ROBOTIC ARM WITH WHEEL ROTATING MECHANISM

A PROJECT REPORT

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

It is estimated that by the year 2030, 800 million workers all over the world be replaced by robots. This is evident that Robotic revolution is happening in a large scale. Robots eliminate dangerous jobs for humans because they are capable of working in hazardous environments. They can handle lifting heavy loads, toxic substances and doing repetitive tasks. They have helped to prevent many accidents, also saving time and money. Recent advancements in embedded systems have opened up a vast area of research and. This project deals with the design and development of a robotic hand with real time control, which is precise and cost-effective. This five fingered robotic arm mimics a small degree of dexterity and could be used for other applications such as prosthesis for leprosy patients. This will allow them to get a higher degree of freedom and will help in their day to day life.

The aim was to investigate how well the robotic hand could imitate the movements of a user-worn controller glove as well as grip objects, both through wireless communication.

Keywords: Robotic Hand, Arduino .

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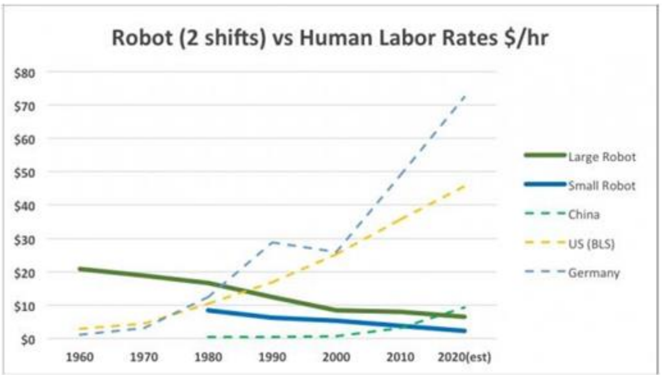
CHAPTER 1

1.1 INTRODUCTION

A robotic arm consists of several sections connected together by linkages that help the arm to travel specifically in a designed pattern, with sensors ensuring that all movements are exactly of the similar pattern. They are endowed with several degrees-of-freedom, giving them the flexibility to move in many directions through multiple angles with utmost ease and agility. The study of robotics originates back to ancient Egypt where priests created masks that moved as a way to intimidate their worshippers. Robotics, as we know it today, originated half a century ago with the creation of a robot named “Unimate”. This Robot was created by George Devol and Joseph Engelberger. Unimate was created with the intention of being used in industry at a General Motors plant, working with heated Die-casting machines. In recent years the development of humanoid robots has become a larger area of focus for the engineering community. Humanoid robots are precisely what their name would lead you to expect, robots designed to look and act like humans. While their Current use is primarily within the entertainment industry, there are hopes that one day they will be able to be used in a broader domain. Modern investigations into humanoid robot development have led to the desire to create a robot that can not only walk from one destination to another, but also discern Objects in front of it and be able to compensate for that by moving around them. This was where the current project came into play. The purpose of this project was to design and build a humanoid robot that was capable of walking smoothly. Due to constant advances in technology, humanoid robots of the future will be capable of helping mankind by accomplishing tasks that may too dangerous, dirty, dull or even physically impossible, such as exploring other planets. Though there is still room for improvement for the locomotion of these robots to become more and more similar to that of a human, the future looks bright for the development of the next generation of Humanoid robots.

1.1.1 USE OF ROBOTIC ARM

The robotic arm is used for multiple industrial applications, from welding, material handling, and thermal spraying, to painting and drilling. The robotic technology also provides human-like dexterity in a variety of environments. These may include servicing nuclear power stations, welding and repairing pipelines on the ocean floor, remote servicing of utility power lines, or cleaning up radioactive and other hazardous wastes[7]. An example of where automated robotic arms are used is in the auto-manufacturing industry. Robots have been a boom to the auto-manufacturing industry. Most industrial robots work in auto assembly lines, putting cars together. Robots can do a lot of this work more efficiently than human beings because they are so fast and precise. They also have significantly reduced worker injuries, including repetitive stress injuries and more significant mishaps that can do major harm. Additionally, the robots turn out a more consistent product at a significantly cheaper cost than can humans.



Currently, robotic-assisted auto manufacturing allows a car to be made with much more precisely as robotic arms always drill in the exactly the same place, and they always tighten bolts with the same amount of force, no matter how many hours they've been working. Finally, robots save on the cost of labor: There are no sick days, strikes, work slowdowns or other problems that can crop up with humans. Robots can, in fact, work around the clock with a minimum of human supervision.[14] The auto-manufacturing industry is a specific example of where the design of our robot can be applied. In this industry robots may be required to collect and stack tyres just as our one does. Need of Robots compare to Human labours mention in Figure 1.2

1.2 SOFTWARE

Embedded C is a set of language extensions for the C Programming the C standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed point arithmetic, multiple distinct memory banks and basic input output operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing. Embedded C use most of the syntax and semantics of standard C, e.g., main () function, variable definition, data type declaration, conditional statements (if, switch. case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, unions, etc.

1.2.1 INTRODUCTION TO EMBEDDED C

Looking around, we find ourselves to be surrounded by various types of embedded systems. Be it a digital camera or a mobile phone or a washing machine, all of them has some kind of processor functioning inside it. Associated with each processor is the embedded software. If hardware forms the body of an embedded system, embedded processor acts as the brain, and embedded software forms its soul. It is the embedded software which primarily governs the functioning of embedded systems. During infancy years of microprocessor based systems, programs were developed using assemblers and fused into the EPROMs. There used to be no mechanism to find what the program was doing. LEDs, switches, etc. were used to check correct execution of the program. Some ‘very fortunate’ developers had In-circuit Simulators (ICEs), but they were too costly and were not quite reliable as well. As time progressed, use of microprocessor-specific assembly-only as the programming language reduced and embedded systems moved onto C as the embedded programming language of choice. C is the most widely used programming language for embedded processors/controllers. Assembly is also used but mainly to implement those portions of the code where very high timing accuracy, code size efficiency, etc. are prime requirements. Initially C was developed by Kernighan and Ritchie to fit into the space of 8K and to write (portable) operating systems. Originally it was implemented on UNIX operating systems. As it was intended for operating systems development, it can manipulate memory addresses. Also, it allowed programmers to write very compact codes. This has given it the reputation as the language of choice for hackers too.

1.2.2 EMBEDDED SYSTEMS PROGRAMMING

Embedded systems programming is different from developing applications on a desktop computers. Key characteristics of an embedded system, when compared to PCs, are as follows:

Embedded devices have resource constraints(limited ROM, limited RAM, limited stack space, less processing power)

Components used in embedded system and PCs are different; embedded systems typically uses smaller, less power consuming components.

Embedded systems are more tied to the hardware. Two salient features of Embedded Programming are code speed and code size. Code speed is governed by the processing power, timing constraints, whereas code size is governed by available program memory and use of programming language. Goal of embedded system programming is to get maximum features in minimum space and minimum time.

Embedded systems are programmed using different type of languages:

- Machine Code
- Low level language, i.e., assembly
- High level language like C, C++, Java, Ada, etc.
- Application level language like Visual Basic, Access, etc.

Assembly language maps mnemonic words with the binary machine codes that the processor uses to code the instructions. Assembly language seems to be an obvious choice for programming embedded devices. However, use of assembly language is restricted to developing efficient codes in terms of size and speed. Also, assembly codes lead to higher software development costs and code portability is not there.

1.2.3 USE OF C IN EMBEDDED SYSTEMS

- It is small and reasonably simpler to learn, understand, program and debug.
- C Compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.
- Embedded systems are computer systems designed to perform specific tasks with real-time constraints and are typically integrated into larger systems or products.
- Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/ microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems.
- C allows for low-level access to hardware resources, enabling developers to optimize their code for specific hardware architectures and improve system performance.
- C provides a wide range of standard library functions for performing common operations, such as memory allocation, string manipulation, and math operations.
- As C combines functionality of assembly language and features of high level languages, C is treated as a ‘middle-level computer language’ or ‘high level assembly language’
- It is fairly efficient and it supports access to I/O and provides ease of management of large embedded projects.

CHAPTER 2

2.1 LITERATURE SURVEY

BACKGROUND

The word robot was derived from Czech word Robota which means "a forced labor". Thus the robot technology is advancing rapidly. Now a day's the most commonly used robots in industry is robotic hand or a robotic manipulator. Robotic hand is basically kinematics chain of rigid links interconnected by movable joints. The hand is also called end effector. The end effecter may be a tool or a gripper or any other device to do the work. The end effector is similar to the human hand with or without fingers.

HUMAN hand is one of the most complex organs of the human body after brain; thus, we understand why its behavior had intensively interested former philosophers, and in the past decades has been object of study and research not only in the medical field but also in the engineering field. From empirical studies of human grasping in medicine due to the interest for hand surgery and the design of prosthetic devices, a substantial medical literature is available. Much of it refers to the categorization and study of six grasps: cylindrical, fingertip, hook, palmar, spherical and lateral, leading to associating the kind of human grasps with the shapes of the objects to be manipulated.

However, Napier noticed that the choice of grasp actually depends more on the task to perform than on the shape and size of objects, therefore suggested to categorize grasps according to function instead of appearance. In his scheme, grasps are divided only into two groups: power grasps and precision grasps. In the first group there is a predomination of stability and security (holding a heavy tool or getting a jar lid unstuck), and are characterized by large areas of contact between the hand and the object. On the other hand, when it comes to precision grasps, considerations of sensitivity and dexterity predominate (writing with a pencil), using the tips of the fingers and the thumb to hold the object.

