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Design and Implementation of Gesture Controlled Robot

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ABSTRACT: In today's era human-machine interaction is becoming widespread. So, with the introduction of new technologies the gap between machines and humans is being reduced to ease the standard of living. Gestures have played a crucial role in diminishing this gap. This paper deals with design and implementation of an accelerometer based hand gesture controlled robot controlled wirelessly using a small low cost, 3-axis accelerometer. A novel algorithm for gesture identification has been developed to replace the approach of conventional controlling mechanism of robots via buttons etc. by an innovative hand gesture based controlling. Using a microcontroller system, the program has been written & executed [1].
KEYWORDS- Accelerometer, Gesture, Microcontroller, Robotics, Bluetooth.

I. INTRODUCTION

The current emerging technology in the field of science is Robotics. It is the new emerging booming field of great use to people in the coming years. These days a number of wireless robots are being developed and put to various applications and uses. In order to enhance the contribution of robot in our daily life we need to find an effective way of communicating with robots. For this purpose, there have been certain developments in area of human-machine interaction. One common form of communication is Gestures that are not only limited to face, body and fingers but also hand gestures. In order to increase the use of robot in places where conditions are not certain like rescue operations, robots can be made to follow the instructions of human operator and perform the task accordingly. This proposes an integrated approach of recognition of hands which is intended to be used as human-robot interactioninterface.Gestures control robots are extensively employed in human non-verbal communication. They allow to express some special situations they can be the only way of communicating, as in the cases of deaf people (sign language) and police's traffic coordination in the absence of traffic lights, a real-time continuous gesture recognition system for sign language Face and Gesture recognition. A Gesture Control Robot is a kind of robot which is controlled by the hand gestures and not by using buttons.
The robot is equipped with two sections- Transmitting section and Receiving section. In the Transmitting section, the accelerometer is mounted on hand of the user capturing its gesture and moving the robot accordingly.

The objective of this paper is to build a wireless gesture control robot using microcontroller, accelerometer, Bluetooth module. The microcontroller reads the analog output values i.e., x-axis, y-axis and z-axis values of the accelerometer and converts that analog value to respective digital value. The digital values are processed by the microcontroller and according to the tilt of the accelerometer sensor mounted on hand, it sends the commands to the Bluetooth transmitter which is received by the receiver and is processed at the receiver end which drives the motor to a particular direction. The robot moves forward, backward, right and left when we tilt our palm to forward, backward, right and left respectively. The robot stops when it is parallel to the ground. So, the primary basic aim of design is to make the robot move as soon as the operator makes any gesture [2]. The goal of this paper is to develop methods that helps user to control & program a robot with high level of abstraction from robot specific language.

II. RELATED WORK

The emergence of service robots in early 90's (Helpmate Robots and Robo-Caddy) followed by the development of natural language interface through keyboard has been given by Torrance in 1994[1]. Speech recognition evolved as an upgradation of the past work to communicate with machines but it lacked the standardization of commands due to varying languages, pitch and accent of different users. Hence, researchers [1]-[2] proposed vision-based interface that included gesture recognition through camera to provide geometrical information to the robots. They developed mobile robot systems that were instructed through arm positions but those robot systems couldn't recognize gestures defined through specific temporal patterns. Other limitation faced by the cameras was the poor illuminations at night and in foggy weather [3]-[4].Motion technology facilitates humans to interact with machines naturally without any interventions caused by the drawbacks of mechanical devices. Using the concept of gesture recognition, it is possible to move a robot accordingly[5].

Gyroscope and Accelerometers are the main technologies used for human machine interaction that offer very reasonable motion sensitivity, hence, are used in large array of different applications [6]. In the past years the manufacturers of robot have made efforts for creating "Human Machine Interfacing Device" [8].Using gesture recognition concept, it is possible to move a robot accordingly. Accelerometers are the main technologies used for human machine interaction which offer very reasonable motion sensitivity in different applications. Motion technology makes easy for humans to interact with machines naturally without any interventions caused by the drawbacks of mechanical devices. Accelerometer-based gesture recognition has become increasingly popular over the last decade compared to vision based technique. The factors that make it an effective tool to detect and recognize the human gestures are its low-moderate cost & relative small size of the accelerometers.

III. PROPOSED WORK

The whole project is divided into two sections one is transmitter section and other is receiver section. The block diagram of transmitter section and transmitter prototype is shown in figure 2 and figure 3 respectively. The transmitter section consists of ATMEGA16 microcontroller, one 3-axis accelerometer and one Bluetooth transmitter module.The block diagram of receiver section and receiver prototype is shown in figure 4 and figure 5. The receiver section consists of one Bluetooth receiver module, PIC16F877A microcontroller, one motor driver IC, four DC motor, four wheels. Here, two separate 5-volt power supply is applied to both the sections. Finally, the microcontroller reads the analog output values i.e., x-axis, y-axis and z-axis values from the 3-axis accelerometer and converts the analog value to respective digital value.

