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WIRELESS HUMANOID BIONIC ARM ON ROBOTIC VEHICLE

(Hand Gesture Controlled)

By

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at USMAN INSTITUTE OF TECHNOLOGY or other institutions.

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WIRELESS HUMANOID BIONIC ARM ON ROBOTIC VEHICLE

ABSTRACT

Robotic appliances have entered in our lives a long time back and now people are finding new ways to facilitate from them. These appliances have taken the command of automation industry, service industry and etc. As far as the service industry is concerned a notable chore in different industry or for rescue or military purpose. People have difficulties for a multiple number of works which can be performed by our project. Considering all these factors a robotic hand gesture arm on mobile chassis is the best possible solution allowing the user to use in domestic, military, industry or for hazardous chores in the safest possible way. This project aims to design and develop a robotic hand gesture arm on mobile chassis that completely relates to any industry and will be helpful in our daily lives. This project includes two main features the robotic arm with claw which moves by separate controls and the chassis which has separate.

The report describes in detail the robotic hand gestured vehicle with mounted robotic arm, along with its operation and factual calculated results. The work which is presented in this report provides the industry, military or domestic user with attention to the factors of safety and available standard specifications.

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MAPPING OF PROGRAM LEARNING OUTCOMES (PLOs)

Chapters 1 through 4 and Appendix A & Appendix B	PLO-(x)-Communication PLO-(viii)-Ethics PLO-(ix) Individual & Team Work PLO-(iv)-Investigation
Chapter 01- Introduction	PLO-(ii)- Problem Analysis
Chapter 02- Methodology	PLO-(iv)-Investigation
Chapter 03- Implementation	PLO-(iii)-Design/Development of Solution PLO-(v)-Modern Tool Usage

CHAPTER # 01
INTRODUCTION

1. INTRODUCTION

Introduction (Background): This project the Robotic Hand Gesture Trolley with Robotic Arm Mount consists of a robotic trolley which has two wheels at the back for its back and forward movements and the two wheels at the front are used to change the direction of the chassis. The other part of the project is the robotic arm which consists of a three pronged claw to lift weights. This is designed to lift a weight of about three Kgs.

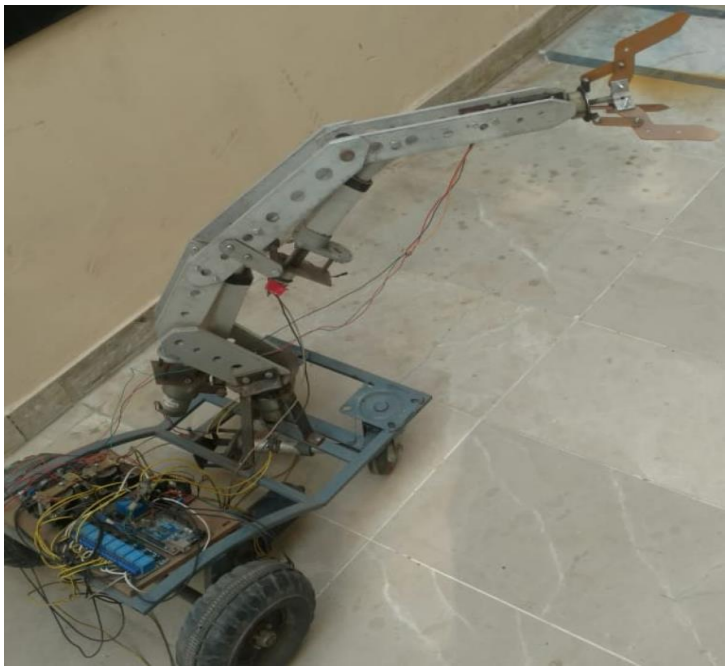

Figure 1.1: complete structure

Let us take a look at the back ground of the project which is basically in robotics. A robot is basically a machine which is electromechanical in nature and it has the freedom to perform a given task on its own that is it can perform autonomously or by human control. However the guidance which the robot receives may be by remote controls from a human controlling it or in many cases it is preprogrammed to perform a specific task.

Here we see an interaction between a machine and human. This is known as human machine interface and is commonly used in industries and elsewhere. Earlier looking back in history we find that all the robots were preprogrammed for their uses. As the technology progresses we saw the advancements in robotics and gesture based robotics was recognized as playing a pivotal role in the field of robotics. The gestures which are used in controlling

the robot basically originate from human movements of hand or facial movements. Here in our project we are basically focusing on hand gestures. The interfacing with the microcontroller, in our case we have used the Arduino Uno microcontroller board which uses the AT MEGA 328p as the AVR micro controller. The gesture logics are sent to the micro controller to be deciphered and then the commands are conveyed to the motors for their individual functions.

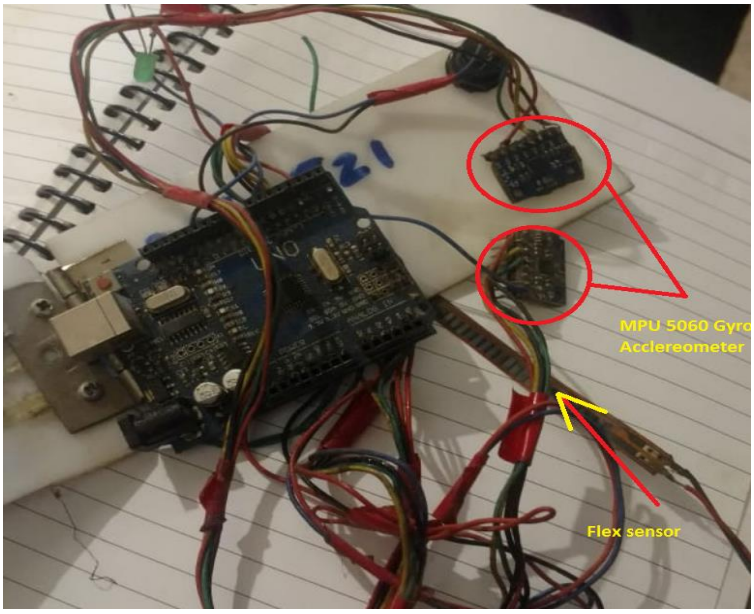

Figure 1.2: MPU5060, Flex sensor for gesture readings

As we can see from the pic 1.2 above that the sensors which are the MPU 5060 which is the gyro accelerometer which depends on the diversion of angle in a movement is used for the control of the chassis and also there are two MPU 5060 used. The other gyro is used also for the movement of the motors of the robotic manipulator. The flex sensor controls the servo motor which is used for the gripping of objects on the gripper. The whole system of controlling the chassis movement and also the arm and gripper is done by these sensors.

