Mechanical Design and Fabrication of Hand Motion Controlled Robotic Arm

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Abstract – *Nowadays, due to globalization and technological improvement there is need to develop autonomous system. Machines, humans and computers are being integrated for diversified range of applications. The aim of this advancement is more robot-human synchronization and to automate tasks in the field of remote control and execution of tasks. Virtual environments have always been considered as a means for more accurate and efficient human. By integration of human and technology it can perform hazardous explicit operations at safe distance with accuracy This project proposes a cutting edge idea of imitating the human hand movement with a virtually controlled robotic arm, which can be utilized in human endurance situations. Evolution of mechatronics field raised the current technological interaction approaches with semi-automatic or automatic machines, which are widening spectrum of Human-machine applications.*

Key Words: **Accelerometer, 8051 microcontroller, RF Module, Dc motor**

1. INTRODUCTION

A robotic arm is utility device which can be programmed to mimic human hand motion. Such arm is equipped with various joints, motors and gear for mechanical movement of the arm allowing rotational and translator motion. Which in turn controlled by algorithm interfaced in microcontroller. Robotic arm has been widely used in manufacturing industry as part of automation system. Typical applications of robotics arms in industry include welding, painting, assembly pick and place, packaging and palletising, product inspection, and testing.

The main characteristics of this project is the robotic arm is being operated wirelessly and have function of grab and release like human arm. The robotic arm is fully controlled by a microcontroller based system, where the user has to control the movement of robotic arm using his own hand motions. The transmitter circuit is mounted on the hand glove which contains accelerometer interfaced to ATmega328 microcontroller. The output of microcontroller is in binary which is encoded to serial data for transmission. Here we used pair of RF Module to facilitate wireless signal transfer between transmitter and receiver circuit. The signal from the transmitter will be received and processed by the AT89S52 (8051 microcontroller) at the receiver circuit. The valid signal then processed by driver IC which controls the

motor unit and results in desired movement of the arm. As the robotic arm has two degrees of freedom, the received command indicates whether to move arm upward or downward or to grip an object or release it.

2. LITERATURE REVIEW

In mechatronics, robotics and computer field various types of approached are made to achieve objective of hand gesture controlled robotic arm. There are different ways like using light to sense motion, machine learning via pattern database, via various sensors etc. In research paper [1] by Navneetlal B. Wagh, Wagh, Prof. Rahul M. Patil, Namrata S. Navale, Eknath S. Shinde, leap motion technology is used in which infrared light of 850nm reflects back from the moving hands in real time and it is captured by two cameras. Then algorithms are used to generate 3D image. This image is further transferred to microcontrollers to process and give valid commands for movement of arm.

In another paper [2] by Lavanya K N, Ramya Shree D, Nischitha B R, T Asha, C Gururaj, the gestures are recognized by different coloured fingers which mainly uses red, blue and green colours. Different gestures performed are captured by camera with its positional data. This data gets converted to binary and then by comparing them with predefined gestures Arduino processes data and sends command to move the arm. There is another approach in which computers are trained for same hand gestures for large numbers of times to create database which in turn can recognize the hand gesture accurately by machine learning.
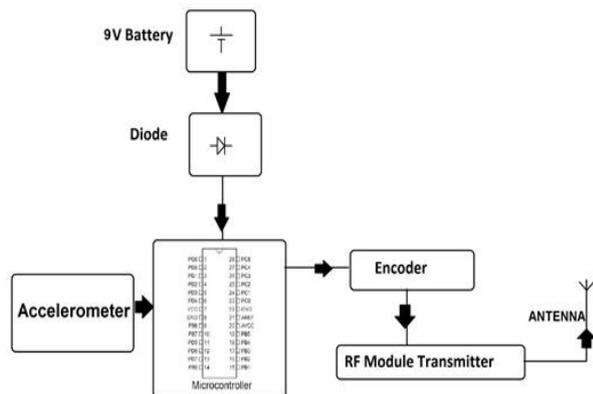
As in paper [3] by Kratz, Sven & Rohs, Michael & Essl, Georg., we can modify system algorithm and integrate gyroscope sensors with accelerometer. It results combined data from both the sensors which improves gesture recognition accuracy with dimensional constraints. We can use this module to obtain 6D data which results in 4% improvement in gesture recognition.

