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Review on Sensor based Hand Gesture Recognition System

Kunal R. Jambhulkar

M. E. Student, Department of Embedded System and Computing , Nagpur Institute of Technology, Nagpur, Maharashtra, India

Abstract

The computers are becoming very useful and important in our daily life with the growing trend of pervasive computing. Pervasive computing provides ways to embed computational capabilities into the daily used objects for performing useful tasks and making it efficient. Gesture recognition system is the system which made possible to humans to interact with machines with the use of hand gestures.

This paper provides a brief review of previous researches in the field of gesture recognition, where different hand gestures are used as input to perform some functions. In our proposed system, micro-electro-mechanical systems (MEMS) accelerometers and flex sensor are going to be used to capture the hand gestures. The information provided by sensors are processed in the ARM 7 microcontroller and then wirelessly transferred to the computer. Various algorithms are going to be used to filter the information provided by sensors and to detect the hand gesture.

Keywords: *Gesture Recognition, Micro-Electro-Mechanical Systems (MEMS), accelerometer, Flex sensor, Microcontroller, Algorithm.*

1. Introduction

The gesture is most useful tool in the human life as a communication method to simplify the process of communication. For some peoples like who cannot speak, these physical gestures are the only language they can use for communication in the form of Sign language, which can be used to efficiently convey facts and feelings.

Gesture Recognition is the process in which the physical gestures can be used for machine control. The main aim of gesture recognition system is to create a system which can recognize physical gestures to transfer information and machine control interfaced by computers using human gestures, commonly hand movements. Some of the mathematical algorithms are used to detect, analyze and interpret the human gestures.

The concept of gesture recognition can be implemented by mainly two methods, Vision-based method and Sensor-based method. In Vision based method, a camera is used for capturing the human gestures; this camera is connected to the computer device which processes the information recorded by the camera and execute the function specified according to the gesture performed. In Sensor based method, the wearable prototype is used which is having some sensors on it to detect the motion and alignment of hand, this device is also connected to a computer device which further analyzes the gesture and performs the specified function.

In our proposed system, we are using the sensor based method for gesture recognition, because it is more hardware dependant hence fast as compare to vision based method which is more software-dependant. Micro electro mechanical system (MEMS) is the miniature device uses the micro-fabrication technology where mechanical parts can be used in microelectronic circuits. Integrated MEMS sensors already consist of data acquisition, data storage, filtering, the communication interface and networking. This product can be used to make the system smaller and better, hence increases the modularity and applicability in our sensor based system.

MEMS accelerometer is a device which detects and measures the acceleration changes in three directions of space. Hence it can be used to detect the hand gestures in our system.

In our system, these MEMS accelerometers are attached to the wearable hand gloves, the acceleration made by hand are detected by these accelerometers in three dimensions and these acceleration values recorded are transmitted to the central microcontroller based on ARM 7 architecture, which then analyze and filters the data and detects the gesture. This information is transferred to the computer system wirelessly to perform the gesture related functionalities.

2. Sensors used in Gesture Recognition

In the sensor-based gesture recognition system, various sensors are used to capture the gesture of the hand.

2.1 Flex Sensors

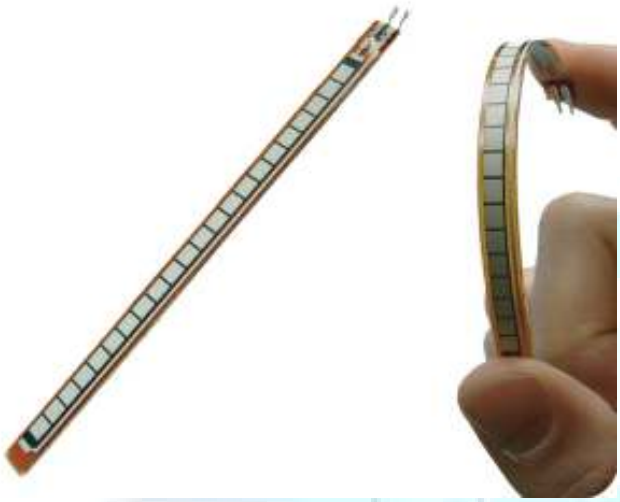


Fig. 1 Flex Sensor and It's Bending direction

A flex sensor is a sensor that measures the amount of bending or deflection. Usually, the sensor is stuck to the surface and resistance or sensor element is varied by bending the surface. Since the resistance is directly proportional to the amount of bending, it is used as Goniometric and often called flexible potentiometer. It is also called Bend sensor.