The main factor in the controlling of the robot via transceiver modules is a very important factor. This requires an interfacing with the Arduino, MPU 5060, Flex sensor, all the motors and the receiving side of the transceiver module with the transmission side. This functioning of the RF is performed in two step. The first is the connections and

programming of the sensors and the Arduino with the NRF24L01 which is the transmitting side communication and then with the Arduino and the relay modules and then the motors which is the receiving aide of the communication. This transmission is done by using 2.4 Ghz. And has a line of sight range of 300 feet. This enables serial communication between the two sides which is done for transmission of the given commands and also the sensor values.

MOTIVATION: Motivation for our project The Robotic Hand Gesture Trolley with Gestured Robotic Manipulator as the name suggests comes from the introduction of robotics in our country on a macro scale. Our country is an under developed country which generally relies on its labor force for its works and the idea of innovative technologies is an alienating factor to the masses. So we have considered this major issue and taken this project .we can sort out this issues by working on multi source control and output in robotics which our University committee has allowed us and our teachers can guide us on this project with accuracy and knowledge. There will be multiple benefits in using a Robotic Hand Gesture Trolley with Gestured Robotic Manipulator, these include pick and place options to life saving services. Looking at the potential of the idea and at the global demand of the current global situation, we find that multiple benefits can be obtained from this idea. We take a look at the different types and methods of controls using sensor modules and present our project which is developed keeping in mind the efficiency, durability and economy of the system if compared to un mechanized and un automated modes of works combined is greater.

1.1. Problem Statement

The progress done by the developed countries relies on the fact that they adopt innovative ideas and improve the productivity and cut time and dependence on unneeded factors. However if we look at the under developed countries which adopt the usual conventional ways and methods we find that they lag behind on the global forum. This

calls for the use of automations and the use of robotic technologies which are common in the developed countries to be adopted in the less developed countries. We have been motivated due to this factor to bring and work on a product which can change the fortune for our country. Our project as a product can be used in various fields. The basics in our project is an example on the variety of control methods that can be adopted to carry out the robotic functions. The research gap that we tried to fill in our project is the use of various sensors that are responsible for the function of the project and also the transmission side has been developed keeping the cost of materials to the bare minimum without compromising on the results.

1.2. Literature Review

Let us take a brief look on the history of robotic workers. The fundamentals of robotics have to be mentioned in explaining the chapter of robotics. The three fundamental laws of robotics were given by a Russian writer of fiction books known as Isaac Asimov [1]. The visualization of Asimov's robot was a human like machine that has no affections or feelings like a human. The brain of the robot was programmed by humans, and done so in such a way that some ethical perspectives were followed by the robot. Asimov's laws were complemented by his ZEROTH law which was given in 1980's. After the establishment of robotic laws the word itself (robot) in the industrial design fields by researchers and engineers who are working in the field of robotics. [12, 2, 4]. The laws given are;-

1) Robot may not injure humans directly or indirectly, or any harm to come to humans.
2) Robot must follow the orders given to him by humans, Except where those particular commands would interfere with the First Law.
3) As long as such protection does not interfere with the First or Second Laws, the robot must defend its own existence.[1]

4) A robot must follow the trajectory specified by its master, as long as it does not conflict with the first three laws.

5) A robot must follow the velocity and acceleration specified by its master, as long as nothing stands in its way and it does not conflict with the other laws.[9]

1.3. Aims & Objectives

The aims of Robotic hand gesture trolley with robotic arm mount is to define the usefulness of robotics in the practical fields of life. The saving of time and energy by implementing robotics for various purposes where work is done by manual or other means at present will have a huge impact in the long run in terms of development of the country. We also aim to be less dependent on labor oriented works producing more and saving cost. This is also a substitute for humans in life threatening issues such as Bomb disposal, handling corrosive chemicals or other dangerous areas of works. Even the search and rescue operations can be conducted by induction of such robots in this particular field.

. The specific aim include:

- To experiment and observe the output data of the robotic vehicle and the arm manipulator for further research on the project.
- To provide positive feedback on the results and applications in various fields and to justify our project.
- A comparison with the conventional ways of work as used in daily life with the innovative idea of robotic manipulation and its economic factors.

Main objectives of this study is detailed below:

- Production of power and accuracy form using robotic technology.
- To introduce this technology in our country for future enhancements in the industrial and various fields.
- To have the knowledge on the fabrication and machining side of the structure being built and to economize on the cost as well as engineer an efficient product.

CHAPTER # 02
METHODOLOGY

2.1. Hardware Detail

The materials and electronic as well as the mechanical and electrical hardware are documented in this chapter. Here we see the reason for the application of the particular material used and why it is used instead of something else. The materials for the structure of the chassis, the arm, claw, the electronic cards and the electrical materials are given below:-

1) Arduino Uno

The main microcontroller board which is used for programming codes and has the AVR At mega 328P IC is the Arduino Uno. Arduino Uno is the most common version of the Arduino family. This is the latest third edition of the Arduino board and was released in 2011. Microcontroller board based on Arduino Uno ATmega3288. It has 14 digital input / output pins (can use up to 6 PWM outputs), 6 analog inputs, 16 MHz ceramic resonator, USB connection, power jack, ICSP header and reset button. Arduino Uno is a great choice for beginners because it is easy to get started. It is required to support a microcontroller, connect to a computer with a USB cable, or power up an AC-to-DC adapter or electrical storage device.

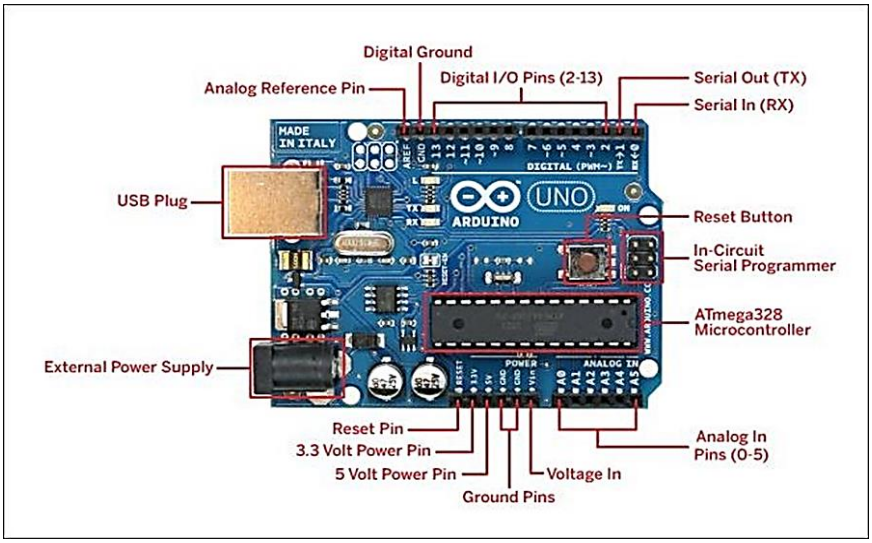

Figure 2.1: Arduino Uno

2) MPU5060

The gyro accelerometer used on the glove for the gesture movements is the MPU 5060. The device offers the world's first integrated 6-axis motion processor solution that eliminates package-level gyroscopes and accelerometer cross-axis misalignment associated with discrete solutions. The devices combine complex 3-axis gyroscope and 3-axis accelerometer with single-silicon onboard digital motion processor to perform complex 9-axis sensor fusion algorithms using field-proven and proprietary motion fusion engines..