From these basic categories a further study based on observations of single-handed operations by machinists working with metal parts and hand tools was carried on by Cutkosky and Wright, who proposed a partial taxonomy of manufacturing grasps. The study of grasping and manipulation can be both experimental, by studying grasping of humans and animals to learn from these natural systems how to construct similar performing mechatronic ones; and analytical, by modeling the interactions between the hand and the grasped object using the laws of physics.

- The design of grasping mechanisms has been the aim of several researches in the field of Robotics. These researches have addressed attention to a physical interface between a robotic system and its environment. This interface provides interaction with objects and offers dexterity manipulation and grasping functionalities. Developments of industrial robotics have produced 3 several types of gripper mechanisms. Robotic grippers are employed in robotic manipulators that perform repetitive tasks. These grippers can only execute limited and specific manipulation tasks, [**Penisi et al., 2003].** They are limited to objects that are very similar in terms of shape, weight and manipulation requirements, **[Chen, 1982].** The use of grippers is also limited to the grasping of objects with regular geometries. Considerable disadvantages of industrial grippers have been found as regarding with the stability of the grasping of objects with irregular geometries or complex manipulation operations. Due to these limitations, research efforts have been dedicated to the development of multiple finger robotic hands. These devices try to mimic one or more characteristics of the human hand.

- The phase that involves identification of applications for a robotic hand is fundamental. It allows focusing the design problem in a more specific way by referring to technological and market requirements. Many of the research efforts for conception of dexterous hands have been oriented to specific applications, **[Banks, 2001].** Some of these applications can be listed as: • Prosthesis; • Manipulators for Astronautic Purposes; • Humanoid Robotics; •Industrial Manipulators. Human prostheses and astronautic manipulators seem to be the most demanding and ambitious applications. For example, the design that is oriented to develop infant or adult prosthesis is a complex problem for robotic hand design, since geometric, ergonomic and functional characteristics of human hands have to be matched in order to develop successful hand prosthesis. The hand structure and material are important aspects to consider for aeronautical applications because of the hard conditions in the working environment.

- In general, the anthropomorphic characteristics of a design are not strong requirements, as are precision of control system and dexterous capabilities of manipulation, as pointed out for example in **[Martin et al., 2004].**

- A design problem for a robot hand with similar complexity can be the application for a sub-system in a humanoid robot, as discussed in **[Ceccarelli, 2003].** A design objective for a grasping sub-system of a humanoid robot can be to generate an autonomous, flexible and anthropomorphic design. In the case of prosthesis, the autonomy cannot be established as a design requirement, as illustrated in [Suares & Grosch, 2004].

- Human hands are universal grasping mechanisms with great flexibility in manipulation, **[Belforte, 1985].** The dexterity of this complex biological mechanism is capable for a great diversity of applications. The sensory system of human hand permits to identify a cognitive representation of grasped objects that is a much desired ability for medical prosthesis as well as in advanced developments in mobile and humanoid robotics. Anthropomorphism and dexterity are two of the main desirable characteristics for robot hands.

- In particular, in [**Buchholz & Armstrong, 1991]** a kinematical model is presented for simulating of finger positions that are required for grasping objects with known geometry. This work presents measured sizes of the metacarpal and carpal bones that can be directly used as dimensional restrictions for a robot hand design. Further analysis is required on the sensory capabilities of human hand and human nervous system to identify requirements for sensory and control systems of robot hands [Banks, 2001]. The next phase in a design process consists in mechanical synthesis that is closely related to the topology of the main functional elements; which are the fingers, palm and wrist. The synthesis process provides the geometric characteristics, materials and actuators for a robot hand.

- In another study by Hsiao et al. (2016), a robotic arm with a two-wheel balancing mechanism was developed for mobile manipulation tasks. The robot was able to balance on two wheels and manipulate objects using its robotic arm, enabling it to navigate through narrow spaces and perform tasks in constrained environments. A study by Jain et al. (2020) focused on the kinematic modeling and control of a mobile robot with a three-wheel holonomic drive system and a robotic arm. The robot was able to navigate through complex environments and manipulate objects using its robotic arm, demonstrating the effectiveness of the proposed control algorithm.

CHAPTER 3
COMPONENTS

- ARDUINO
- ACCERELOMETER SENSOR
- TRANSCEIVER MODULE
- 9V BATTERY
- DC MOTOR DRIVE MODULE
- GRIPPER
- RF SENSOR
- POWER DISTRIBUTION BOARD

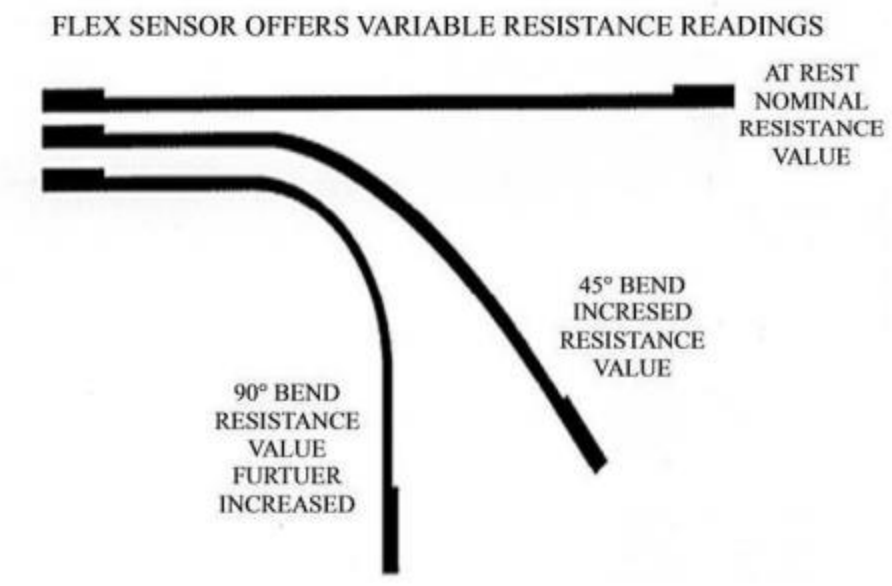
3.1 FLEX SENSORS

A simple flex sensor is 2.2" in length. As the sensor is bent, the resistance across the sensor increases. Flex sensors are sensors that change in resistance depending on the amount of the bend on the sensor. They are often used in gloves to sense finger movement. Flex sensors are simple in construction. As shown in figure. they convert the change in bend to electrical resistance the more the bend, the more the resistance value. They are usually in the form of thin strip 1-5 long that vary in resistance. They can be made unidirectional or bi-directional.

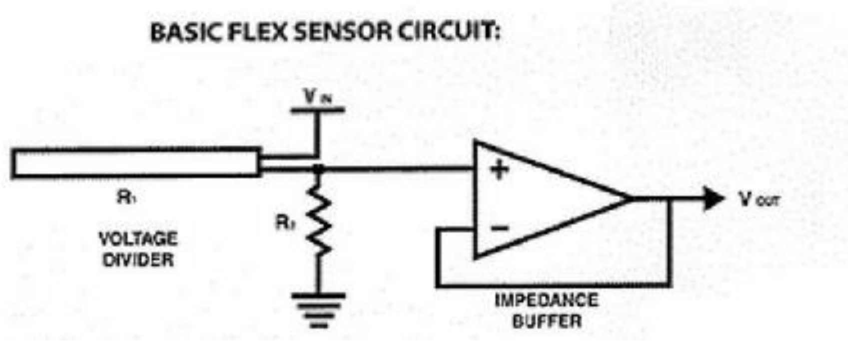
Flex sensors are passive resistive devices that can be used to detect bending or flexing. The flex sensor shown in this figure. is a bi-directional flex sensor that decreases its resistance in proportion to the amount it is bent in either direction. The sensor we are building is about 3/8" wide by 5" long. The ranges of the flex sensor are 10kΩ to 40kΩ. The Flex sensor offers variable resistance readings, resistance for the unflexed is 10kΩ and for the flexed the resistance is 40kΩ. Flex sensors are analogue resistors. They work as variable analogue voltage dividers. The flex sensor shown in is the unidirectional. Flex sensor is a unique component that changes resistance when flexed. Flex sensor is bent in one direction the resistance gradually increases. Flex sensors are typically made of a resistive material, such as carbon or a conductive polymer, that changes its resistance in response to bending. The sensor is usually mounted on a flexible substrate, such as a thin film or printed circuit board, and connected to an electrical circuit. When the sensor is bent, the resistance changes, and the resulting signal can be used to determine the degree of bending.

3.1.1 HOW IT WORKS

Flex sensors are analogue resistors, they works as variable analogue voltage divider. Inside the flex sensors are carbon resistive elements within a thin flexible substrate. More carbon means less resistance, when the substrate is bent the sensor produces a resistance output relative to the bent radius. The higher the resistance value yielding smaller radius.