The digital values are processed by the microcontroller and send to the Bluetooth transmitter which is received by the Receiver and is processed at the receiver end which drives the motor to a particular direction. The robot moves forward direction, backward direction, right direction and left direction when there is tilt in the palm of user in forward direction, backward direction, right direction and left direction respectively as shown in figure 1.

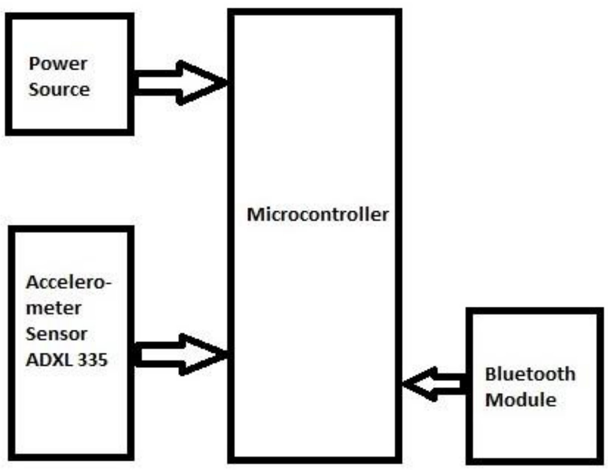

Figure 2: Transmitter section

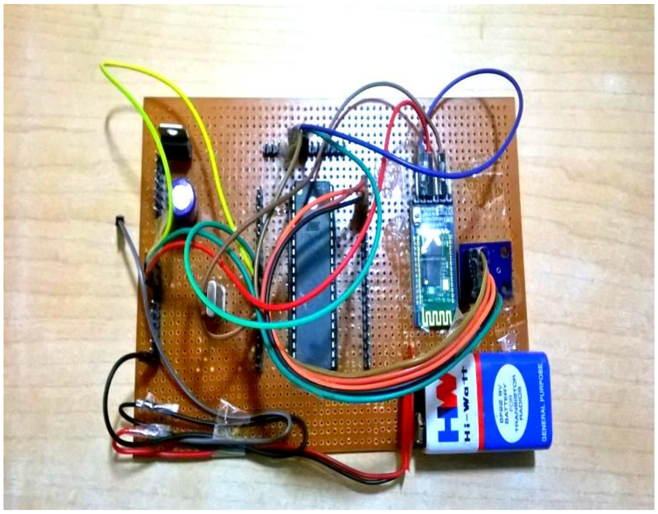

Figure 3: Transmitter Prototype

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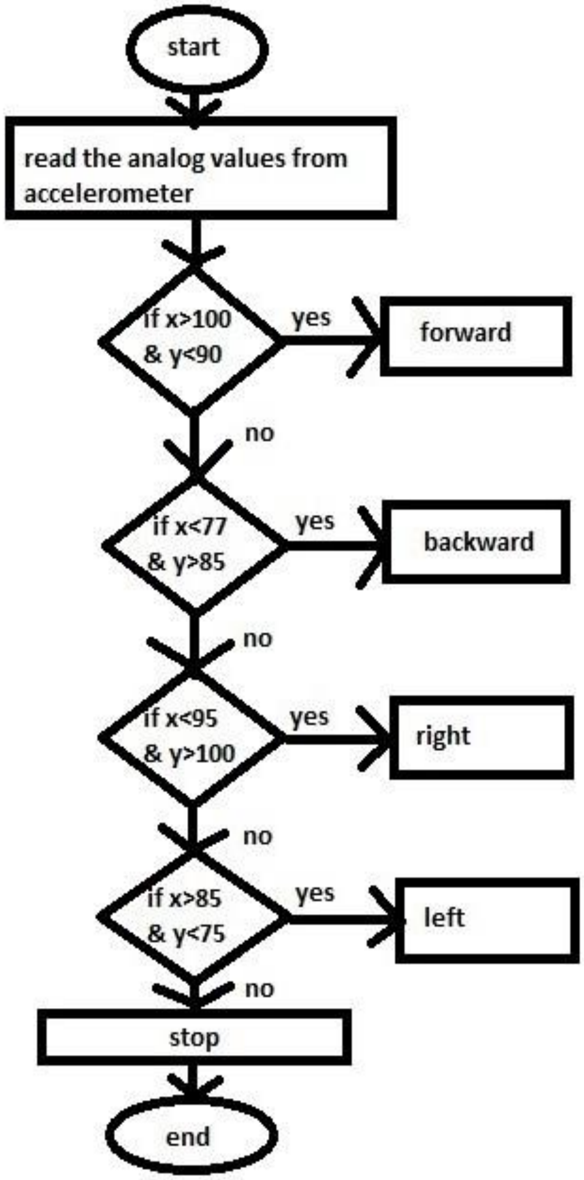

