Design of MEMS based Gesture Controlled Robot by using AVR Microcontroller

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Abstract— MEMS means micro-electromechanical system, also known as Microsystems technology is characterized both by their small sizes and the manner in which they are made. MEMS devices are consider to range in characteristic length from one millimeter near to one micron-many times smaller than the diameter of a human hair. In robotics, sensor plays an important role. Robotics application demand sensors with high degree of repeatability, precision and reliability. In this project we are going to implement a model to control robotic arm through human gesture using accelerometer. A three axis accelerometer is mounted on the human hand in order to perform the action of robotics arm according to the action of human hand. Here in place of button, joysticks we are going to use some other more initiative techniques, i.e. controlling complete robotics arm by hand movement or motion or gesture. This is achieved by using MEMS-accelerometer technology, showing the diversity of the application of same technology. To implement this here, there is a use of AVR microcontroller both at transmitter and receiver side. We are going to implement MEMS based gesture control robot using AVR microcontroller with the help of transceiver module CC2500.

Key words: MEMS, Gesture, AVR Microcontroller

I. INTRODUCTION

Nowadays in each and every field robotics is playing an important role in enhancing the productivity and to improve efficiency of the all the system. The increasing population leads to the expectation of new technical innovation to fulfill the new challenges being faced by human being. The main objective of the project is to implement the hand movement gesture, being captured by the sensor called accelerometer. The project is to design and to develop the Robot that is used to move using wireless system by recognizing hand gestures that is controlled by accelerometer sensors for virtual environment & human-machine system. In this project a general method of mapping human motion to the robotic arm domain has been demonstrated. The arm movement is reciprocated almost exactly by the robotic arm. Gesture controlled robots are extensively employed in human non-verbal communication. They allow to express orders, mode state, or to transmit some basic cardinal information. This project reports an adaptation of this combination gloves for transmitting gestures to control function of robot. The use of intelligent robots encourages views of the machines as a partner in communication rather than as a tool. In the near future, robots will interacts closely with the group of humans in their everyday environment in the field of entertainment, healthcare, nursing. Therefore, it is essential to create model for nature and intuitive communication between humans and robots. Furthermore, for initiative gesture-base interaction between humans and robot, the robots should understand the meaning of gesture with respect to society and culture.

II. OVERVIEW OF MEMS SENSOR

MEMS sensor plays a significant role in process control, factory automation & machine control applications. MEMS sensors are created using micro-fabrication technology like surface micromachining, Bulk Micromachining or by LIGA process. Micro sensors (e.g., accelerometers for automobile crash detection and pressure sensors for biomedical applications) and micro actuators (e.g., for moving arrays of micro mirrors in projection systems) are examples of commercial applications of MEMS. Micro sensors are built to sense the.

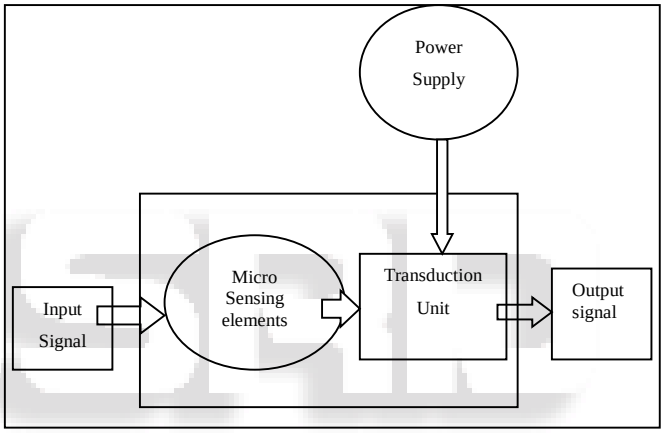

Fig. 1: Shows MEMS as Micro Sensor

existence and the intensity of many physical, chemical and biological quantities, such as temperatures, pressures, forces, sounds, light, nuclear radiation, magnetic fluxes, and chemical compositions.

Micro sensors have the advantages of being sensitive and accurate with minimal amount of required sample substance. Fig.1 shows MEMS as micro sensor. There are many different types of micro sensors developed for a variety of application, they are widely used in industry. Common sensors include bio sensors, chemical sensors, optical sensors, and thermal and pressure sensors. The piezo resistors constitute a part of the transduction unit. The change of electrical resistance in the resisters induced by the change of the crystal structure geometry can be further converted into corresponding voltage changes by a micro Wheatstone bridge circuit also attached to the sensing element as another part of the transduction unit. The output signal of this type of micro sensor is thus in the voltage change corresponding to the input pressure.