3.1.2 FLEX SENSOR CIRCUIT

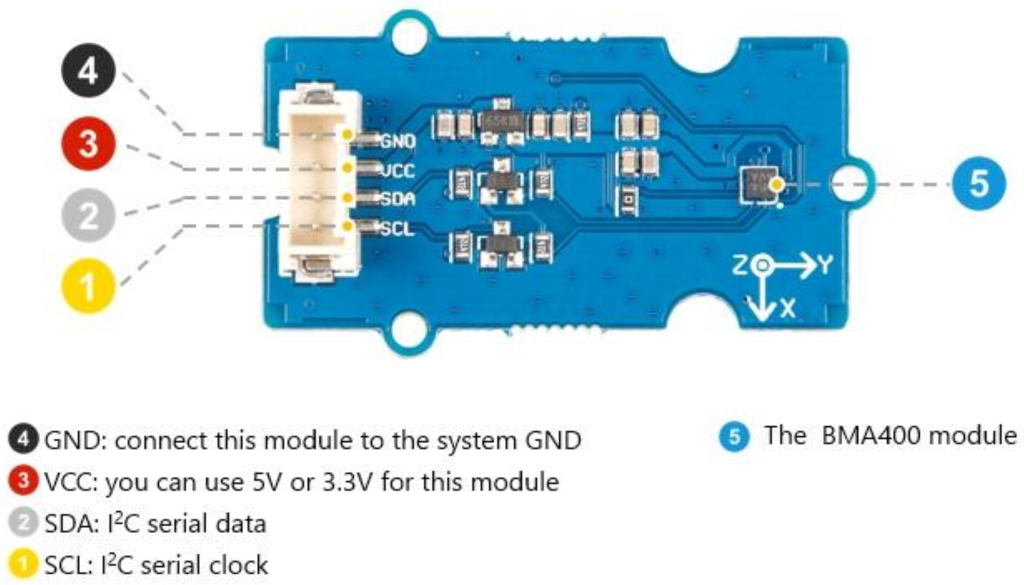


3.1.3 APPLICATIONS

Flex sensors may be used in robotics to determine joint movement or placement. They may also be used like whiskers for wall detection. The sensors we are making are also pressure sensitive so they can also be used as bumper switches for wall detection or pressure switches on robotic grippers. For bio-metrics, the sensor can be placed on a moving joint of athletic equipment to provide an electrical indication of movement or placement. A few of the sensors can be incorporated onto a glove to make virtual reality glove.

3.2 ACCELEROMETER SENSOR

An accelerometer is a tool that measures proper acceleration. Proper acceleration is the acceleration (the rate of change of velocity) of a body in its own instantaneous rest frame; this is different from coordinate acceleration, which is acceleration in a fixed coordinate system. For example, an accelerometer at rest on the surface of the Earth will measure an acceleration due to Earth's gravity, straight upwards (by definition) of g ≈ 9.81 m/s^2. By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about 9.81 m/s^2) will measure zero.



Accelerometers have many uses in industry and science. Highly sensitive accelerometers are used in inertial navigation systems for aircraft and missiles. Vibration in rotating machines is monitored by accelerometers. They are used in tablet computers and digital cameras so that images on screens are always displayed upright. In unmanned aerial vehicles, accelerometers help to stabilise flight.

A piezoelectric accelerometer is an accelerometer that employs the piezoelectric effect of certain materials to measure dynamic changes in mechanical variables (e.g., acceleration, vibration, and mechanical shock).

As with all transducers, piezoelectrics convert one form of energy into another and provide an electrical signal in response to a quantity, property, or condition that is being measured. Using the general sensing method upon which all accelerometers are based, acceleration acts upon a seismic mass that is restrained by a spring or suspended on a cantilever beam, and converts a physical force into an electrical signal. Before the acceleration can be converted into an electrical quantity it must first be converted into either a force or displacement. This conversion is done via the mass spring system shown in the figure to the right.

3.3 TRANSCEIVER MODULE

In radio communication, a transceiver is an electronic device which is a combination of a radio *trans*mitter and a re*ceiver*, hence the name. It can both transmit and receive radio waves using an antenna, for communication purposes. These two related functions are often combined in a single device to reduce manufacturing costs. The term is also used for other devices which can both transmit and receive through a communications channel, such as *optical transceivers* which transmit and receive light in optical fiber systems, and *bus transceivers* which transmit and receive digital data in computer data buses.

Radio transceivers are widely used in wireless devices. One large use is in two-way radios, which are audio transceivers used for bidirectional person-to-person voice communication. Examples are cell phones, which transmit and receive the two sides of a phone conversation using radio waves to a cell tower, cordless phones in which both the phone handset and the base station have transceivers to communicate both sides of the conversation, and land mobile radio systems like walkie-talkies and CB radios. Another large use is in wireless modems in mobile networked computer devices such laptops, pads, and cellphones, which both transmit digital data to and receive data from a wireless router. Aircraft carry automated microwave transceivers called transponders which, when they are triggered by microwaves from an air traffic control radar, transmit a coded signal back to the radar to identify the aircraft. Satellite transponders in communication satellites receive digital telecommunication data from a satellite ground station, and retransmit it to another ground station. Transceiver modules can be either standalone devices or integrated into other systems. Standalone transceiver modules are typically small and compact, and can be easily interfaced with microcontrollers and other electronic devices. Integrated transceiver modules, on the other hand, are often embedded in larger systems, such as wireless routers, access points, or network adapters.

3.4 9V BATTERY

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 volts. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very common size is known as PP3, introduced for early transistor radios. The PP3 has a rectangular prism shape with rounded edges and two polarized snap connectors on the top. This type is commonly used for many applications including household uses such as smoke and gas detectors, clocks, and toys.

The nine-volt PP3-size battery is commonly available in primary zinc-carbon and alkaline chemistry, in primary lithium iron disulfide and lithium manganese dioxide (sometimes designated CRV9[2]), and in rechargeable form in nickel-cadmium (Ni–Cd), nickel-metal hydride (Ni–MH) and lithium-ion. Mercury batteries of this format, once common, have been banned in many countries due to their toxicity. Designations for this format include *NEDA 1604* and *IEC 6F22* (for zinc-carbon) or *MN1604 6LR61* (for alkaline). The size, regardless of chemistry, is commonly designated PP3—a designation originally reserved solely for carbon-zinc, or in some countries, *E* or *E-block*.[4] A range of PP batteries was produced in the past, with voltages of 4.5, 6, and 9 volts and different capacities; the larger 9-volt PP6, PP7, and PP9 are still available. A few other 9-volt battery sizes are available: A10 and A29.

Most PP3-size alkaline batteries are constructed of six individual 1.5 V LR61 cells enclosed in a wrapper. These cells are slightly smaller than LR8D425 AAAA cells and can be used in their place for some devices, even though they are 3.5 mm shorter. Carbon-zinc types are made with six flat cells in a stack, enclosed in a moisture-resistant wrapper to prevent drying. Primary lithium types are made with three cells in series.

3.5 DC MOTOR DRIVE MODULE

Motor drive means a system that includes a motor. An adjustable speed motor drive means a system that includes a motor that has multiple operating speeds. A variable speed motor drive is a system that includes a motor and is continuously variable in speed. If the motor is generating electrical energy rather than using it – this could be called a generator drive but is often still referred to as a motor drive.

A Variable Frequency Drive(VFD) or Variable Speed Drive(VSD) describes the electronic portion of the system that controls the speed of the motor. More generally, the term drive, describes equipment used to control the speed of machinery. Many industrial processes such as assembly lines must operate at different speeds for different products. Where process conditions demand adjustment of flow from a pump or fan, varying the speed of the drive may save energy compared with other techniques for flow control.

Where speeds may be selected from several different pre-set ranges, usually the drive is said to be adjustable speed. If the output speed can be changed without steps over a range, the drive is usually referred to as variable speed.

Adjustable and variable speed drives may be purely mechanical (termed *variators*), electromechanical, hydraulic, or electronic.

Sometimes motor drive refers to a drive used to control a motor and therefore gets interchanged with VFD or VSD. DC motor drive modules can be classified into two main types: analog and digital. Analog modules use voltage or current signals to control the motor's speed and direction, while digital modules use digital signals, such as PWM (pulse width modulation), to control the motor's speed and direction. DC motor drive modules can also vary in terms of their power rating, voltage and current ratings, and other features, such as over-current protection, over-temperature protection, and fault detection.

3.6 GRIPPER

Grippers, sometimes called hand grippers, are primarily used for testing and increasing the strength of the hands; this specific form of grip strength has been called crushing grip, which has been defined as meaning the prime movers are the four fingers, rather than the thumb.

There are differences from brand to brand, but the common features of standard grippers are that they use a torsion spring fitted with two handles. The exact dimensions of these elements vary, as well as the materials used to make them; the springs are made from various types of steel, and the handles are generally made from wood, plastic, steel or aluminum.

Grippers come in a range of strengths, suitable for everyone from beginners to World's Strongest Man winners, such as Magnus Samuelsson, whose YouTube video clip closing the No. 4 Captains of Crush Gripper has been viewed over 2 million times.

In 1991, IronMind began certifying people who could close its toughest grippers under official conditions, and it maintains lists of the people certified on the Captains of Crush No. 3, Captains of Crush No. 3.5and Captains of Crush No. 4, Closing grippers of this strength level has been compared to crushing a raw potato in one's bare hand.[18] In 2011, IronMind began certifying women who officially closed the Captains of Crush No. 2 Gripper.

The user holds the gripper in one hand and squeezes the two handles together until they touch. Once touched, the handles are released and the movement is repeated. Variations of this basic movement include negatives [see below], and a variety of partial movements. For example, if the strength of the gripper is beyond that of the user, the user might apply maximum force, moving the handles as far as possible, even if the handles cannot be made to touch. Another partial movement involves using two hands to squeeze the handles within approximately 19 mm (3/4 inch) of each other, releasing one hand, and then using the other hand to make the handles of the gripper touch each other. Negatives involve starting the gripper handles touching and then resisting as the gripper opens up, in an eccentric contraction. Grippers are typically mounted on the end of a robot arm or a conveyor belt, and can be controlled by a robotic controller or a programmable logic controller (PLC). Grippers are often equipped with sensors that allow them to detect the presence of an object and adjust the grip force accordingly. Overall, grippers are an essential component of robotics and automation systems, allowing robots to manipulate objects and perform various tasks with precision and efficiency. They come in different types and configurations to suit different applications and requirements.