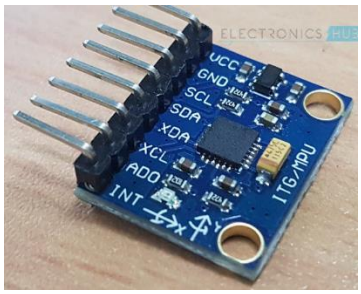

Figure 2.2: MPU 5060

Pin configuration:-

Pin Number	Pin Name	Description
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used
2	Ground	Connected to Ground of system
3	Serial Clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial Data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary Serial Data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional
6	Auxiliary Serial Clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional
7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used to vary the address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

Table 1: pin configuration

3) Flex sensor

The flex sensor is a sensor which has a total value of 10k ohms when it is at its default straight position. However when it is bent as the finger is bent it changes the resistance values and these values are used as reference for the microcontroller for finding the position or the degrees which it is intended to. The flex sensor which we have used is 4 inch in length.

Figure 2.3 Flex sensor used.

Specification of the flex sensor which we have used is given below:-

- Operating voltage of FLEX SENSOR: 0-5V
- Can operate on LOW voltages
- Power rating : 0.5Watt (continuous), 1 Watt (peak)
- Life: 1 million
- Operating temperature: -45ºC to +80ºC
- Flat Resistance: 25K Ω
- Resistance Tolerance: ±30%
- Bend Resistance Range: 45K to 125K Ohms(depending on bend)

4) NRF24L01

NRF24L01 comes as a single chip and has been developed by Nordic Semiconductor. It is operational and is not licensed 2.4GHz ISM band (ISM – Industrial, Scientific and Medical) with support for data rates of 250kbps, 1Mbps and 2Mbps. Pin connections are given below with pic.

- **VCC:** Power Supply Pin. Only 3.3V must be given.
- **GND:** GND pin of the power supply.
- **SCK:** SPI Clock Pin.
- **MOSI:** SPI Slave Data Input Pin.
- **MISO:** SPI Slave Data Output Pin.
- **IRQ:** Active LOW Interrupt Pin.
- **CE:** Chip Enable Pin.
- **CSN:** SPI Chip Select Pin.

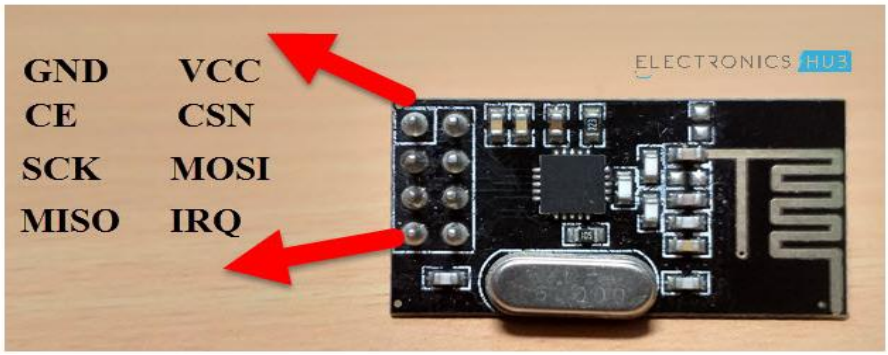

Figure 2.4: NRF24L01

In 2Mbps mode the data rate, the Radio Frequency (RF) channel bandwidth is 2MHz or is more for non-overlapping.

5) Buck converter

The servos require a voltage of 5volts for their operation so does the arduino and this is provided to the servos by the buck converters which step down the voltage to five volts but gives the servos of about 1 to 5 amperes which is required by it on load. A brief explanation of the buck converters workings is given.

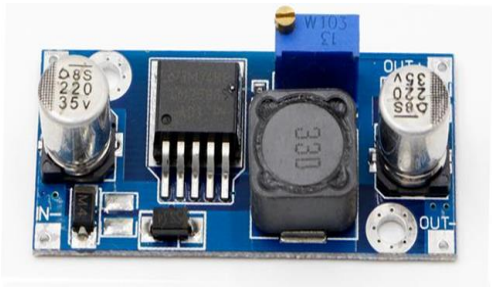

Figure 2.5: Buck converter

These are basically the Electronic and electrical components which we are using in the making of the project.

6) Relay module 10 amps

For the initial commands and for directly activating the linear motors we have used the relay modules which can be activated by 5 volts directly from the arduino and are used in sets of eight and two pair.

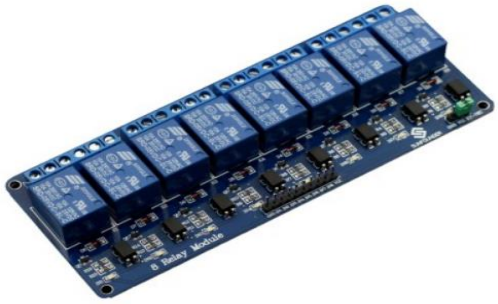

Figure 2.6: 8 channel relay module 10 amps

Specifications:-

- 5V 8-Channel Relay interface board, and each relay requires 15-20mA Current
- Equiped with high Amperage relay, AC250V 10A ; DC30V 10A
- LED's for relay output status
- Typical interface that is directly controlled by microcontroller

7) Relay 50 amps

The 50 amps 12 volt big relays are used for the 12 volt geared rotary motor. Since the latching voltage required by these relays are 12 volts. This is why the command from the arduino Uno operated the small relay first which activates on 5 volts and from the small relay the gate of the big relay is connected which then takes the power from the battery to operate the 12 volt 6 ampere motor. Pics of the relay is given below:-

Figure 2.7: Big relays 50 amps

8) MG945 Servo

The MG945 servo with metallic gear is used for the opening and closing the claw. It is controlled by the Flex sensor and the difference in resistance in the flex sensor is a yardstick for the opening and closing of the claw by the servo. This servo has a torque which is 10 kilos and works on 5 volts DC. The rotation of this servo is restricted to 180 degrees and in the codes this 180 degree is divided into 255 steps doe the extremes of the servo operations. The movement of the claw is done on 180 degree for opening and closing. However there are also servos with the same specs but we get them in 360 degree of rotation, Pics and specs are given below:-

Figure2.8: MG945 Servo

9) 24volt 600milliamps 50 Kg torque Linear geared motor

DC linear motor for spray boom lowering and lifting movement is a multipurpose motor and with a linear actuator has been used. This is a motor with enough torque to perform the function. Details are given below.