In paper [4] by Mohamad, Auday & Tareq Abdulbaqi, Basil & Jumaa, Noor, the hand recognition system has integrated accelerometer, gyroscope and magnetometer. As the sensors have noise and errors which may lead to false recognition. Hence the readings from all the sensors are combined using sensor fusion algorithm which acts as the complementary filter to provide more accurate results.
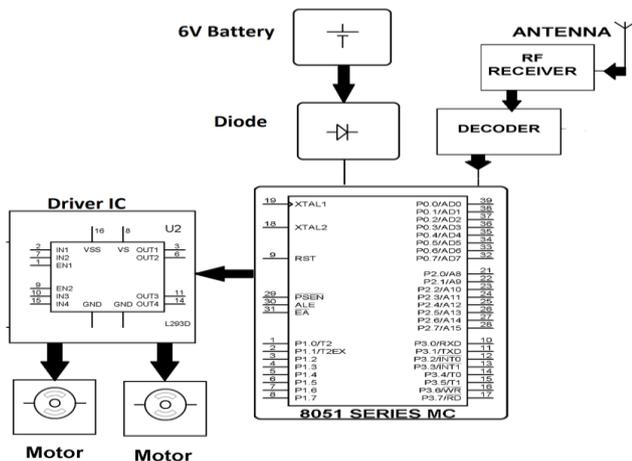
There is also work done on gesture recognition with help of flex sensor. In the flex sensor hand motion changes the resistance which is fed to microcontroller to get appropriate results. There is vast scope and application in remote gesture recognition technology hence effective development is needed in this field.

3. BLOCK DIAGRAM

4. WORKING

Transmitter: On transmitter end there is accelerometer interfaced with microcontroller which is powered by 9V battery, As soon as hand moments are sensed by accelerometer it develops change in voltage which is converted to binary language by ATmega328 microcontroller. Further encoder is used to convert binary data to serial and transferred by RF module transmitter.

Receiver: On receiver end after receiving data from RF module receiver it is converted into binary data by encoder

and transferred to AT89S52 microcontroller. The microcontroller process the data according to interfaced logic and it controls the two DC motors via Driver IC. Then motor movement is utilized to move the arm.

5. MAJOR COMPONENTS

5.1 Accelerometer

In this project accelerometer is major component as it used to sense change in dynamic and static acceleration due to hand motion. Accelerometer can recognize rotational motion with respect earth surface as it have static (gravity) sensor. As the rotational motion takes place accelerometer gives output in terms of varied voltage which is fed to microcontroller. In this project tilt of accelerometer along x-axis in left direction results in grab or pick motion and in right direction results in release motion of arm. Similarly, tilt of accelerometer along y-axis in upward direction results in upward lift motion and downward direction results in lowering of robotic arm.

5.2 ATmega328 Microcontroller

The ATmega328 microcontroller is from Atmel which is low powered 8-bit microcontroller. It has 32 registers which are directly connected to arithmetic logic unit. This is microcontroller is programmed to process the data from accelerometer. The ATmega328 microcontroller gives output according to defined dimensional constraints as in program interfaced. As it has high processing power of 1 MIPS per MHz at low power consumption, it reduces lag and works efficiently.

5.3 RF Module

Radio frequency module consist transmitter and receiver end which are connected at hand gloves and robotic arm circuit respectively. Electromagnetic wave signal is produced at transmitter end and travels to certain distance to receiver end wirelessly.

5.4 Encoder And Decoder

RF Encoder HT 12E is used, it's operating voltage range is 2.4V to 12V. It is capable of encoding N address bits and 12N data bits. It encodes data from output of microcontroller into serial and transferred wirelessly via RF module. Decoder HT 12D receives serial addresses and data from RF medium. The received data is compared with local addresses. If no error is found then data is decoded and transferred to output pin and fed to AT89S52 microcontroller.

5.5 AT89S52 Microcontroller

The AT89S52 is from 8051 family of Atmel microcontroller is a low-power, CMOS 8-bit microcontroller with 8K bytes of in

programmable Flash memory. This microcontroller is utilized to take decision of start/stop of DC motors and also whether clockwise or anticlockwise. This microcontroller is powered by 12V Dc input. it processes input according to interfaced program code and gives output to Driver IC.