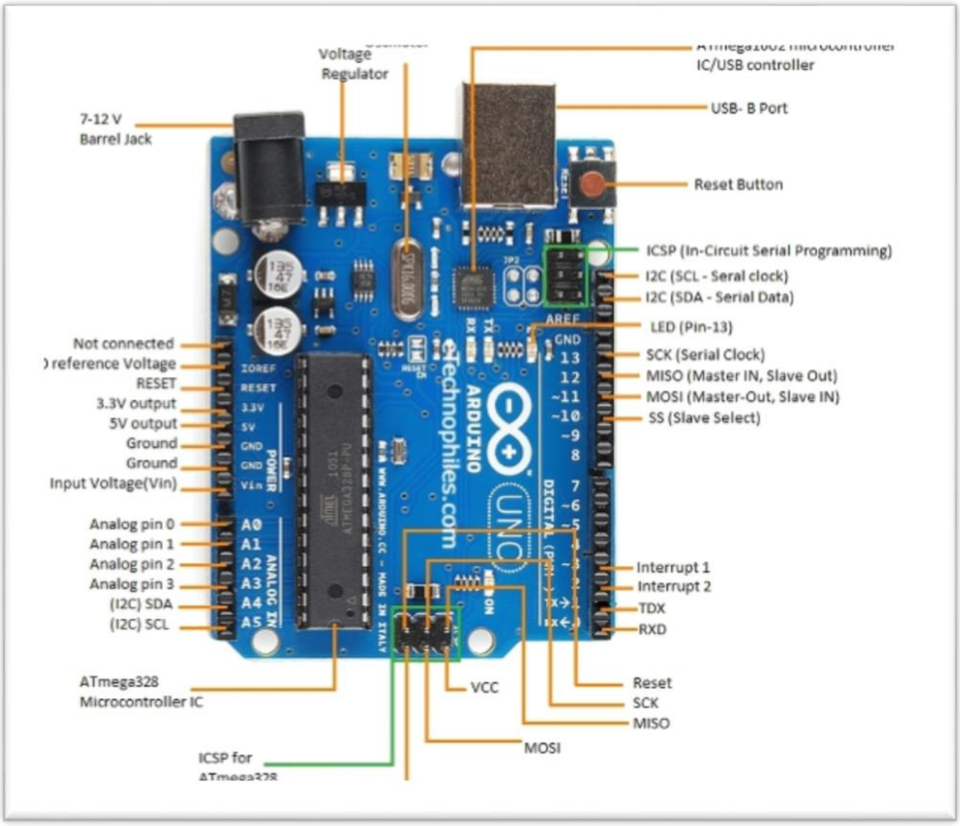
3.7 ARDUINO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes pre programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

3.7.1 PIN DIAGRAM

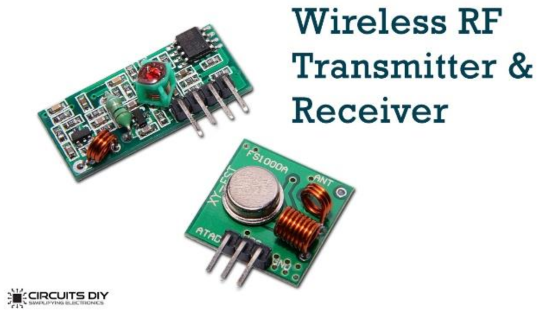


3.7.2 GENERAL PIN FUNCTIONS

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- VIN: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.

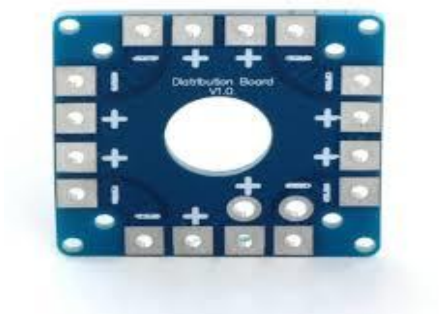
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields that block the one on the board.

3.8 RF SENSORS



The RF sensor operates by defining a sensitive volume and interrogating the values of these parameters for whatever materials invade this volume.
Any or all of the parameters may be simultaneously measured by either a single sensor or a sensor pair and the sensor deduces the nature and behaviour of the invading items from the resulting signature. The sensitive volume is defined by a radio frequency antenna which is tuned to the sensor electronics. The size and nature of the antenna and the nature of the material detected govern the optimum operating frequency of the RF sensor, which can be a few Kilohertz for large systems or tens of Gigahertz for very small ones. An inductive antenna is used for susceptibility detection and a capacitive antenna is used for permittivity detection. The size of the antenna determines the sensitive volume and choice of construction materials of the antenna determines permissible operating temperature

3.8 POWER DISTRIBUTION BOARD



A power distribution board (PDB) is an electrical component that distributes electrical power from a main power source to multiple secondary circuits. It is typically used in industrial and commercial settings, as well as in some residential settings.The PDB receives power from a main source, such as a generator or utility line, and distributes it to various circuits throughout a building or facility. The board may have one or more input sources and multiple output circuits, which are protected by fuses or circuit breakers. These safety devices help prevent damage to equipment and minimize the risk of electrical fires.

PDBs can be designed and customized to meet specific power distribution needs. They may include features such as monitoring systems, surge protection, and remote control capabilities. Some PDBs may also incorporate smart technology to optimize energy usage and efficiency. Overall, a power distribution board plays a critical role in managing electrical power distribution and ensuring the safe and efficient operation of electrical systems.

CHAPTER 4

4.1 EMBEDDED SYSTEM

Embedded systems are controllers with on chip control. They consist of microcontrollers, input and output devices, memories etc., on chip and they can be used for a specific application. A small computer designed in a single chip is called a single chip microcomputer. A single chip microcomputer typically includes a microprocessor RAM, ROM, timer, interrupt and peripheral controller in a single chip. This single chip microcomputer is also called as microcontroller; These Microcontrollers are used for variety of applications where it replaces the computer. The usage of this microcomputer for a specific application, in which the microcontrollers a part of application, is called embedded systems. Embedded systems are used for real time applications with high reliability, accuracy and precision, Embedded systems are operated with Real Time Operating systems like WinCE, RT Linux, VxWorks, PSOS, etc.., Embedded systems are very popular these days Most of the Electrical, Electronics, Mechanical, Chemical, Industrial, Medical, Space and many more areas have the embedded systems in their applications

4.2 ROLE OF EMBEDDED SYSTEM

Embedded systems are compact, smart, efficient, and economical and user friendly, they are closed systems and respond to the real world situation very fast, closed system means, everything required for a specific application is embedded on the chip and hence, they do not call for external requirement for their functioning. The role of embedded systems is to provide a dedicated and efficient solution to perform a specific task or set of tasks. They are often used in a wide range of applications, including consumer electronics, automotive, medical devices, industrial control systems, and more.

4.3 APPLICATIONS OF EMBEDDED SYSTEM

- Robotics
- Aviation
- Telecommunication and Broadcasting
- Mobile Phones and mobiles networking
- Satellite Communication
- Blue Tooth
- Electronic sensors
- Home Appliances etc.

4.4 PERIPHERALS

Embedded Systems talk with the outside world via peripherals, such as:

- Serial Communication Interfaces (SCI): RS-232, RS-422, RS-485 etc.
- Synchronous Serial Communication Interface: I2C, SPI, SSC and ESSI (Enhanced Synchronous Serial Interface)
- Universal Serial Bus (USB)
- Multi Media Cards (SD Cards, Compact Flash etc.)
- Networks: Ethernet, Lon Works, etc.
- Fieldbuses: CAN-Bus, LIN-Bus, PROFIBUS, etc.
- Timers: PLL(s), Capture/Compare and Time Processing Units
- Discrete IO: aka General Purpose Input/Output (GPIO)
- Analog to Digital/Digital to Analog (ADC/DAC)
- Debugging: JTAG, ISP, ICSP, BDM Port, BITP, and DP9 ports.