- Model Number: LM-P5
- Usage: Boat
- Usage: Home Appliance
- Usage: car
- Usage: Fan
- Usage: Electric Bicycle
- Type: Tubular Motor
- Efficiency: IE 2
- Continuous Current(A): /
- Torque: /
- Protect Feature: Totally Enclosed
- Lift: 750N=75KG=165Pound
- Stroke: 100MM
- color: black ,white
- with English Manual: yes
- is_customized: Yes
- Speed(RPM): 4500r/min
- Voltage(V): 24V 36V

Figure 2.9: Linear actuator

10) 12 volt DC rotary geared motor

The 12 volt DC geared motor is used which consumes 5 amps while on load. This is a powerful motor which has to deal with the weight of the chassis and the installed arm and the carried load by the claw. It has a torque of 40 kilos.

Figure 2.10: 12V 6 amp DC geared motor

11) 20 x 10 RHS for structure

RHS abbreviates for rolled hollow section, which is in this case mild steel is used in the fabrication of the chassis. We can see that the RHS used is 20mm x 10mm and is 1mm thick. Still being so thin the structural value has made the section many times stronger. Even if a light weight person stands on the frame the structure will be able to bear the load of that person without deforming its shape.

Figure 2.11: RHS mild steel.

12) 6mm Aluminum flat bars

6mm Aluminum flatcars are used for the manipulator arm and they are chosen because it has high strength to maintain the structural positioning and carry the load at the same time and it is of light weight as compared to steel.

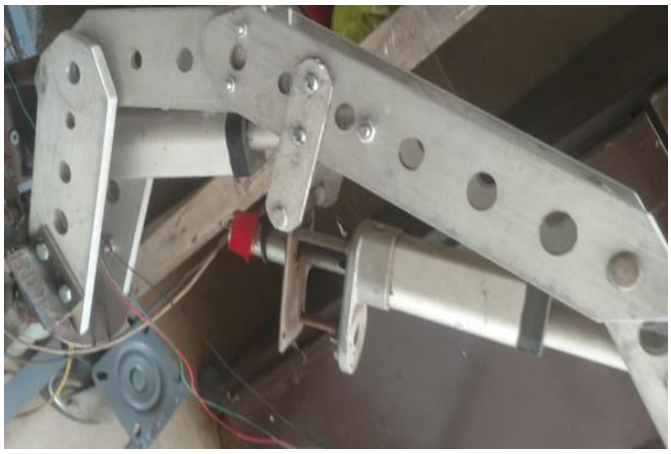

Figure 2.12: Aluminium material for arm.

13) Fiber glass claw

The claw jaws are made of fiber glass 1.5mm thick materials and the holder of the claw is made of aluminum. The fiberglass has some flexibility in it but it is rigid enough to hold the given material strongly. Fiber glass is chosen here because it is light weight and rigid, but also has gripping flexibility.

Figure 2.13P: Fiberglass claw material

14) Wheels

The wheels of the chassis are 6 inch wheels made of plastic toughened and with indentations for rough surfaces. These are basically responsible for the movement of the vehicle forward and backwards. The front wheels are made of toughened rubber and are 3 inch in diameter. Pics are given below:-

Figure 2.14: Front and rear wheels

All the above mentioned materials are mentioned with their detail which go in the making of the Robotic hand gesture trolley gestured robotic manipulator.