III. LITERATURE REVIEW

This paper describes about the gesture control robot which can be control by your normal hand gesture by using Arduino IDE[11].In this paper to replicate the motion of

human arm MEMS accelerometer have been used. The idea is to change the perception of remote controls for actuating manually operated robotic arm[4]. The hardware and software co design of robotic arm controller using four servomotors employing micro controller. Micro controller programming can be done with a easy way to suit the requirements [9]. Unlike [7] which employ FPGA based control. Micro controller based program can be flexible in modifying to suit the necessary drive control of the servo motor.

IV. WORKING PRINCIPLE

In this project we are going to use Atmega 8 Microcontroller at the transmitter side and Atmega 16 Microcontroller at receiver side as shown in fig.2 & 3 respectively. The transmitter circuit consist of accelerometer which is mounted on human arm, which will sense the hand gesture and after processing it with the help of microcontroller the signal is given to the receiver through transceiver module. At the receiver side motor have been used to replicate the motion of human arm.

A. Block Diagram

1) Transmitter

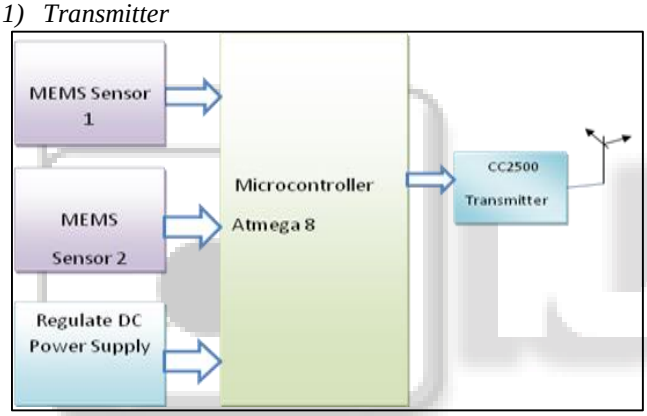

Fig. 2: Block diagram of Transmitter

2) Receiver

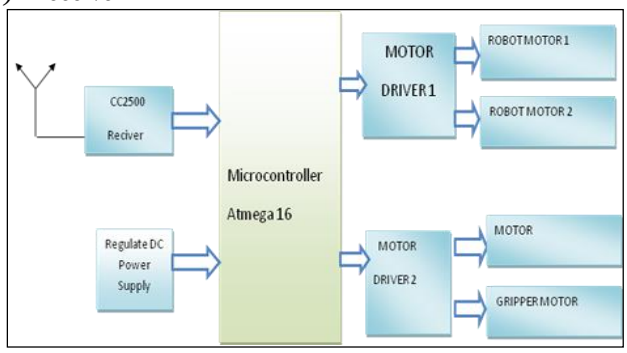

Fig. 3: Block Diagram of Receiver

MEMS Accelerometer (ADXL335): Accelerometer is a sensor which is used to detect the motion of operator's hand. It convert the displacement caused by the inertial force into voltage signal. In this project two accelerometer sensors are used. The ADXL335 is small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs.

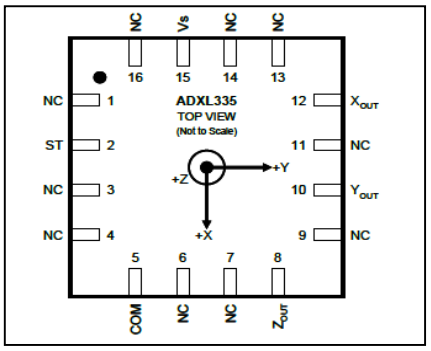

Fig. 4: Pin diagram of ADXL335

AVR Microcontroller (Atmega 8, 16): To implement this project we are using AVR Atmega 8 bit &, 16 bit microcontroller. The following feature of this microcontroller make it suitable for this application.

- RISC architecture with having fixed length instruction, load store memory access, and 32 general purpose registers.
- A two staged instruction pipeline that speeds up the execution.
- Majority of instruction take one clock cycle.
- Up to 10 MHz clock operation.
- Internal program and data memory.
- In-system programmable.
- Available in 8 pin to 64 pin package size to suit wide variety of applications.
- Wide operating voltage from 2.7 V to 6.01V.
- A simple architecture offers a small learning curve to the uninitiated.

Atmega 8 is a 28 pin IC whereas Atmega 16 is a 40 pin IC. They work on the 5V power supply. The maximum operating frequency of these IC are 16 MHz These IC have inbuilt ADC circuit.

C2500 Transceiver Module: It is a wireless transmitter & receiver module which is used to transmit the data over 30 feet distance. The operating frequency of CC2500 is 2.4GHz. It works in the voltage range of 1.8V - 3.6V. It has high sensitivity & also It has low current consumption.

Motor Driven IC: In this project, two motor drivers IC L293D have been used. Motor drivers acts as current amplifiers since they take low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. One for movement of robot & another for movement of robotics arm. These ICs are work as an amplifier.