4.5 CODING

```
#include <SoftwareSerial.h>
SoftwareSerial HC12(11, 12); // HC-12 TX Pin, HC-12 RX Pin

int x_axis_1, y_axis_1, x_axis_2, y_axis_2;

void setup()
{
 Serial.begin(9600);             // Serial port to computer

 HC12.begin(9600);               // Serial port to HC12
}

void loop()
{
  x_axis_1 = analogRead(A0);
  y_axis_1 = analogRead(A1);
  x_axis_2 = analogRead(A2);
  y_axis_2 = analogRead(A3);

  HC12.write('%');

  HC12.write(x_axis_1/100%10+48);
  HC12.write(x_axis_1/10%10+48);
  HC12.write(x_axis_1/1%10+48);

  HC12.write(',');

  HC12.write(y_axis_1/100%10+48);
```

```
  HC12.write(y_axis_1/10%10+48);
  HC12.write(y_axis_1/1%10+48);

  HC12.write(',');

  HC12.write(x_axis_2/100%10+48);
  HC12.write(x_axis_2/10%10+48);
  HC12.write(x_axis_2/1%10+48);

  HC12.write(',');

  HC12.write(y_axis_2/100%10+48);
  HC12.write(y_axis_2/10%10+48);
  HC12.write(y_axis_2/1%10+48);

  HC12.print("#\r\n");

  delay(100);
}



#include <SoftwareSerial.h>
SoftwareSerial HC12(11, 12); // HC-12 TX Pin, HC-12 RX Pin



const int IN1 = 9;
const int IN2 = 8;
const int IN3 = 6;
const int IN4 = 7;
```

```
const int IN5 = 5;
const int IN6 = 4;
const int IN7 = 3;
const int IN8 = 2;

int x_axis_1, y_axis_1, x_axis_2, y_axis_2;

unsigned char inByte;

unsigned char arr[20], ii, start_flag = 0, over_flag = 0;

void setup()
{
 Serial.begin(9600);            // Serial port to computer

 HC12.begin(9600);              // Serial port to HC12

 pinMode(IN1, OUTPUT); digitalWrite(IN1, LOW);
 pinMode(IN2, OUTPUT); digitalWrite(IN2, LOW);
 pinMode(IN3, OUTPUT); digitalWrite(IN3, LOW);
 pinMode(IN4, OUTPUT); digitalWrite(IN4, LOW);
 pinMode(IN5, OUTPUT); digitalWrite(IN5, LOW);
 pinMode(IN6, OUTPUT); digitalWrite(IN6, LOW);
 pinMode(IN7, OUTPUT); digitalWrite(IN7, LOW);
 pinMode(IN8, OUTPUT); digitalWrite(IN8, LOW);
}

void loop()
{
```

```
while(HC12.available())  // If HC-12 has data
{
 inByte = HC12.read();

 //Serial.write(inByte);

 if(start_flag == 0)
 {
  if(inByte == '%')
  {
   ii = 0;

   start_flag = 1;
  }
 }
 else if(start_flag == 1)
 {
  if(inByte == '#')
  {
   over_flag = 1;

   start_flag = 0;
  }
  else
  {
   arr[ii++] = inByte;
  }
 }
}
```

```
if(over_flag == 1)
{
 x_axis_1 = (((int)arr[ 0] - 48) * 100) + (((int)arr[ 1] - 48) * 10) + (((int)arr[ 2] - 48)
* 1);
 y_axis_1 = (((int)arr[ 4] - 48) * 100) + (((int)arr[ 5] - 48) * 10) + (((int)arr[ 6] - 48)
* 1);
 x_axis_2 = (((int)arr[ 8] - 48) * 100) + (((int)arr[ 9] - 48) * 10) + (((int)arr[10] - 48)
* 1);
 y_axis_2 = (((int)arr[12] - 48) * 100) + (((int)arr[13] - 48) * 10) + (((int)arr[14] - 48)
* 1);

/*
Serial.write(x_axis_1/100%10+48);
Serial.write(x_axis_1/10%10+48);
Serial.write(x_axis_1/1%10+48);

Serial.write(',');

Serial.write(y_axis_1/100%10+48);
Serial.write(y_axis_1/10%10+48);
Serial.write(y_axis_1/1%10+48);

Serial.write(',');

Serial.write(x_axis_2/100%10+48);
Serial.write(x_axis_2/10%10+48);
Serial.write(x_axis_2/1%10+48);
```

```
 Serial.write(',');

 Serial.write(y_axis_2/100%10+48);
 Serial.write(y_axis_2/10%10+48);
 Serial.write(y_axis_2/1%10+48);

 Serial.print("\r\n");
 */

  if(  (x_axis_1 > 290 && x_axis_1 < 370) && (y_axis_1 > 290 && y_axis_1 < 370)
)
  {
   //Serial.write('S');

   digitalWrite(IN1,  LOW); digitalWrite(IN2,  LOW);
   digitalWrite(IN3,  LOW); digitalWrite(IN4,  LOW);
  }
  else if( !(x_axis_1 > 290 && x_axis_1 < 370) && (y_axis_1 > 290 && y_axis_1 <
370) )
  {
   if(x_axis_1 <= 290)
   {
    //Serial.write('R');

    digitalWrite(IN1,  LOW); digitalWrite(IN2, HIGH);
    digitalWrite(IN3, HIGH); digitalWrite(IN4,  LOW);
   }
   else if(x_axis_1 >= 370)
   {
```

```
    //Serial.write('L');

    digitalWrite(IN1, HIGH); digitalWrite(IN2,  LOW);
    digitalWrite(IN3,  LOW); digitalWrite(IN4, HIGH);
   }
  }
  else if(  (x_axis_1 > 290 && x_axis_1 < 370) && !(y_axis_1 > 290 && y_axis_1
< 370) )
  {
   if(y_axis_1 <= 290)
   {
    //Serial.write('F');

    digitalWrite(IN1,  LOW); digitalWrite(IN2, HIGH);
    digitalWrite(IN3,  LOW); digitalWrite(IN4, HIGH);
   }
   else if(y_axis_1 >= 370)
   {
    //Serial.write('B');

    digitalWrite(IN1, HIGH); digitalWrite(IN2,  LOW);
    digitalWrite(IN3, HIGH); digitalWrite(IN4,  LOW);
   }
  }


  if(  (x_axis_2 > 290 && x_axis_2 < 370) && (y_axis_2 > 290 && y_axis_2 <
370) )
  {
```

```
 //Serial.write('E');

 digitalWrite(IN5,  LOW); digitalWrite(IN6,  LOW);  //gripper
 digitalWrite(IN7,  LOW); digitalWrite(IN8,  LOW);  //shoulder
}
else if( !(x_axis_2 > 290 && x_axis_2 < 370) && (y_axis_2 > 290 && y_axis_2 < 370) )
{
 if(x_axis_2 <= 290)
 {
  //Serial.write('A');

  digitalWrite(IN5,  LOW); digitalWrite(IN6, HIGH);  //gripper
 }
 else if(x_axis_2 >= 370)
 {
  //Serial.write('B');

  digitalWrite(IN5, HIGH); digitalWrite(IN6,  LOW);  //gripper
 }
}
else if(  (x_axis_2 > 290 && x_axis_2 < 370) && !(y_axis_2 > 290 && y_axis_2 < 370) )
{
 if(y_axis_2 <= 290)
 {
  //Serial.write('C');

  digitalWrite(IN7,  LOW); digitalWrite(IN8, HIGH);  //shoulder
```

```
 }
 else if(y_axis_2 >= 370)
 {
  //Serial.write('D');

  digitalWrite(IN7, HIGH); digitalWrite(IN8,  LOW);  //shoulder
 }
}


over_flag = 0;
                                                        }
                                                       }
```

CHAPTER 5
MODEL DESCRIPTION

5.1 CONSTRUCTION

A robot is a machine designed to execute one or more tasks automatically with speed and precision. We need robots because robots are often cheaper to use over humans, in addition it is easier to do some jobs using robots and sometimes the only possible way to accomplish some tasks! Robots can explore inside gas tanks, inside volcanoes, travel the surface of Mars or other places too dangerous for humans to go where extreme temperatures or contaminated environments exist. Robotics is an interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. Robotic system has been widely used in manufacturing, military and surgery since the robot can perform many advantages and used as the countermeasure for some job that cannot be conduct by the human excellently. Robots are used in different fields such as industrial, military, space exploration, and medical applications. These robots could be classified as manipulator robots and cooperate with other parts of automated or semi-automated equipment to achieve tasks such as loading, unloading, spray painting, welding, and assembling. Generally robots are designed, built and controlled via a computer or a controlling device which uses a specific program or algorithm. Programs and robots are designed in a way that when the program changes, the behavior ofthe robot changes accordingly resulting in a very flexible task achieving robot.

AXIS:

Axis are used for movement indication, one use for a line, two for a plane and three for a point at anywhere in space. Roll pitch and yaw control are the main factors of a robotic arm axis, use for full control. Before 1987 robots robotic arms are working. In 2-axis and 3-axis. But now there in 4-axis, in 5-axis, in 6-axis and in multi-axis robotic arms are available. Figure 2.3 shows a six axis- robotic arm[1]. Freely moving are good for a three dimensions, rotating axis arm must be positive

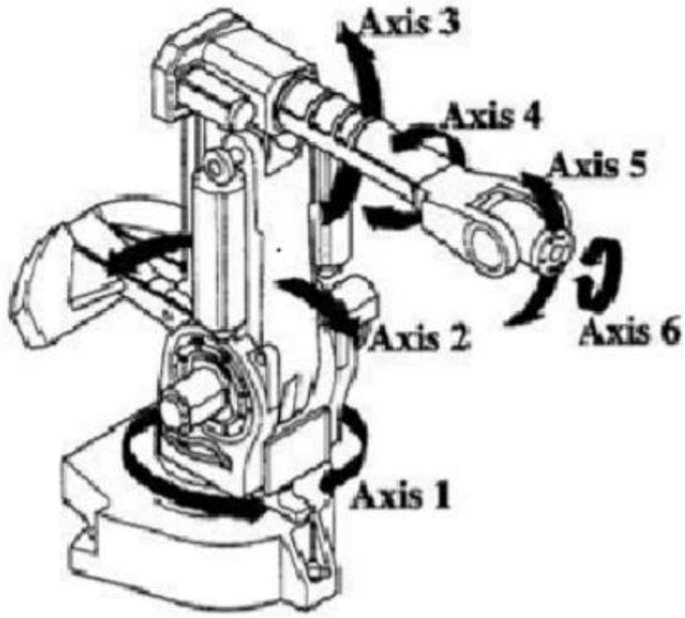


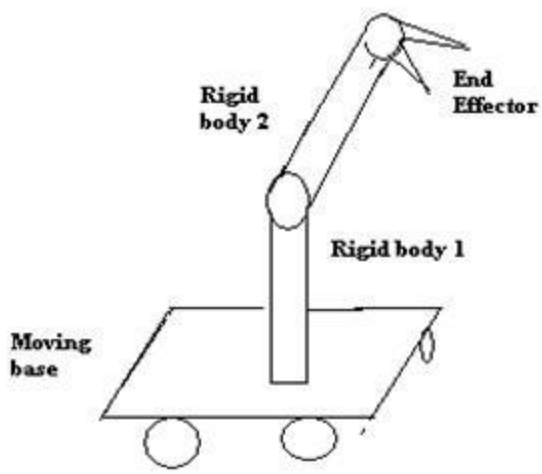
Figure 2.3: A six-axis-robotic arm

interactive for good stability. Mass of arm should be less for less force of inertia at different joints, lighter arm performs more dynamically than bulky arms at same stability level. Industrial robotic arms are using bulky tool and weight of arm also very high, use for big construction. Robots may become flexible and less in weight by using multiple axis arms.