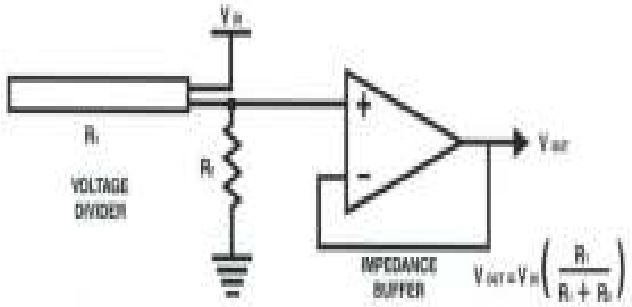


Fig. 2 Basic Flex Sensor Circuit

Flex sensor consists of carbon resistive elements within a thin strip, that are flexible. When strip bends, flex sensor generates output resistance depending upon the radius of the bend. In gesture recognition system the flex sensors are used to measure the bend in the finger so that some basic gestures can be generated.

2.2 Contact Sensors

Fig. 3 Contact pad Sensor

Contact sensors can be made using only two metal plates with pull down resistance. Which produce high values to the microcontroller, when they get connected with each other. In gesture recognition system, they can be used to detect whether the two fingers with contact sensors attached are in contact with each other or not.

2.3 Accelerometers

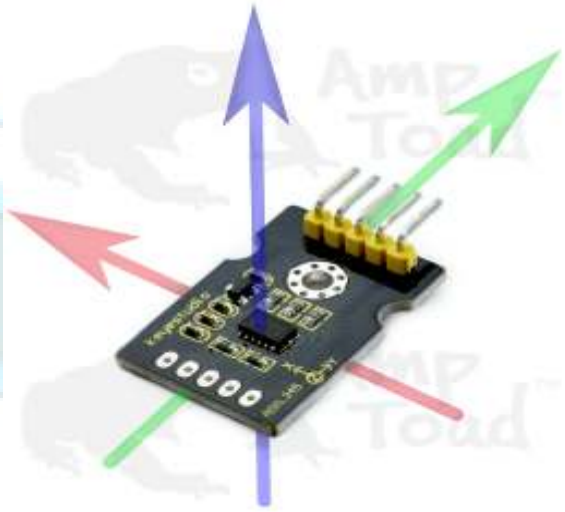


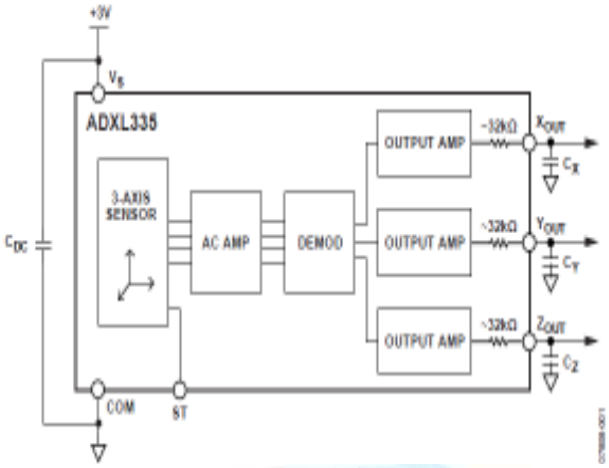
Fig. 4 A 3-Axis Accelerometer

An accelerometer is a sensor which measures the acceleration or motion of the device with respect to gravity. A 3-axis accelerometer measures the 3-dimensional values of the motion. Accelerometers are electromechanical

devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations and movement.

Generally, accelerometers contain capacitive plates internally. Some of these are fixed, while others are attached to miniature springs that move as a force of acceleration acts on the sensor. As the movement of plates are in relation to each other, the capacitance between them changes. From these changes in capacitance, the acceleration can be determined.

Other accelerometers can be centred on piezoelectric materials. These tiny crystal structures output electrical charge when placed under mechanical stress.



Fig, 5 Accelerometer ADXL335 Circuit

The product measures the acceleration with a minimum range of ±3 *g*. The user can select the bandwidth of the accelerometer using the CX, CY, and CZ capacitors provided at the X, Y, and Z pins. Bandwidths can be selected to a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis as suitable to the application.

2. Literature Survey

This section describes some of the related works already done in the field of Sensor based Gesture recognition.

D.K. Barbole and Dr. D. V. Jadhav [1], proposed a system for gesture recognition using flex sensors. The two or three flex sensors are connected serially and output of these sensors are sent to Analog to Digital convertor (ADC). The operational amplifier is used to amplify the output voltage of the sensors. PIC microcontroller and ARM7TDMI microcontroller are used at transmitter and receiver section respectively for processing of the sensor data at both sides. RF transmitter and receiver module were used to make system wireless. In this system, only limited type of gestures can be performed because flex sensors are capable of detecting only bending gestures.