Motors: Motors are required for achieving the movement of robotic arm. Here four motors are used for the movement of mobile platform in forward & backward direction, while the remaining motors are used to move arm in upward and downward direction for pickup & pick down operation.

B. Circuit Diagram

1) Transmitter

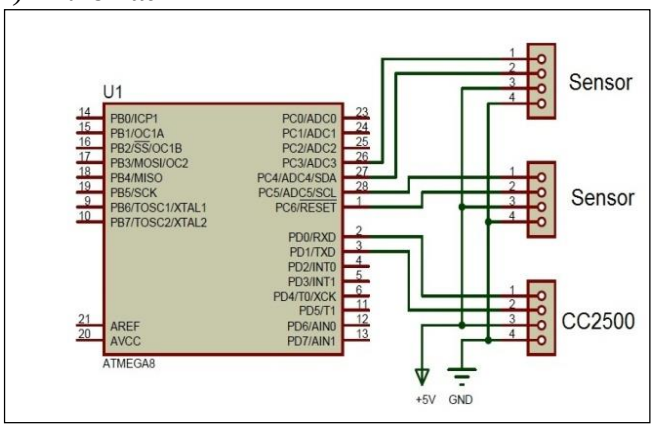

Fig. 5: Circuit Diagram of Transmitter

Transmitter: Above fig.5 shows the circuit diagram of transmitter. In this circuit, we used the Atmega 8 which is 28 pin IC and it works on the 5v supply. Here we have to use two accelerometer which are connected to the pins of port c and the remaining pins i.e., pin 3 and pin 4 are connected to the +5v supply and ground respectively. The next is the CC2500 module. It is a transceiver module. Since it is a transceiver module it can transmit as well as receive the information. It works on 2.4GHz frequency and its range is 100 feet.

2) Receiver

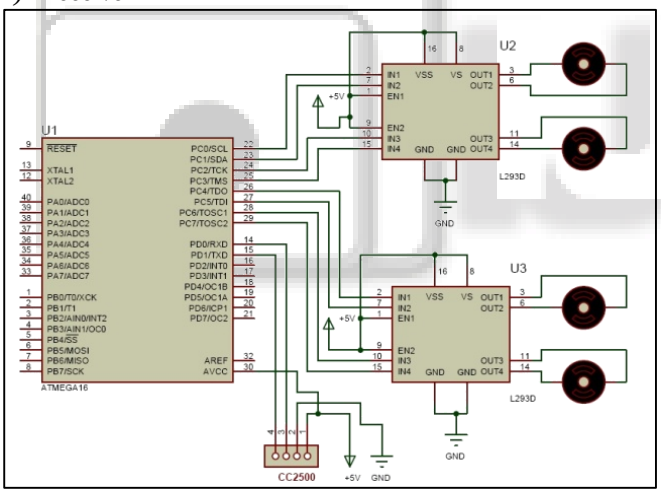

Fig. 6: Circuit diagram of receiver

Receiver: Above fig.6 shows the circuit diagram of receiver. In this circuit, we use Atmega 16 which is 40 pin IC. In the receiver side we use Atmega 16 because at the receiver side there are more connections are present than the transmitter side and we also required more memory space for the programming. We connect two motor driver IC i.e. L293D at receiver side. It works as amplifier. Pins of the both motor driver IC i.e. pins of L293D are connected to the pins of port C of the IC. We also connect the four motors to two motor driven IC. It works on the 9v supply and then again connect to the CC2500 module for the transmitting and the receiving purpose.

C. Power Supply

Power Supply: Above fig.7 shows the circuit diagram of power supply. We apply 12v input supply to it and it gives us the 5v supply which is applicable for Atmega8 and Atmega16 IC. In this power supply circuit we use the 7805 voltage regulator IC which can convert the 12v supply to the 5v. We can also use the capacitor for the filtering purpose and there is one LED for the indication purpose.