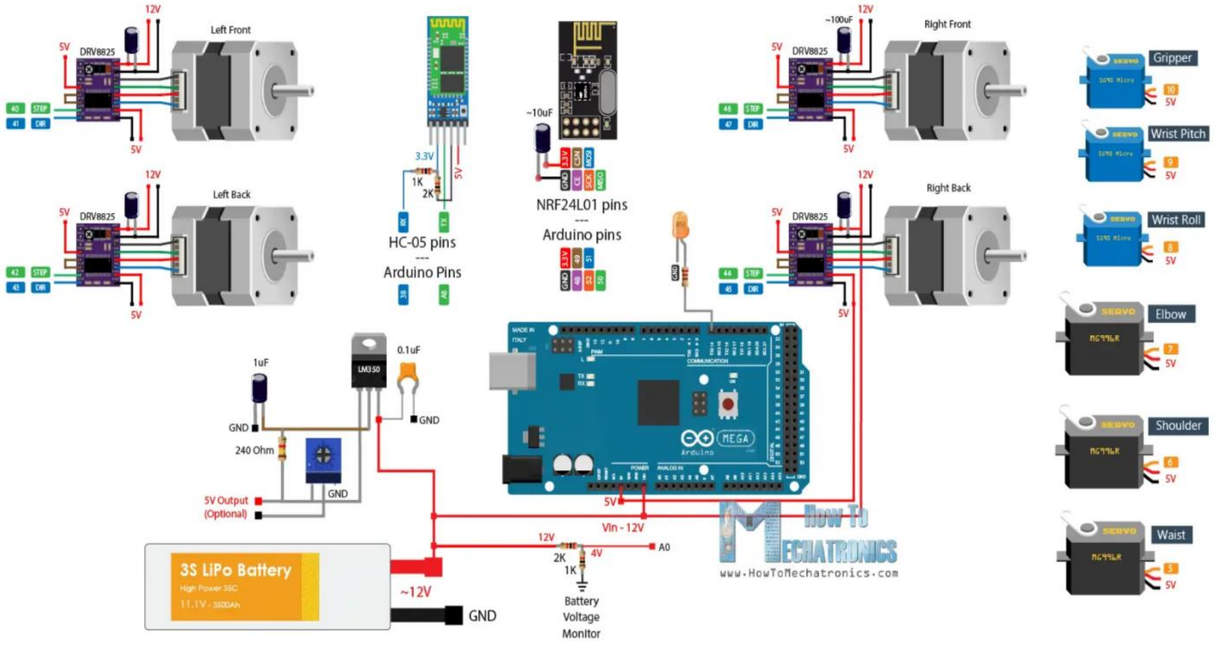
5.2 WORKING PRINCIPLE

The wheels are attached on four stepper motors which are individually control. By rotating the wheels in certain pattern, they exert diagonal forces due the diagonally positioned rollers on the circumference of the wheels, and so they can move in any direction. The robot car can be remotely controlled either vie Bluetooth communication and an custom build Android application. Also, we can control it using an DIY RC transmitter with the help of the NRF24L01 transceiver module.

As the robot uses stepper motors for the wheels and servo motors for the robot arm, we can precisely control them using the custom build Android application. What's even cooler, we can record the movements of the robot and then the robot can automatically repeat them**.**



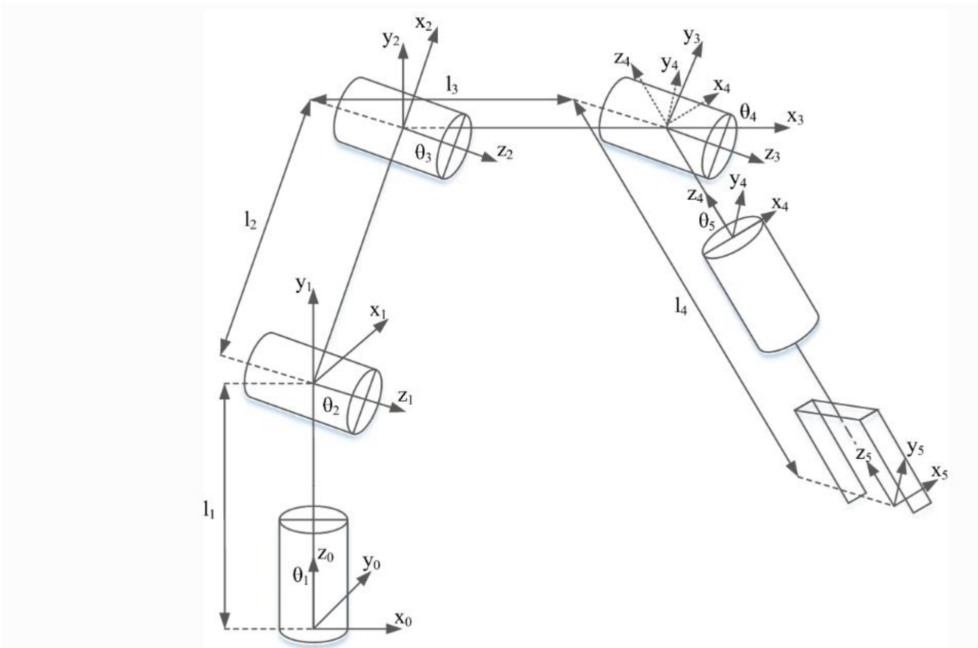
The arm should have the ability to lift, move, lower and release an object while closely mimicking the motion of the human arm with full extension. Any device that can perform the required motions to pick and place an object required would have met the requirements of this criterion. The choice of the number of the parts in this particular robotic arm is taken by comparing it with a human arm. Let the action of human hand picking up a container appear in your mind. We have the waist, shoulder, elbow, arm, wrist and fingers do the job. This is the motivation for the choice of the number of parts. This robotic arm also has 5 parts and 5 joints which are pretty much like the human hand.



CHAPTER 6
ROBOT MODELLING CALCULATION

Kinematic modeling

The kinematic modeling and the coordinate establishment is the key point to achieve the harmonization between the robotic manipulator and the control device. Thereafter, the Denavit Hartenberg (DH) conception is performed where some homogeneous matrices of individual kinematic pairs are used to define the transformation of the coordinate. The DH coordinate frames are exhibited in Fig. 2 which comprises the layout of the manipulator's joints, links and the orientations. From the figure, the four links of the manipulator are labeled as li, l2, l3, and l4 and their lengths are 15 cm, 44 cm, 37 cm and 25 cm respectively. The arm comprises five rotational joints which are labeled as J11, J22, J33, J44, and J55. These five joints work concurrently for gripping an object in a three-dimensional workspace and thereby acquire a high performance gripping.



For analyzing the inverse kinematics, the DH parameters are listed in Table 1. From the table, θ is the rotation of i−1 frame around zi−1 axis that is required to get xi−1 axis to match xi axis which also includes the rotation due to the joint; d expresses the distance from the center of i−1 frame to the center of *i* frame along zi−1 axis; r indicates the distance from the centre of i−1 frame to the centre of *i* frame along xi axis; α denotes the rotation of i−1 frame around xiaxis that is required to get zi−1 axis to match zi axis.