CIRCUIT DIAGRAM

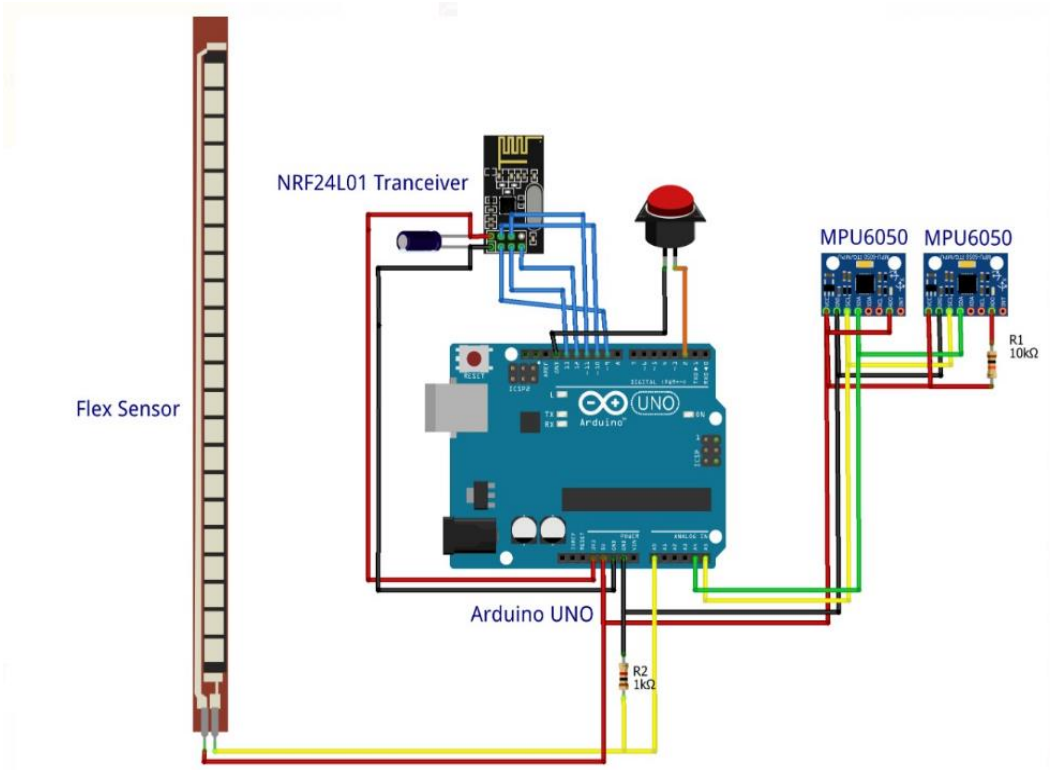

Figure 2.15: Electrical Diagram of connections on the transmitter side

This circuit diagram is of the transmitter side of the project. It shows the wirings of the sensors which are the two MPU 5060 gyro accelerometer sensors the yellow wires coming out of the serial clock of the MPU5060 goes to the analog input A5 of the arduino, whereas the green wires are the serial data output of the sensor which goes to the analog pin A4 of the arduino. The black wire from the sensors is the ground wire which goes to the ground of the arduino and the red wine is the 3.3 volt which goes to the 3.3 volt output of the arduino. For the flex sensor the two wires go to the arduino are the red wire which goes to the 5 volt of the arduino and the yellow wire which goes to the analog input A0 of the arduino and also to the ground via a resistor of 1K ohm. The NRF24L01 transceiver wires occupy the digital input of the arduino from digital pin 13, 12, 11, 10, and 9. The connections of the power and ground is also done on the arduino. There is a switch which is used for switching from the driving mode to the arm and claw control mode and the wires go to the ground and pin number 2 of the arduino. This setup is done on the transmitting side.

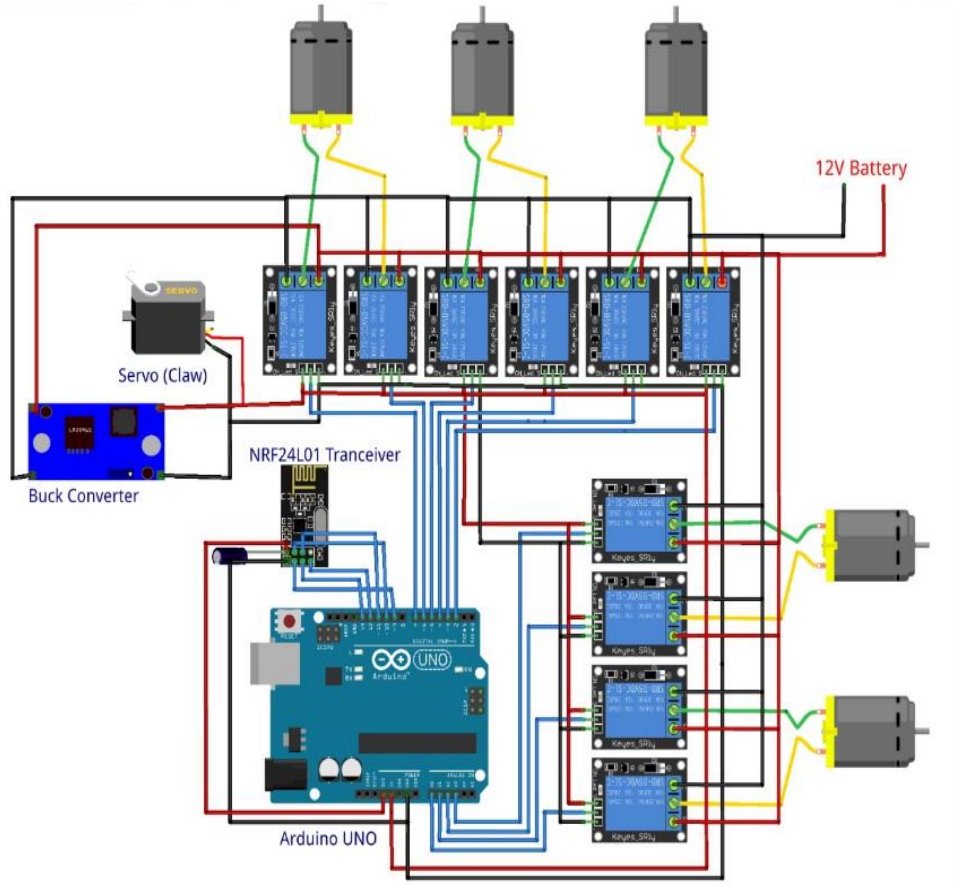

Figure 2.16: Electrical Diagram of connections on the receiver side

On the receiver side we have a cluster of relay modules which are used to take the signals from the arduino for starting and stopping but the relays supply 12 volt dc to the motors and their needed amperes. There are basically 10 relays which together act as an H bridge for reverse and forward biasing the motors. The wires of the relay modules are shown in blue and occupy pin number 0 to 3 on the analog input and are on 2 to 7 pins of the digital input. From these pins the command of the motors are received. There is a buck converter of 5 volts which is implemented to give power to the servo motor and the arduino which both work on 5 volts. The fixing of the wirings of the NRF24L01 is the same to the arduino as done on the transmitting side. The pic below shows the actual receiving side circuitry fixed on the chassis.

Figure 2.17: Circuitry on chassis

2.2. Software Detail

To understand the software used in our project we have to understand the micro controller board the Arduino Uno. Many other microcontrollers and microcontroller platforms are available for physical computing. Parlex Basic stamps offer similar functionality to Net Media's BX-24, jumble, MIT's handboards and more. All of these tools take the gripping details of microcontroller programming and wrap it into an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it does provide some benefits for teachers and students. Arduino does not solely run using C or even C++ languages. There is a machine code which is basically compiles from any other language or C or C++ and this is a compiler which the arduino instruction set uses. The Arduino compiler / IDE accepts C-C ++. In fact, most libraries are written in C ++. Most of the underlying system is not object-oriented, but it can be. Thus, "The Arduino language" is not C ++ or C. The software side of the project involves the knowledge of the C++ language which is done for programming the Arduino Uno.

Software Designing involved the following steps:

1. Understanding the concept and codes of Sensors in use for the project.
2. Understanding the codes used for DC motors, relay modules and Servo.
3. Programming C++ language for interfacing with the mechanical side & testing the codes for the use in the actual machine.
4. Finding the appropriate electronic modules and components to cater for the required purpose.

