sense. But it can only detect the two dimension static gestures since only one camera is contained and dynamic gestures require high computing resources. Unlike vision, wearable sensor based method requires relatively small computing resources even for the dynamic gestures. Moreover, it is possible to detect the three dimension nature gestures in daily life through well designed sensors combination and deployment. ARC proposed a watch-type wearable remote system to recognize hand motions, and the concept of virtual menu to operate various kinds of consumer appliances in a unified way. But it still request user to face to a display to navigate the menu. Wearable control does not need to be held in hand, and can provide at-hand service with little accessing time. Moreover, wireless can provide two-way communication among multiple devices at the same time. More specifically, a wearable ring-type sensing mote called transmission node is adopted to detect the nature finger gestures. So far, various kinds of devices and methods are proposed to detect the finger gestures. But due to the limitation of the technologies at that time, the size of device is too big to be worn on the finger. Recently, development of several kinds of technologies, including MEMS sensor, system on chip, mini size Li Po battery, and wireless power transportation, have make it feasible to design and implement such kinds of small light-weight sensing mote with relatively low cost.

3. Proposed system

This proposed project is based on developing application and demonstrates the usage of gesture in air.Hand motion sensor is used to trace the pattern in air and transmits to the domotics control system. The pattern made in the air could be in 3-Dimensional form, since the accelerometer used in here is 3D.

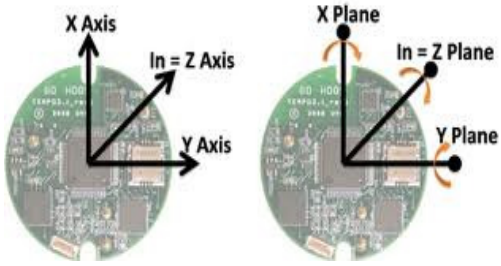

Fig: A tri-axial Accelerometer

The pattern drawn in air is converted into strokes by the ADC (Analog to Digital Convertor) connected to the accelerometer. The converted strokes gets transmitted to the receiver through RF (Radio Frequency). The receiver in the control system receives the Strokes and matches with the predefined pattern.Once pattern is matched to stored pattern, corresponding device is switched ON/OFF.

4. Hardware Design

System Model

This system comprises of accelerometer sensor, microcontroller, analog to digital converter, I2C protocol, radio frequency transmitter and receiver of certain range and LCD interfacing for displaying operation that is currently performed. P89V51RD2 microcontroller is made use of in this system as it capable of performing the operations which are needed to be done. Radio frequency of 433.92/315 MHz is being used at both the transmitter and receiver circuit. It operates at 1.5-12V and requires 11mA current consumption at 3V.

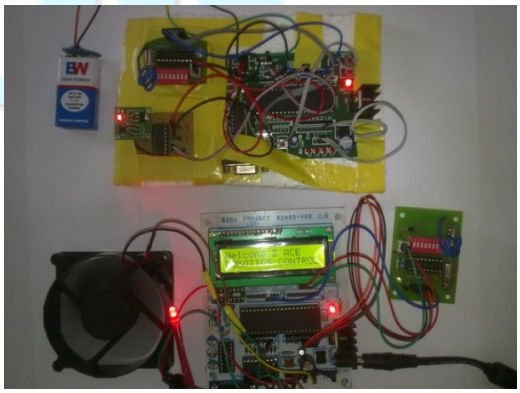

Fig: Domotics control system

Transmitter:

It consists of MEMS based 3-axis accelerometer that senses the gesture drawn in air and sends the sensed signals to the ADC where the conversion process takes place. The microcontroller matches the stored or recorded pattern with that of the pattern drawn. The converted strokes are transmitted on to the receiver circuit through the radio frequency transmitter.

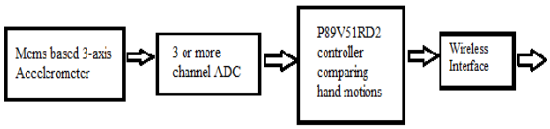

Fig: Transmitter Circuit

Accelerometer:

The accelerometer measures the acceleration *i.e.* hand motion.An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer.

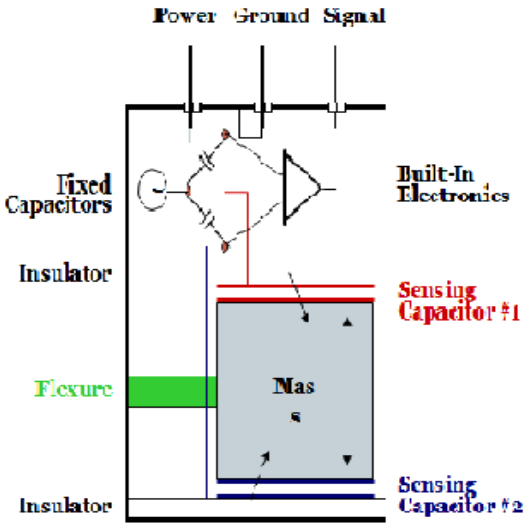

Fig: Capacitive operational principle

ADC:

The analog to digital converter converts the pattern into strokes for processing the signals. This ADC is connected internally to the microcontroller by I2C protocol.

I2C Protocol:

Inter Integrated circuit is a multi master serial single-ended computer BUS used for attaching low speed peripherals to a mother board or embedded system. It is a two wire interface which only describes a compatible hardware. I2C uses only two bidirectional open-drain lines, Serial Data Line (SDA) and Serial Clock (SL), pulled up with resistors. Typical voltages are +5/+3.3V although systems with other voltages are permitted.

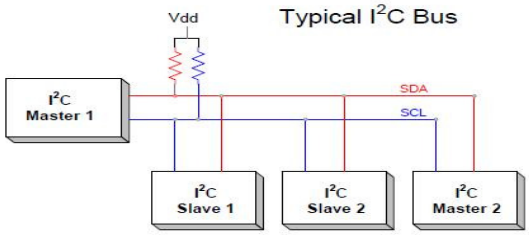

Fig: I2C BUS

Receiver:

The radio frequency signal is received by the receptor circuit which inturns receives the commands serially. The LCD interface displays the command being received and the operation that is performed. The domotics control system takes care of the appliances that are connected to it which has been programmed. Specific appliances are controlled using the predefined pattern. RS232 port is used to burn the program in to the microcontroller/embedded system through PC interface.

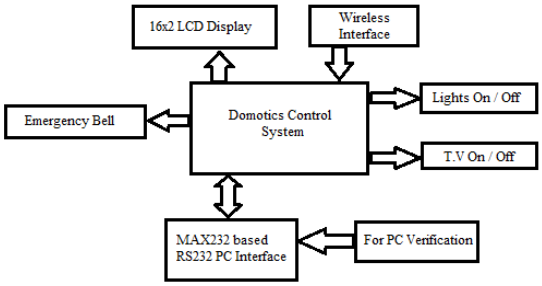

Fig: Receiver circuit

5. Conclusion and future work

A gesture based method for appliance control is proposed and preliminary evaluated. Comparing with infrared remote controller, a competitive performance can be achieved after tens of minutes of practice. Moreover, the limitation of such a kind of control paradigm is pointed out, which is not fit for long-term continuous operation due to mental fatigue problem. In the future, effort should be taken to minimize the negative factors for the proposed method like the stable gesture recognition method and intuitive gesture definition.

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