According to the DH parameters, the transformation matrices of the links are represented in (1), (2), (3), (4) and (5).

$$H_1^0 = \begin{bmatrix} \cos\theta_1 & 0 & \sin\theta_1 & 0 \\ \sin\theta_1 & 0 & -\cos\theta_1 & 0 \\ 0 & 1 & 0 & l_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (1)$$

$$H_2^1 = \begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 & l_2\cos\theta_2 \\ \sin\theta_2 & \cos\theta_2 & 0 & l_2\sin\theta_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (2)$$

$$H_3^2 = \begin{bmatrix} \cos\theta_3 & -\sin\theta_3 & 0 & l_3\cos\theta_3 \\ \sin\theta_3 & \cos\theta_3 & 0 & l_3\sin\theta_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (3)$$

$$H_4^3 = \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & 0 \\ \sin\theta_4 & 0 & -\cos\theta_4 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (4)$$

$$H_5^4 = \begin{bmatrix} \cos\theta_5 & -\sin\theta_5 & 0 & 0 \\ \sin\theta_5 & \cos\theta_5 & 0 & 0 \\ 0 & 0 & 1 & l_4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (5)$$

By multiplying these transformation matrices, the equations of the forward kinematics are obtained from (6).

$$H_{end-effector}^{base} = H_5^0 = H_1^0 H_2^1 H_3^2 H_4^3 H_5^4 \quad (6)$$

The reference transformation matrix is provided in (7).

$$H_5^0 = \begin{bmatrix} i_x & j_x & k_x & p_x \\ i_y & j_y & k_y & p_y \\ i_z & j_z & k_z & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (7)$$

$$\begin{aligned}
i_x &= -s_1 s_5 + c_5 c_1 c_{234} & j_x &= -s_5 c_1 c_{234} - c_5 s_1 \\
i_y &= c_1 s_5 + c_5 s_1 c_{234} & j_y &= c_5 s_1 - s_5 s_1 c_{234} \\
i_z &= c_5 s_{234} & j_z &= -s_5 s_{234} \\
k_x &= -c_1 s_{234} & p_x &= c_1 \left(l_2 c_2 - l_4 s_{234} + l_3 c_{23} \right) \\
k_y &= -s1 s_{234} & p_y &= s_1 \left(l_2 c_2 - l_4 s_{234} + l_3 c_{23} \right) \\
k_z &= c_{234} & p_z &= l_1 + l_2 s_2 + l_3 s_{23} + l_4 c_{234}
\end{aligned}$$

The human operator inputs the expected position of the manipulator through a joystick. In order to move the robotic arm to that expected position, the actuators set the arms joint values. The values of joint angle $\theta_1, \theta_2, \theta_3, \theta_4,$ *and* θ_5 are calculated by using (8), (9), (10), (11), and (13).

$$\theta_1 = \tan^{-1} \frac{p_y}{p_x} \quad (8)$$

$$\theta_2 = \tan^{-1} \frac{n(l_2 + l_3 c_3) - m l_3 s_3}{n l_3 s_3 + m(l_2 + l_3 c_3)} \quad (9)$$

$$\theta_3 = \cos^{-1} \frac{m^2 + n^2 - l_2^2 - l_3^2}{2 l_2 l_3} \quad (10)$$

$$\theta_{234} = \tan^{-1} \frac{l_2 c_2 + l_3 c_{23} - p_x c_1 - p_y s_1}{p_z - l_1 - l_2 s_2 - l_3 s_{23}} \quad (11)$$

$$\theta_4 = \theta_{234} - \theta_2 - \theta_3 \quad (12)$$

$$\theta_5 = \tan^{-1} \frac{(i_y c_1 - i_x s_1) s_{234}}{i_y s_1 + i_x c_1} \quad (13)$$

where, in (9) and (10):

$$m = p_x c_1 + p_y s_1 + l_4 s_{234}$$
$$n = p_z - l_1 - l_4 c_{234}$$

CHAPTER 7
ESTIMATION AND CALCULATION

7.1 COST ESTIMATION

S.NO	MATERIAL	COST
1.	ARDUINO NANO	800
2.	ARDUINO UNO	1500
3.	DC MOTOR	600
4.	WHEELS	300
5.	ARDUINO NANO CABLE	300
6.	6V BATTERY	700
7.	9V BATTERY	20
8.	ACCLEROMETER SENSOR	600
9.	GRIPPER	1300
10.	RF SENSOR	2000
11.	POWER DISTRIBUTION BOARD	500
12.	DRIVER BOARD	300

7.2 PROBLEMS ENCOUNTERED

- It was difficult to fix wheels and wiring takes lot of times to complete
- Motor was given from department was of different rom so it was difficult to manage with them.
- We felt coding was slight hard.
- The robotic arm may require a sensor and feedback system to ensure accurate and precise movement. This can be challenging to design and implement.

Although these problems occurred, we completed our project and ran a successful testing. We took help and supports from our seniors and friends to cope with these problems.

CHAPTER 8
DESIGN AND MERITS

8.1 ADVANTAGES

- Improved safety. Robotic arms help keep workers safe by operating in environments that are hazardous and executing tasks that present high risk of injury to humans.

- Robotic arms with wheel rotation technology can be operated remotely, allowing for greater control and flexibility. This is useful in applications such as space exploration or hazardous environments where it may not be safe for humans to operate.

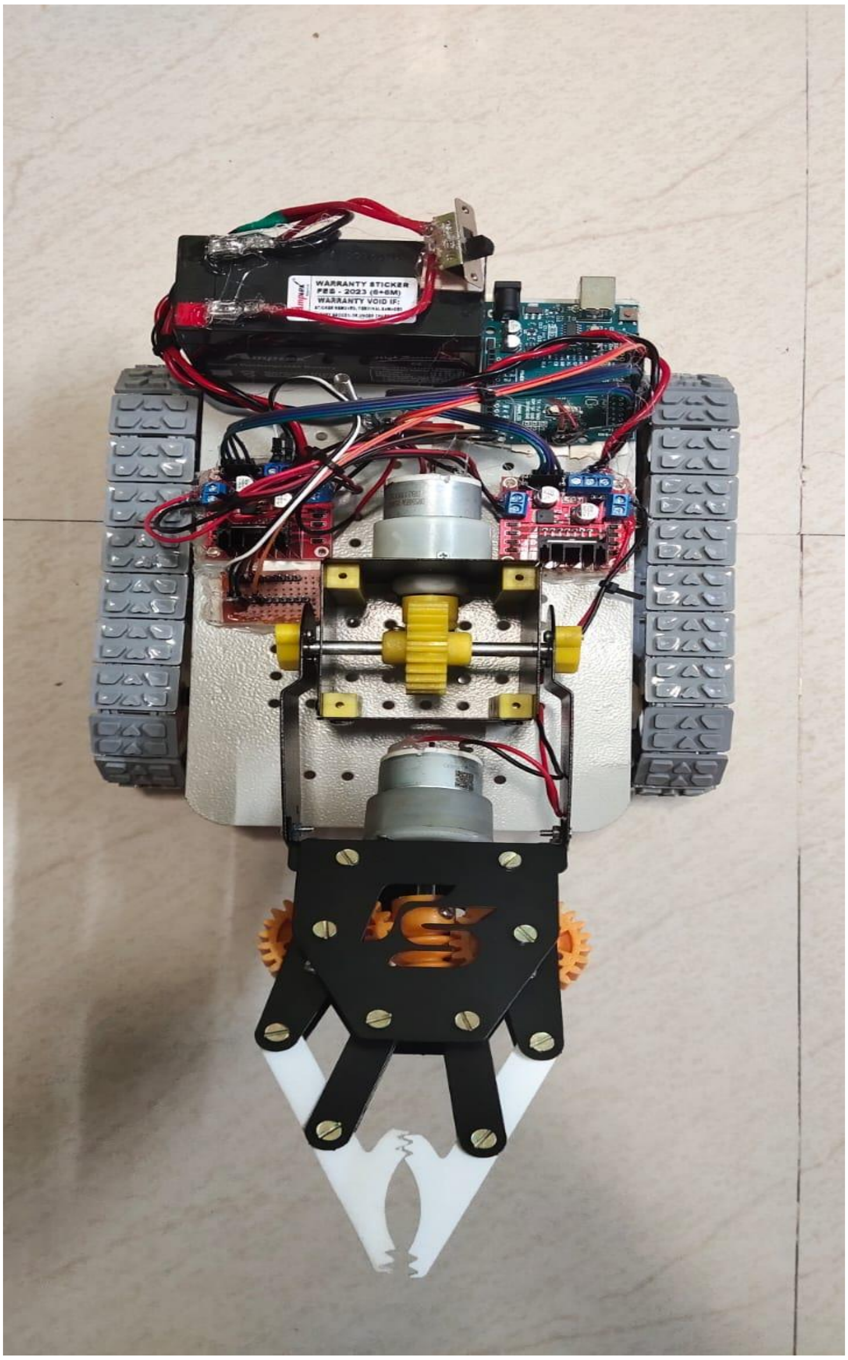
- The robot arm can move around with greater ease and speed, making it more versatile and efficient in performing tasks.

- The combination of a robotic arm and wheel rotation mechanism allows for precise positioning and control of the arm's movements.