Figure 1: Flow Chart For The Proposed System

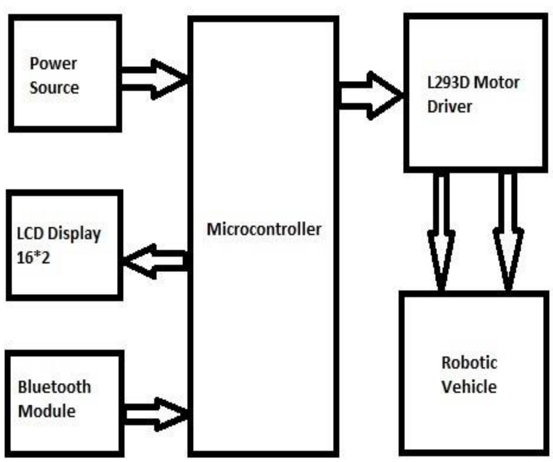

Figure 4: Receiver Section

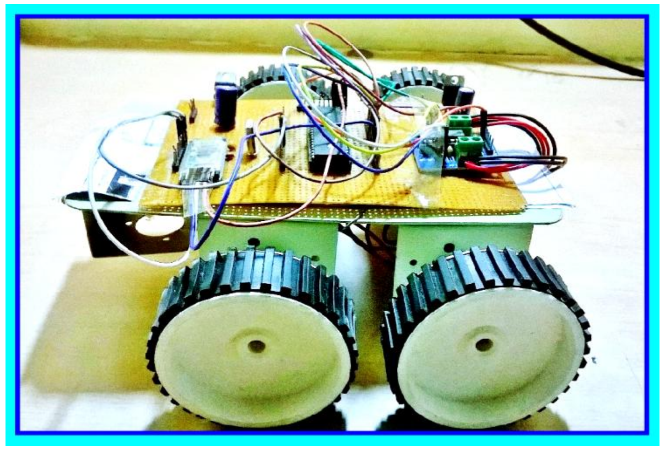

Figure 5: Receiver Prototype

IV. SOFTWARE USED

A. Atmel Studio 7

Atmel studio 7 is the integrated development platform (IDP) for development and debugging Atmel AVR microcontroller. Studio 7 IDP gives you a seamless and easy to use environment to write, build and debug your applications written in C/C++ or assembly code. It also connects seamlessly to Atmel debugging and development kits.

B. MikroC PRO for PIC

mikroC PRO for PIC is a powerful, feature rich environment tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution to developing applications for embedded systems, without compromising performance or control. PIC and C fit together well: PIC is the most popular 8-bit chip in the world, used in a wide variety of applications and C, prized for its efficiency, is the natural choice for developing embedded systems. mikroC PRO provides a successful match featuring highly advanced IDE, ANSI compliant compiler, broad set of hardware libraries, comprehensive documentation and plenty of ready to run examples.

V. HARDWARE USED

A. ACCELEROMETER SENSOR

The ADXL335 is a small, thin, low power 3-axis accelerometer which measures acceleration with a minimum full-scale range of ±3g along with measurement of the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. Tilting an accelerometer along its measured axis, gives the gravitational force relative to the amount of tilt.

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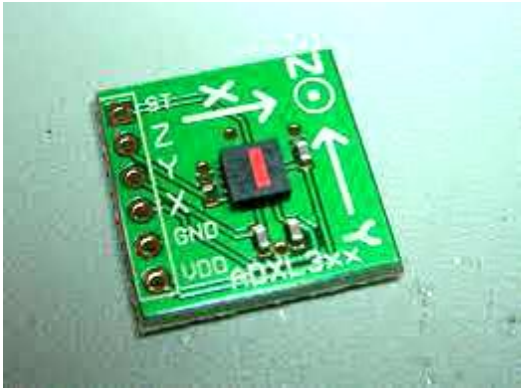

Fig.6: Accelerometer

As shown in Fig.6, there are three axes that can be measured by accelerometer and labeled as X, Y and Z with each axis representing separate degree of freedom (DOF) and the data at that corresponding axis is turned into analog form. They are used in Mobile devices, Gaming systems, Disk drive protection, Image stabilization, Sports and health devices applications.

B. MICROCONTROLLER

ATmega16 Microcontroller

ATmega16 microcontroller is used as the hardware platform. It is the controlling unit, to which all other components (Accelerometers, Motors, Bluetooth modules etc.) are interfaced. It is a low voltage, high performance CMOS 16-bit Microcomputer with 2K bytes of Flash Programmable & Erasable Read-Only Memory. It is an 8-bit high performance microcontroller of AVR family with low power consumption and is based on enhanced RISC) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. It can work on a maximum frequency of 16MHz. It has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. It is a 40-pin microcontroller and have 32 I/O (input/output) lines. The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts.