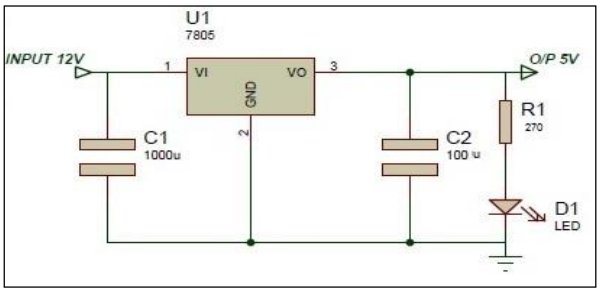

Fig. 7: Power Supply

D. Flowchart

1) Transmitter

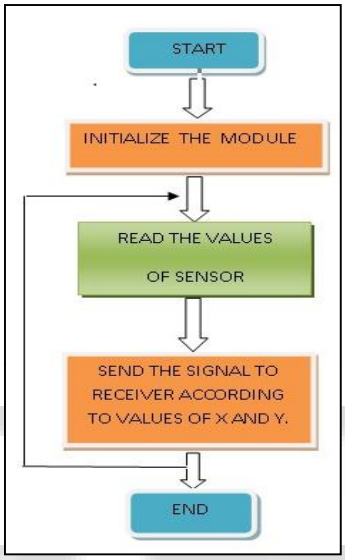

Fig. 8: Transmitter

2) Receiver

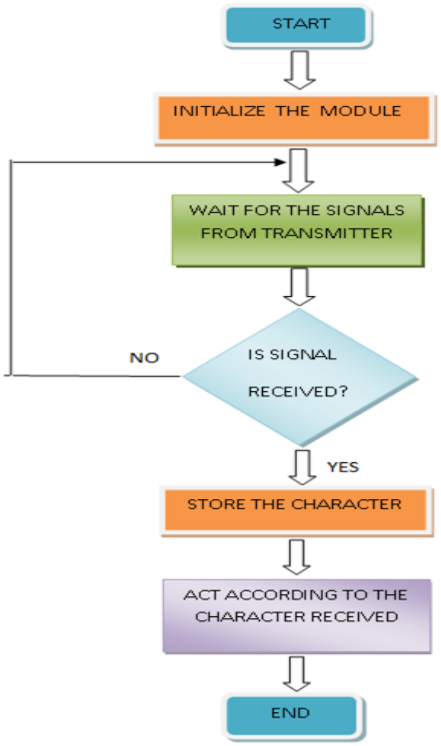

Fig. 9:

E. Robotic Arm Design

To design Robotic Arm is an important part of this project, which performs pick & drop mechanism. The Robotic ARM is built on the board which has dimensions 15*20 cm. The arm is sub divided into four main parts such that base (supporting part), main arm (it's also known as post arm), fore arm and end effectors (it's used as for the gripper).The motor of 10 rpm is used. The actuator is required for actuation flow. Motor is used to the base part which is known as the 1st link, then to the 2nd link and to the fore arm. The moment of inertia for lifting nodes required for arm movement and gripping. The height of the arm part is 40 cm and the angle is 120 degree.

V. FUTURE SCENARIO

1) Research is going on to use brain signals to control the robotic arm. This, if achieved will be of great help to the physically handicapped.
2) Currently under research is the clothing retail industry which will help the users to feel, the texture of the clothes on the internet.
3) We may use Zigbee in place of CC2500 Module to improve the range of the system.

VI. CONCLUSION

In this paper mobile platform along with robotic arm has been designed using MEMS accelerometer and AVR microcontroller. As per the hand gesture there is movement of robotic arm in upward and downward direction as well as mobile platform in forward and backward direction. Here, there is use of CC2500 transceiver module which operates at the frequency 2.4 GHz and has a range of 30 feet. The implemented module may used in the application where precise controlling is required and in application where human life cannot kept on risk like bomb diffusion, space etc.

VII. RESULT

The main objective of the project is to design a gesture controlled robot, which recognizes hand gestures and respond accordingly. The robotic arm is mounted on mobile platform which perform pick and drop function with left and right movement. Finally, the designed structure of arm and mobile platform, works efficiently replicating the gestures of human arm.

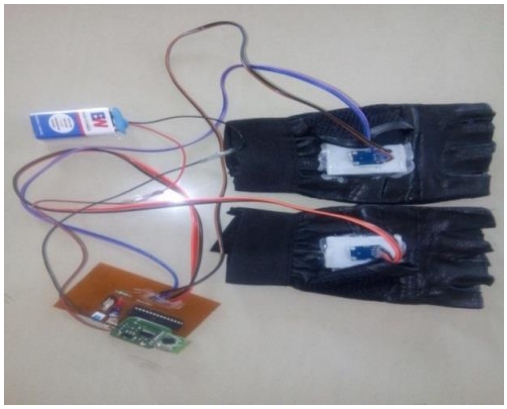

Fig. 10: Pictorial view of Transmitter along with accelerometer

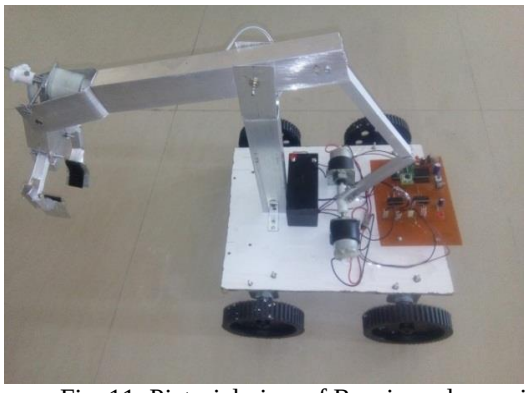

Fig. 11: Pictorial view of Receiver along with robotic arm

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