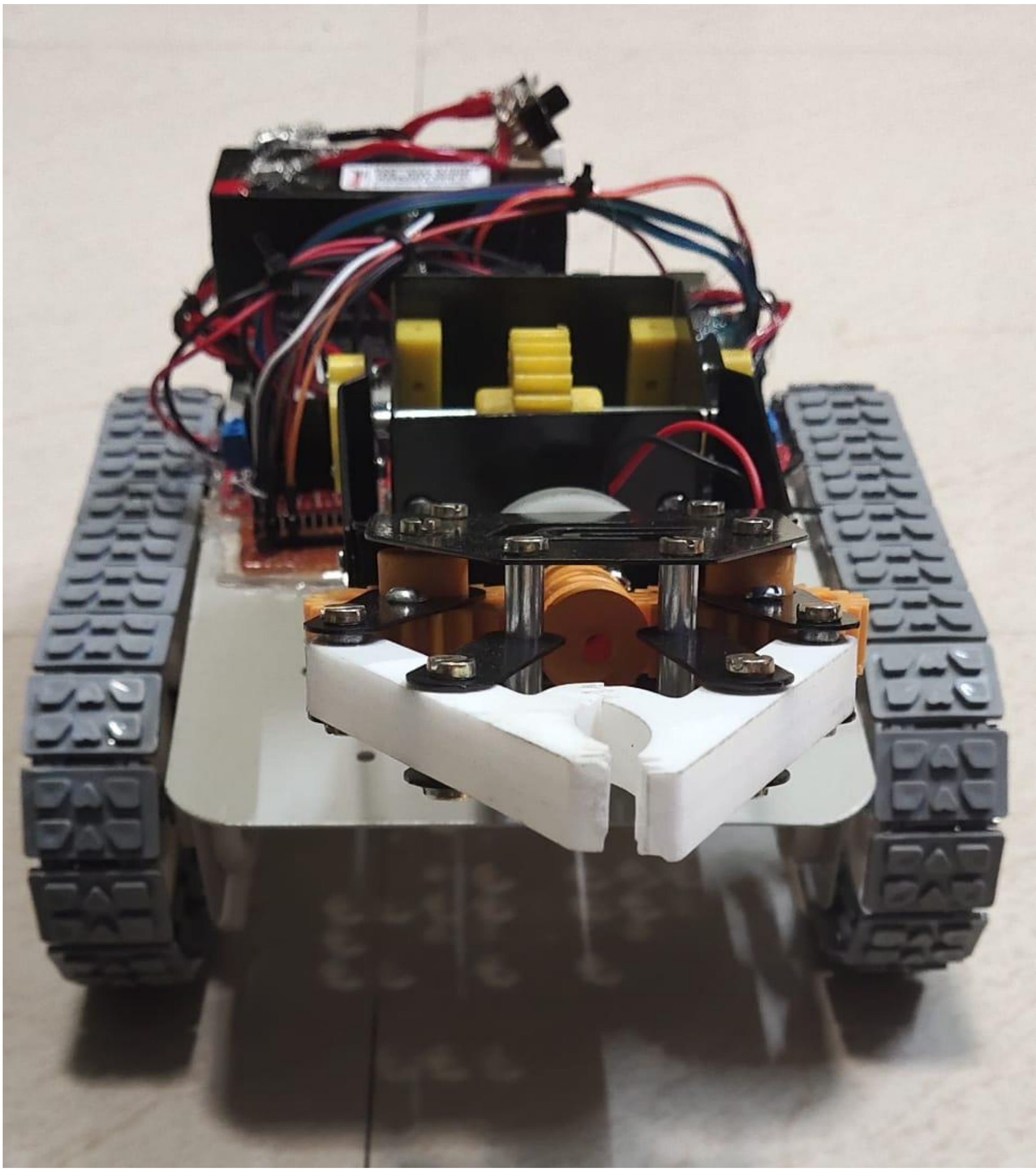
- Robotic arms with wheel rotation technology can be programmed to perform a wide range of tasks, making them highly flexible and adaptable.This makes them useful in a variety of industries and applications.

8.2 PROJECT IMAGES

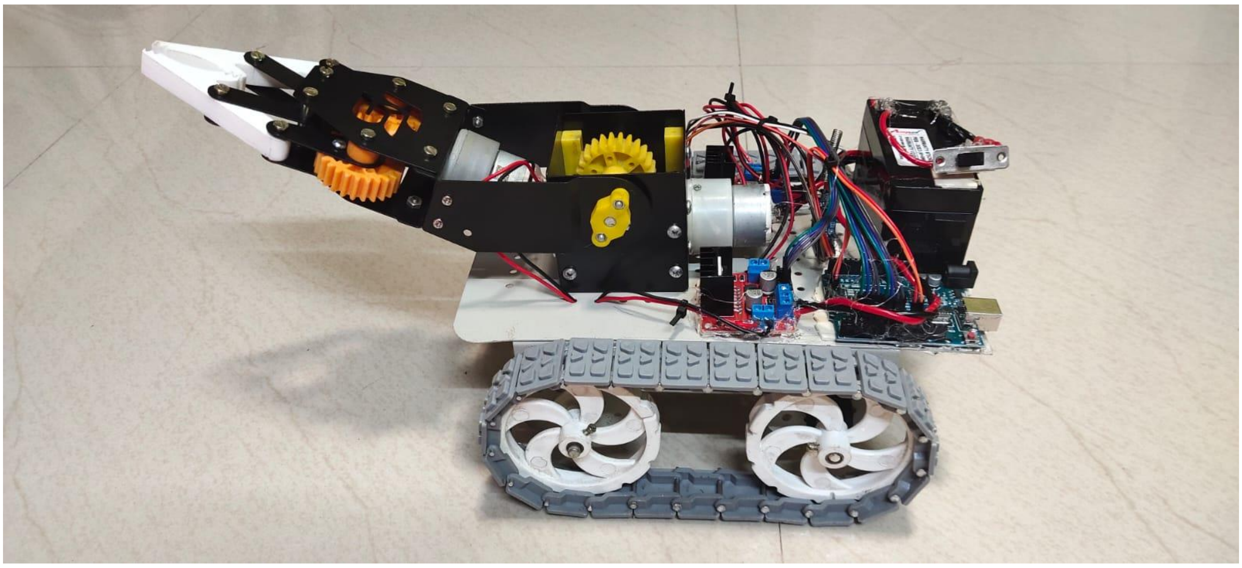
TOP VIEW

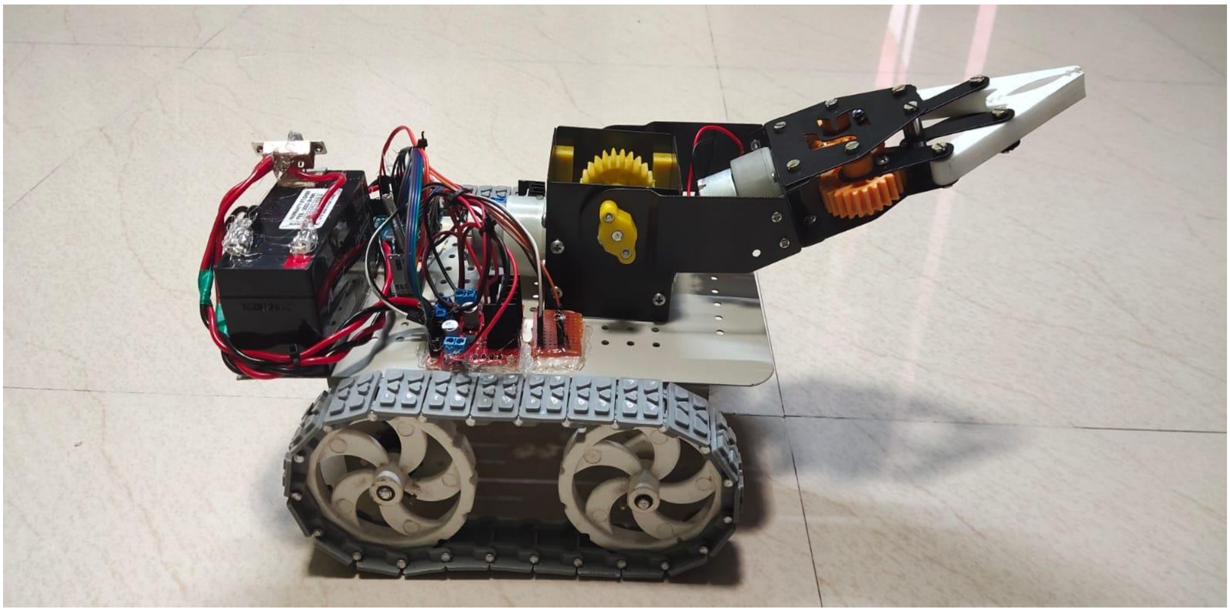


FRONT VIEW



SIDE VIEW





CHAPTER 9

CONCLUSION

The overall system performs reasonably well. The user is able to carry out comfortable and precise functions of the robotic Hand through the use of a sensor based control glove. Furthermore, the robotic Hand is capable to carry normal routine function as human hand does. The microcontroller accepts inputs from the sensor and generates the proper control signals based on those inputs. The usable lifetime of the flex sensors seems to be limited. The sensors themselves are very fragile and easily wear out from overuse. Careful maintenance and protection of the flex sensors is crucial to successful operation of the system. In this project i have learn about basic and advance concept of Robotic Arm.In the robot kinematics, the gripper can be moved where is wanted using rotation of links and joints. For this purpose, links and joints are accepted as a coordinate system individually, as using homogeneous transformations. Robot kinematic is divided in two types: forward kinematic and inverse kinematic. Direct(forward) kinematics involves solving the forward transformation equation to find the location of the hand in terms of the angles and displacements between the links. Inverse kinematics involves solving the inverse transformation equation to find the relationships between the links of the manipulator from the location of the hand in space. By using user interface program, data is sended as a packet. This packet include servo angles and error check value. This value is controled both by user side program and hardware side program.

FUTURE SCOPE

The integration of a robotic arm with wheel rotation technology has the potential to enable a wide range of applications and advancements in various industries. Some potential future scope of this technology include:

Industrial Automation: Robotic arms with wheel rotation technology can be used in industrial automation for various tasks such as material handling, assembly line operations, and packaging.

Agriculture: In the agriculture industry, robotic arms with wheel rotation technology can be used for tasks such as planting, harvesting, and pruning.

Logistics and Warehousing: Robotic arms with wheel rotation technology can be used for tasks such as order picking, palletizing, and inventory management in logistics and warehousing operations.

Healthcare: Robotic arms with wheel rotation technology can be used in healthcare for tasks such as assisting with surgery, rehabilitation, and patient care.

Space Exploration: Robotic arms with wheel rotation technology can be used for space exploration missions to perform tasks such as collecting samples, assembling structures, and repairing equipment.

The future scope of robotic arms with wheel rotation technology is vast, and their potential applications are limited only by our imagination and creativity. With ongoing advancements in robotics, machine learning, and artificial intelligence, we can expect to see continued innovation and development in this field in the years to come.

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