Aaisha Parveen S and Rohitha U. M. [2], proposed a flex sensor-based gesture recognition system for disabled people. It uses 3 flex sensors mounted on each of the fingers of the glove. These sensor values are sending to the PIC 16F877 microcontroller mounted on that glove for processing of sensor data and detection of gesture. Then this information is further provided to GSM modem which acts like a mobile phone to send a predefined message to another cell phone.

Solanki Krunal M. [3], proposed an Indian sign language recognition system using flex sensor glove for deaf and dumb peoples. Five flex sensors are used in the system for each finger of the hand glove. In this system, user had to press a button to start capturing the gesture. When a user presses the button, five signals coming from five flex sensors are captured and amplified using amplification circuit. Then the information is sent to the microcontroller where analog signals are converted to digital form and if the gesture pattern matches with the samples in the database then the particular message is shown on the LCD.

Meenakumari M. and M. Muthulakshmi [4], proposed a MEMS accelerometer based hand gesture recognition system. A 3-axis accelerometer is used which measure the analog acceleration values which then sends to the microcontroller then analog signals are converted to digital values and these values are sends to the computer by Zigbee transceiver module. The trajectory recognition algorithm is used for gesture recognition. The limitation of trajectory recognition algorithm is that it can only recognize a letter or number finished with a single stroke.

G. Vijaya Kumar, Dr. Y. Padma Sai, V. Naveen Kumar and A. Prathibha [5], proposed an accelerometer based hand gesture recognition system for the disabled. The system uses a tri-axial accelerometer MPU-6050, microcontroller MSP430g, Bluetooth module HC-05. The System is developed on Linux OS platform and microcontroller is programmed with Energia, an IDE and Application for gesture recognition is developed using Qt creator, a framework for the creation of desktop applications.

David Mace, Wei Gao and Ayse K. Coskun [6], proposed an accelerometer based hand gesture recognition

system using Feature weighted naïve Bayesian classifiers and Dynamic time warping. In this paper, the two methods for gesture recognition system are compared and tested for 5 gesture samples of 4 gesture types from 5 different people. The accuracy is 97% for Feature weighted Bayesian classifier and 95% for dynamic time warping. Both the proposed methods have comparable accuracy with Hidden Markov models and k-mean algorithms.

Osama Nisar, Muhammad Anas Imtiaz, Shehwar Hussain and Omer Saleem [7], proposed a performance optimization technique for flex based gesture recognition system. The Glove designed using flex sensors and an accelerometer is used. It discusses the basic and exceptional problems can occur in such system and gives the procedure for performance optimization.

4. Proposed System

In our proposed system, we tried to justify the problems arises in the already proposed system by respected authors. We are going to use accelerometers and flex sensors both to address every possible hand gestures.

The proposed system will be divided into the following modules.

- Sensor Selection
- Microcontroller Selection
- Development of Hardware
- Development of Software

The first module consists of the selection of sensors for gesture recognition such as 3-axis accelerometer and the flex sensor. 6 tri-axial MEMS accelerometer are going to be used 5 for each finger and 1 for detecting an orientation of palm; also a flex sensor is going to be used for detecting any bending finger gesture.

The second module consists of the selection of microcontroller for the system. We are going to use Teensy board, which is a complete USB based microcontroller development system in a very small footprint, capable of implementing many types of projects. It consists of 32 bit ARM cortex M4 core which is based on ARM 7 architecture. It also had on chip 16 bit analog to digital converter (ADC) and works on 3.3 to 5 volts.

The third module consists of all the arrangement and connections on the hand glove. The hand glove consists of accelerometers, flex, teensy board, wireless transmitter and battery.

The fourth module consists of the development of software in which microcontroller programming for sensor data processing and a computer application which detects the gesture and performing functions according to it.

5. Conclusions

This paper gives a brief review of some already proposed approach in the field of sensor-based gesture recognition and according to that, we propose a system which can be addressing the problem arises in this type of sensor-based gesture recognition system such as fast and accurate gesture recognition system. The teensy development board used is the compact in size and perfectly suitable for our glove based model and capable of handling our required tasks also two types of sensors are used for effective and accurate capturing of gestures. The receiver section has the wireless receiver module attached to the computer by which the sensor data is transferred to the computer where an efficient algorithm can be used to process the data, detect the hand gesture and perform the respective operations.

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