PIC16F877A Microcontroller

PIC16F877A microcontroller is also used as the hardware platform. This controller is very convenient to use, the coding of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology. It has total 40 pins and there are 33 pins for input and output. Its operating frequency is 0-20 MHz and operate at 2.0-5.5volt. It has 8K ROM memory in FLASH technology. It has 256 bytes of EEPROM memory.

C. MOTOR DRIVER

The primary need is to supply current to the motors as it cannot be done through the microprocessors. The L293D is a 16-pin IC dedicated to controlling of motor. It consists of two H-bridge which is a simplest circuit for controlling low current rated motor. H-bridge has four switches rotating motor in clockwise or anti-clockwise direction.We have used L293D IC which is 16 pin DIP package motor driver having 4 input pins, 4 output pins, 4 VCC pins and 4 ground pins. All 4 input pins are connected to the output pins of microcontroller. And 4 output pins are connected to the DC motors of robot. We have connected all 4 VCC pins to 5V DC supply.

Figure 7: Motor Driver

D. DC MOTORS

The permanent magnet DC[7] motor consists of an armature winding as used in case of a usual motor, but does not necessarily contain the field windings. The constructions of these types of DC motor are radially magnetized permanent magnets and are mounted on the inner periphery of the stator core to produce the field flux. The rotor on the other hand has a conventional DC armature with commutator segments and brushes. The diagrammatic representation of a permanent magnet dc motor is shown in figure. The torque equation of dc motor suggests Tg= Kaφ Ia. Here φ is always constant, as permanent magnets of required flux density are MOTOR chosen at the time of construction and can't be changed thereafter. For a permanent magnet dc motor Tg = Ka1Ia WhereKa1 = Ka.φ which is another constant. In this case the

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torque of DC Motor can only be changed by controlling armature supply. Four DC motor of 200 rpm are used in this paper. One motor is connected to pin 3 and 6 of motor driver and another motor is connected to pin 11 and 14.

E. BLUETOOTH MODULE

The HC-05 Bluetooth Module can be used as a Master or slave configuration, making it a great solution for wireless communication. It has operating frequency of 2.4GHz. The HC-05 Bluetooth module has 6 pins- VCC, GND, TX, RX, Key, and LED. It comes pre-programmed as a slave, so there is no need to connect the key pin, unless you need it change it to master mode. The range for Bluetooth communication is usually 30m or less.

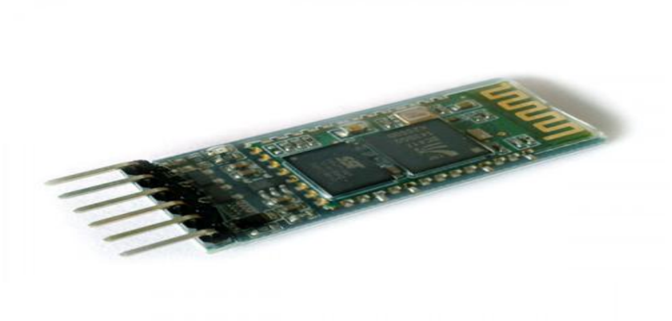

Figure 8: Bluetooth Module

VI. DESIGN AND WORKING

The transmitter prototype is kept on the palm and the receiver prototype (i.e; robot) moves according to the palm movement. This paper explains about the 5-different gesture position of the hand i.e; stop condition, forward movement, backward movement, moves towards right and moves towards left.

Stop Condition

When the accelerometer is parallel to the horizontal plane, then robot will not move.

Forward Movement

When the accelerometer is tilted to forward, this condition commands the robot to move in forward direction.

Backward Movement

When the accelerometer is tilted towards backward direction, then the robot will move in backward direction.

Tilt Towards Right

When the accelerometer is tilted towards right, then the robot will move in right direction.

Tilt Towards Left

When the accelerometer is tilted towards left, then the robot will move in left direction.

Figure 9: Hand Movements

VII. CONCLUSION AND FUTURESCOPE

Hand Gesture Control becomes an example of companionship between man and machine in the race of man vs. Machine. There is a rapid growth on application development considering gesture recognition system. So in this paper, we propose a model of a robot based on "Gesture Controlled Robot" utilizing hand gestures to communicate with the robot. The 3- axis accelerometer selected to be the input device of this system captures the human gestures. When compared with the other input devices accelerometer is easier to work and offers the possibility to control a robot by wireless means. The low price and short set-up time are other advantages of the system.Future work will build upon the improvement of the correctly recognized the gestures. One approach might be the implementation of this robot to detect human life in earthquake and landslide by implementing the sensor accordingly and second approach can be that we can install a GPS in the system to track the position of robot.

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