5.6 Driver IC:

Here we are using L293D driver ic which contains two inbuilt H-bridge driver circuits. It has capability to drive two DC motor simultaneously in both anti-clockwise and clockwise direction. It is interfaced between AT89S52 microcontroller and two Dc motors. It provides and controls on demand need of voltage to DC motors.

5.7 DC Motors:

Dc motors are used to convert the electrical energy to rotational mechanical energy. There is pair of DC motors are used to facilitate motion of grab and release and up-down motion of arm. Change in input voltage changes the speed, torque as well as start and stop motion of motor which is controlled by Driver IC and microcontroller.

5.8 Battery/Power supply

A 9V battery is used to power the microcontroller and circuit at transmitter end. At receiver end as power demand is high due to Dc motors, 12V volt DC supply from main source is used to power the circuit at receiver.

5.9 Robotic Arm Unit

The robotic arm has two degrees of freedom hence equipped with two DC motors. One is utilized for grab and release operation and other for upward and downward motion of the arm.

6. MODEL AND CIRCIUT

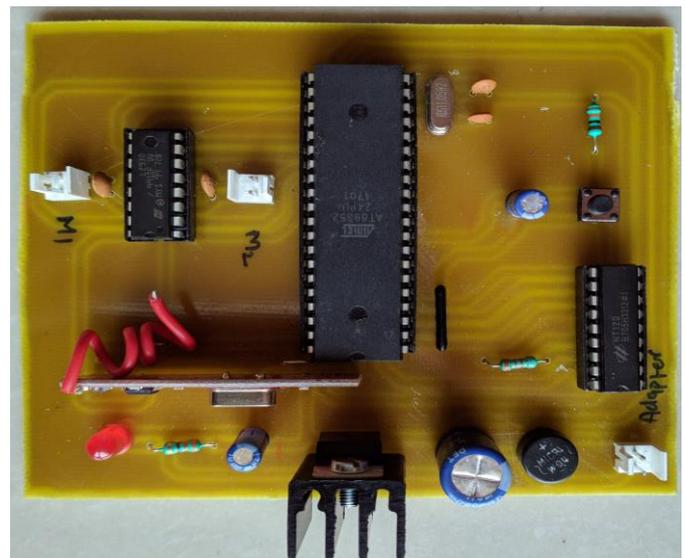

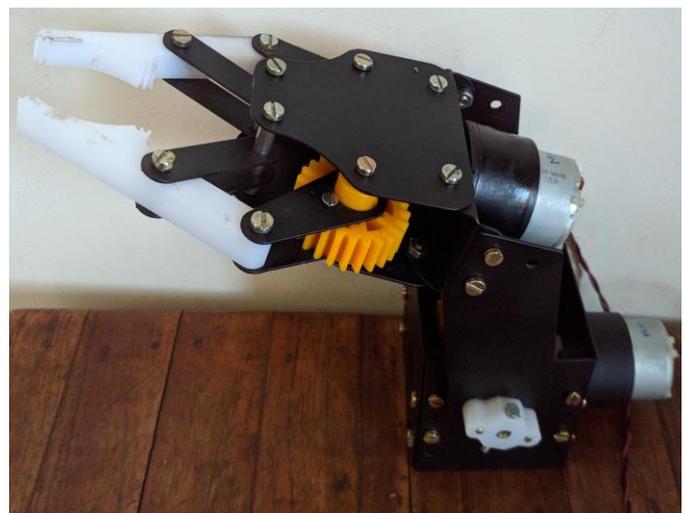**Fig -1**: Transmitter

Fig -2: Receiver

Fig -3: Robotic Arm

7. CONCLUSION

Transmitter-hand glove circuit and receiver-robotic arm circuit are set to work wirelessly by interfacing program in microcontroller. Moment of robotic arm is precise, lag free and work as expected. This technology can be utilized for distant operation at hazardous places like nuclear power plant, bomb diffusion and military purpose. It has wide application in manufacturing industry for distant pick and place, also we can use one transmitter to command more than one receiver to automate the operations. After further improvement it can be utilized to do distant medical surgeries in remote areas and in unmanned space applications.

8. REFERENCES

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