BLOCK DIAGRAM:

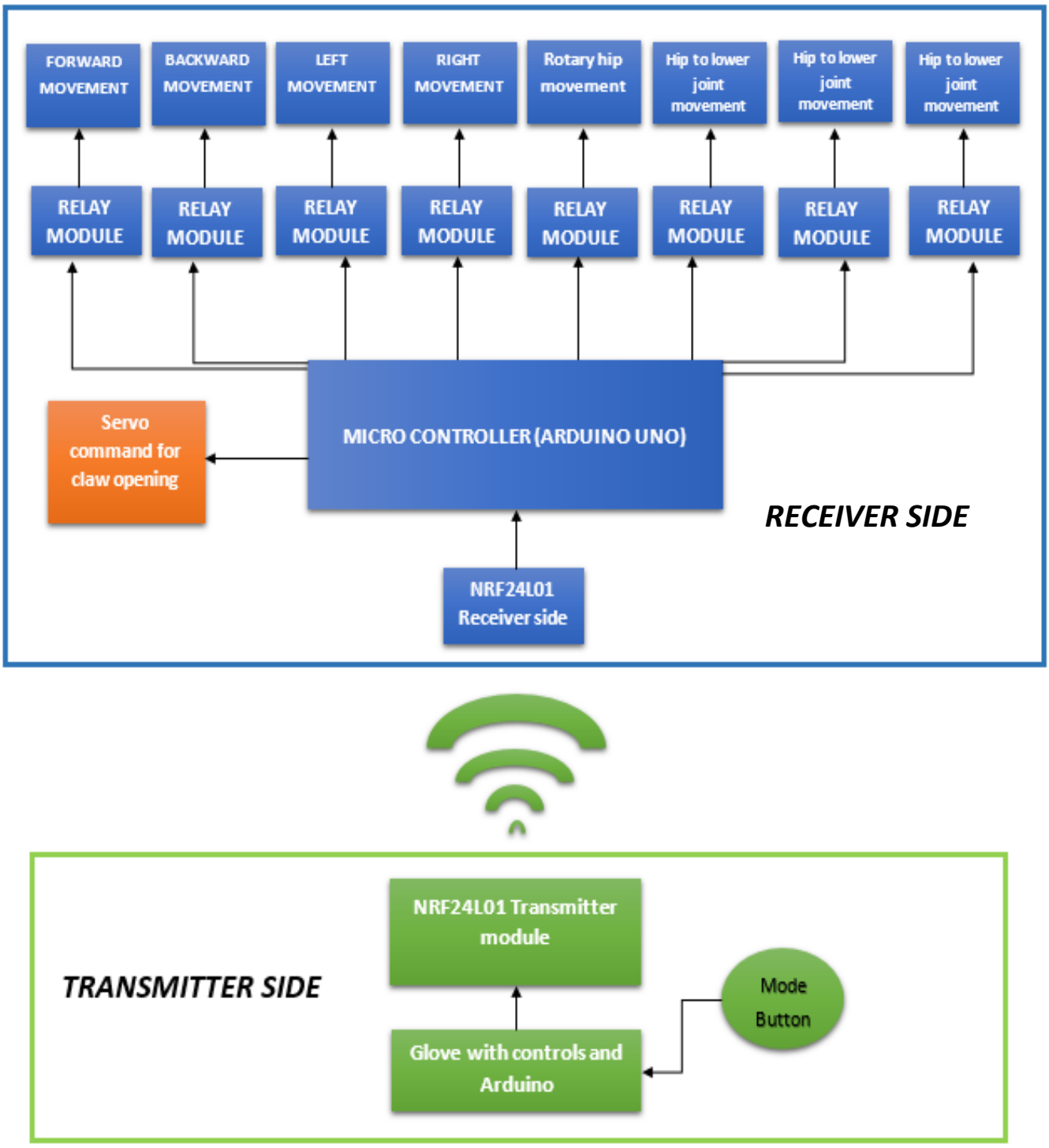

Figure 2.18: Block Diagram

CHAPTER # 03
IMPLEMENTATION

3.1. Details of Hardware Implementation

The details of implementing the hardware for the project consists of various materials used for various functions. There are different materials which have to be fabricated and welded as well as cut to size for the making and completion of the project. Body making involved the following steps:

- Designing the entire hardware model on AutoCAD
- Procurement of materials
- Cutting of steel and aluminum flat bars and RHS.
- Assembling of frame and arm and claw.
- Joining with linear motor and structural fittings and supports together.
- Painting
- Installing individual modules in the body.

We start by taking a look from the initial phase of manufacturing. First of all before we start manufacturing the project we have to design the whole system on AutoCAD to see if the design is workable.

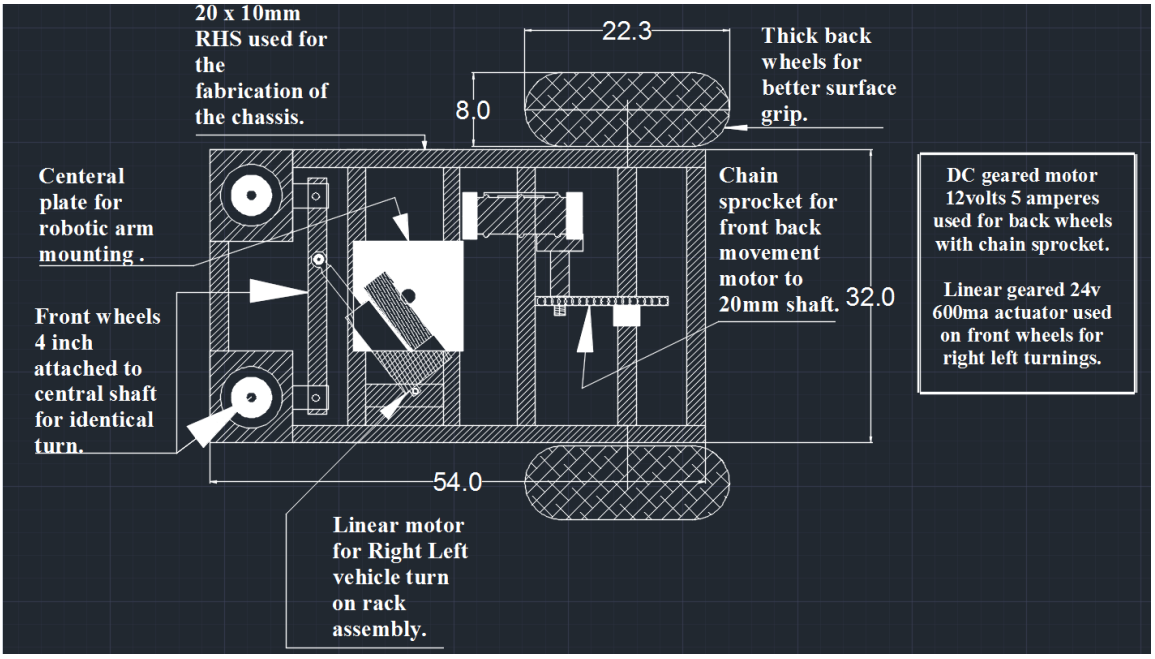

Figure3.1: Design of the robotic trolley on AutoCAD.

After consultations with experienced welders and fabricators regarding the practicality of the design we have to alter the design so that it is not some design which if we start to make, we get stuck due to our own inexperience. The figure below shows the CAD design made for the project.

Then after the materials are purchased such as the steel RHS which is required for the construction of the chassis and the aluminum flat bars which is required for the manipulator arm, we contacted an experienced fabrications engineer for the fabrication of the chassis and the arm. First the chassis was fabricated and the wheels which are the 6 inch wheels were fitted on the rear of the body and the small two wheels which are the 2.5 inch wheels were fitted on the front. The back wheels are meant for the forward and reverse movement of the vehicle. A motor 12 volt 6 amps is coupled to the shaft of the rear wheels by a chain and sprockets to give it movement. Similarly a rack and pinion assembly is made for the font wheels to give it a turning motion on the right and left. This is then coupled from the center with a linear shaft geared motor

which is used for the turning purpose. The forces applies on the movements of the chassis and the arm while carrying the weight are considered in the making of the arm. For this reason we have used 6mm aluminum to make the robotic arm.

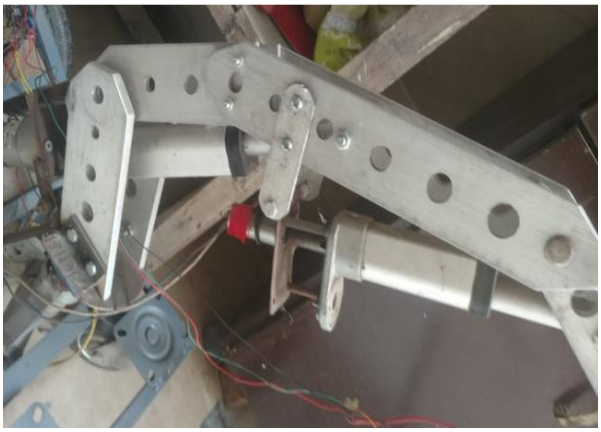

Figure 3.2: Aluminium manipulator arm

The arm of the manipulator has 3 DOF that means that it has four joints for its movement. DOF signifies the degree of freedom of movements. The sketch below shows the 3 DOF of our arm. The sizing of the lengths of the aluminum strips are kept as such that the claw can reach the ground to lift an object from any position within 180 degrees at the front of the trolley. The robotic arm has a length of three feet and is fixed 6 inches higher on the chassis. Below that 8 inch spacing is the motor which rotates the arm 180 degrees.

Figure 3.3: Claw design

The claw is fabricated from fiber glass and this material is used to make the gripper fingers. The use of three fingers has been chosen because in lifting a round or square shaped object it is more helpful and convenient. A mechanical assembly which is also made from aluminum is made to hold the fingers in position and the servo is also fixed on that assembly which opens and closes the fingers and this command is dependent on the flex sensor fixed on the glove.

Figure 3.4: Transmitter controls on glove.

The transmitter side is placed on a glove which is worn on the hand and has a fixed position on the hand. This also has the arduino and the sensors are placed on it as previously mentioned above. The gloves used in this part are fabric gloves which can stretch according to the hand size of the user.

3.2. Details of Software Implementation

The language used by the Arduino Uno does not does not comprise solely on C or even C++. There is a machine code which is basically compiles from any other language or C or C++ and this is a compiler which the arduino instruction set uses. This is explained above. So the codes of the individual components such as the sensors, the transceiver modules on the receiver and the transmitter end, servo and the relay module activation are all taken up individually and compiled to form the required code to run the project.

CHAPTER # 04

PROJECT CHARACTERIZATION

4.1. Results

After the project was completed in terms of fabrication, assemblies and software program was uploaded, it was time to test the robot for the results. The following results were achieved on the applied tests:-

Speed test for trolley and manipulator.

Since the speed of the trolley had to be tested for short distances which were nearly 20 feet in distance, the trolley was moved at a distance of 20 feet by giving full power to the DC geared motor fixed for forward movements. It was seen that it took 10 seconds for the trolley to travel the distance of 10 feet. This speed is ideal for the robotic trolley since the weight which was picked up by the claw was firmly held and no instability was observed at this speed.

Range Test.

The NRF24L01 has a specified range of one kilometer. But in actual testing we found out that the quality of the components to be poor and the maximum range we could get was about 1200 feet at line of sight whereas the actual length should be around 300 feet. However there are better quality of NRF24L01 available which are very high for us to afford and are out of the range for students. The results of those NRF modules are much more precise.

Weight test.

The weight test was meant to find out the capacity that the claws can carry. We started with lifting 10 grams and slowly increased the weight. At 900 grams the weight was enough to close the claws but there was still much force on the linear that could have been lifted. So we fixed the lift value of the object to be lifted to be 900 grams.

Battery backup test.

Finally we tested the battery used which is the 7 ampere 12 volt battery for the backup test and found out that we got around 45 minutes on full charge.

4.2. Analysis

If we evaluate our project by perspective of its value, we find an attractive and a lucrative market for the invertors. As we know and as explained above that by implementing innovative technology we can get better output and be efficient and reduce cost. Plus as far as the human lives are concerned we can save lives by using this technology and also reduce dangers. If we can introduce the product in only our country in a macro scale, then there could be industries which could be setup for the manufacturing of these marvelous products and other suppliers and businesses related to this field will benefit from the newly setup branch of business. This would increase the GDP income of the country and will go to lift the debt burden upon our country. However on the contrary if there is an argument on the loss of jobs for human resource then it can be said that the requirements in the robotics or the industry or business related to it can accommodate the labor force or the managerial or engineering force in the country.

4.3. Conclusion

Robotics technology advancements made in recent years have turned robots more user friendly and economical in cost. This means that in near future this technology and product will be more adaptable in the markets. This type of vehicle robot are being further developed for multi-tasking and being made more precise to the user commands and more dexterous in handling the carried loads. This is being done on a prototype scale and will soon be introduced in the markets worldwide.

In the development of our project, we have tried on a student level to show the usefulness of the technology used, despite the technical and financial restraints that we faced. The main aim is not just to display the working functions of this project but to show that this project can be implemented in a variety of sectors for their purpose.

4.4. Future Recommendations

The Example provided by our project for the robotic manipulator on chassis can be seen as not only a source of convenience but an answer to many problems which require dexterity and strength if a human would be doing the same chores manually. The factors which can be improved are given below:-

The project can be implemented in future for industrial, rescue, firefighting, other planet exploration, bomb disposal, handling dangerous chemicals and many other purposes.

- Hard-line cable control link (an RF link is desired)
- Unreliable RF link
- Limited range, speed, and battery life
- Complicated controls
- Robot arm lacking adequate degrees-of-freedom
- Mobility over rough terrain (from users of smaller models)
- Lack of agility, difficult to control (from users of larger models)

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APPENDIX A: Complex Engineering Problem

Appendix A1: Range of Resources

The making of the robot from start to end involved various diversified resources. This is the practical side of the project and has to be done to perfection so that the project is successful. This is also because we have to do various type of works which involve fabrications of the metal structure, machining the parts of the arm and claw and the wirings and installations of the electronic components as well as the mounting of the motors and the interfacing of the software with the hardware and the mechanical side of the project. For this purpose the following persons with expertise in the field described below have to be involved.

1. The diversified resources are required for the development of the project because the project deals with multiple fields of engineering works. These resources involve the work on mild steel structure, the aluminum manipulator arm and claw, the complete assemblies. This also involves the electrical and electronics placements and connection and also the software coding and implementations on the interfacing side.

For the steel structure fabrication we basically require a person who is an experienced fabricator and has good command over fabrication. For the cutting of the aluminum arm and precise engineering on the movements we require a machine worker who has expertise on lathe and milling machine works. For the other works we require the help of experienced electrical persons who can guide us on the connections and combinations of wiring. On the software side where the programming is done and the codes are readied for downloading in the Arduino Uno. We have a programming instructor who has to give us some tuitions on the practical programming of the micro controller and how it is done. This is very important because we do have a basic knowledge on the programming of the micro controller but if we start without any

guidance then we un necessary put a lot of time in learning the correct way towards programming which we can't afford on our university project. After this step we can assemble the whole project and complete the project including the software side interfacing. The only thing left will be the troubleshooting of the project which can be done after completion.

2. The table given below gives the range of resources used and goes to show the necessity of the resources required by us in making the project. Table 1Range of Resources

Human Resource			
S. No.	Discipline	Resource	Description
1	Fabrication	Fabricator (welder)	Required to make the structure of the project. Finishing works.
2	Machinist	Machining works	Fir joints on shafts and motor seating's and pivots.
3	Programmer	Coding works	Tutorials on programming for project.
Material/Equipment			
S. No.	Discipline	Resource	Description
1	Arduino Uno	Micro controller board	Use to upload codes and control project
2	MPU5060	Gyro Accelerometer	Used to recognize Gestures
3	Flex sensor	Resistance feed back	Used to recognize Gestures on finger
4	NRF24L01	Transceiver module	For RF communication
5	Buck converter	5 volt DC power	Used for Arduino and Servo and Sensor
6	Relay module 10 amp	Switching and H-bridge	For moving motors
7	Relay module 50 amp.	H- Bridge	For moving chassis motor 12 volt.
8	MG 945 servo	180 degree servo	Used For gripper movements
9	24 volt DC linear motor	Linear shaft movements	Rising and lowering of arm and direction of chassis left, right.
10	12 volt rotary gear dc motor	Heavy power motor	For chassis movement forward and reverse.

11	10 x 20 RHS	Mild Steel section	For structure of chassis
12	6mm Aluminum	Light metal	For manipulator arm structure.
13	Fiber glass sheet	Light and durable flex material	For fingers of gripper.
14	Wheels	Plastic, Rubber	For movements of robot.
Reference Literature			
S. No.	Discipline	Resource	Description
1	Robotics	Articles/Books/Research Papers	World Robotics 2006, Photo bucket. Photos, videos and images, Modelling and Control of Robot Manipulators

Appendix A2: Innovation

The novelty of our project is in its display of the various types of controls which can be used to control the robot. For example we have used gyro accrelometers and flex sensors as well as buttons to control the movement of our robot. Our display of the robot also goes to show the practicality of this type of robotics in a numerable functionalities it can perform. By looking at this project it is so self-explanatory that a common man who does not possess much knowledge in robotics can easily get the knowhow on the abilities of robotics and its uses.

1. Looking at the technical advancements in electronics and sensors it can be seen that the use of sensors for operating the robot becomes very practical, which has potential for this project.
2. The combination of a manipulator on a chassis is not that new but to make such a thing on a very economical scale using the technological advancement is not found commonly and is a new perspective.
3. What new approaches do you use? If we talk about the new approaches that we have done then we see that the whole project is kept very simple in as far as the structure, electronics and programming are concerned.

4. Basically the idea as mentioned above is not a new one, but the introduction of a very economical way to do it is a combination of the existing idea and the innovative one.

Appendix A3: Level of Interaction

For the assemblies of this project we require a diversified platform in materials and technologies. But the main point in the combination of such technologies is not as simple as it sounds and a lot of reasoning and competence is needed from the alpha to the omega of the project this is explained as below:-

1. We find that a diversified number of problems arise in the final phase of the project when the project is being assembled. This is mainly because we as students are very unfamiliar with the practicality of the situation and are very motivated by the fictions in our minds. However by the working done in a step by step form on the project the fact and the fictions separate in our minds and we get a firsthand experience on the real time works on the project.
2. Common problems, such as defining the balanced structure and the movements of the manipulator arm and claw and the interfacing of the software with the hardware and the mechanical side arise in the making of the project and further problems after the project is completed arise when the final testing's are done.
3. While as the problems arise we have to analyze the gravity of the situation and look at the problem with logic, not with frustration. If the problem is not solved by us then mutual consultations with the required personals who are experts in that particular field is done for the solutions.

Appendix A4: Consequences to Society and Environment

The impact of the developed project tends not only at the efficiency of a particular function which was performed conventionally however if we look at the whole scenario from an ethical point of view we find that it is also serving in the saving of precious lives and decreasing the risk factor. On the other hand we find that on a mass production of such a resource an industrial revolution also will take place, providing jobs for the community and the advancement of the countries will also rely on it. If we look at the power consumption of the project we see that the whole project utilizes battery power which can be charged by alternate energy, such as solar or wind. This form of energy also goes to have a positive impact on the environment and will be a nature friendly solution.

Appendix A5: Familiarity

The important things we learned from this project goes to add the experience in our practical works. This is because we have to deal with the buying of the materials the working on those materials and the people who do the various works on the project besides us.

Value addition towards the below defined fields:

- ✓ Analyzing the problem and solutions in the designing phase.
- ✓ Learning and improvements in our existing Skills
- ✓ Knowledge on various materials and functions and their practical usage.
- ✓ To execute certain specifies job in its certain time and avoid delays.
- ✓ Professionally and Ethics in the professional environment etc.

APPENDIX B: TURNITIN REPORT