Visvesvaraya Technological University, Belagavi.

PROJECT REPORT

on

"Mobile Drive Robot"

Project Report submitted in partial fulfillment of the requirement for the award of the degree of

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in

Electronics and Communication Engineering

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Submitted by

USN lCR16EC165 SHUCHI DEVEN JANI

USN 1CR16EC166 SNEHA C

USN 1CR16EC167 SNEHA SWATI

USN 1CR16EC176 SUSHMITHA M

Under the guidance of

Mr. Sachin Aralikatti

Asst.Professor

Department of ECE

CMRIT, Bengaluru

Department of Electronics and Communication Engineering

CMR Institute of Technology, Bengaluru – 560 037

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CELEBRATING 25 YEARS CMR INSTITUTE OF TECHNOLOGY

CERTIFICATE

This is to Certify that the dissertation work **"Mobile Drive Robot"** carried out by **Shuchi Deven Jani** ,**1CR16EC165**; **Sneha C**,**1CR16EC166**; **Sneha Swati**,**1CR16EC167**; **Sushmitha M**,**1CR16EC176** bonafide students of **CMRIT** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belagavi,** during the academic year **2019-20**. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said degree.

Signature of Guide	Signature of HOD	Signature of Principal
___________________	___________________	___________________
Mr.Sachin Aralikatti, Asst.Professor, Dept. of ECE., CMRIT, Bengaluru.	Dr. R. Elumalai Head of the Department, Dept. of ECE., CMRIT, Bengaluru.	Dr. Sanjay Jain Principal, CMRIT, Bengaluru.

External Viva

Name of Examiners	Signature & date
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CHAPTER 1.0

INTRODUCTION

In this fast-paced world, anyone who can't keep up gets left behind, there are no exceptions made for anyone. The graph of the number of **differently-abled** people that have entered the industry and are scaling new heights is positively pacing, but these individuals **require additional help to keep up with their peers.**

Autonomous robots are helpful in busy environments, like a hospital. Instead of employees leaving their posts, an autonomous robot can deliver lab results and patient samples expeditiously. Without traditional guidance, these robots can navigate the hospital hallways, and can even find alternate routes when another is blocked. They will stop at pick-up points, and collect samples to bring to the lab. As the population grows, the health industry is also experiencing the saddening truth that the ratio of medical professionals to patients is 1:1000 in India which leads to **many patients not receiving the care that they deserve,** especially in the care of the disadvantaged and the elderly.

1.1 Problem Statement

Mortality rates have gone down; the minimum age till which a regular individual survives has now crossed 80 years. When an individual crosses this limit, there are a lot of tasks that they require assistance in eg. picking things up from the ground or cleaning up after themselves, or sometimes even to take their medicines. In old age and assisted homes, the **ratio of nurses to patients is 1:10**, which stretches the nurses too thin and also does not give the patients the attention they deserve.

COVID 19 has created a situation where senior citizens are the most at risk, they have to practice social distancing. This leads to a situation which puts their caregivers into jeopardy, instead of physical transfer of items, our robot can bridge the gap.

The percentage of people that work in companies that are **differently-abled** has increased in the past few years, they require assistance but they should not have to rely on another human to do so.

Today technology is fast-evolving, which makes it imperative that we, the students, come up with ideas that can be used in numerous fields and make the most of our product. Our project comprises a **mobile drive robot** that will have an arm connected to it. Mobile robots can move around in their environment and are not fixed to one **physical location**. This gives them the advantage of being able to cover a larger area and have vast applications. Mobile robots are also termed as "**Autonomous Mobile Robots**", that is, AMR, which also means that they are capable of **navigating** in an uncontrolled environment without using physical or electro-mechanical guidance devices that allow them to travel a predefined navigation route in relatively controlled space. Hence, also termed as "**AGV-Autonomous Guided Vehicle**".

CHAPTER 2.0

LITERATURE SURVEY

Paper- 1

Design and Implementation of Robot Arm Control Based on MATLAB with Arduino Interface

By- T.Rajesh, M. Karthik Reddy, Afreen Begum, D.Venkatesh

In the present days, a number of situations exist where it is not possible for a human operator to do an activity on his/her own, due to a level of danger or difficulty involved. They may involve taking readings from an active volcano, entering a building on fire, diffusing a bomb, or collecting a radioactive sample. Rather than compromising on human lives, it is better to employ robotic systems for performing difficult tasks. Robotic systems are far superior in ensuring the accuracy of the system under adverse circumstances wherein a human operator may lose his/her composure and focus. Here we propose to build a robotic arm controlled by Matlab/Simulink interfacing with Arduino Uno. The development of this arm is based on the Arduino platform and Matlab A servo motor is a combination of DC motor, position control system, gears. The position of the shaft of the DC motor is adjusted by the control electronics in the servo, based on the duty ratio of the PWM signal. Servo is proposed for low speed, medium torque and accurate position application. These motors are used in robotic arm machines, flight controls and control systems. This project presents an interactive module for learning both the fundamental and practical issues of servo systems interface with ARDUINO UNO. This project, developed using Matlab coding tool, is used to control robotics applications. The objective of this project is to control the servo by using ARDUINO UNO with MATLAB & SIMULINK.

This paper proposes to build a robotic arm controlled by MATLAB/Simulink interfacing with Arduino Uno. The development of this arm is based on the Arduino platform and MATLAB. A servo motor is a combination of DC motor, position control system, gears. The position of the shaft of the DC motor is adjusted by the control electronics in the servo, based on the duty ratio of the PWM signal. Servo is proposed for low speed, medium torque and accurate position application. These motors are used in robotic arm machines, flight controls and control systems. This project presents an interactive module for learning both the fundamental and practical issues of servo systems interface with ARDUINO UNO. This project developed using MATLAB coding tool, is used to control robotics applications. The objective of this project is to control the servo by using ARDUINO UNO with MATLAB & SIMULINK.

Paper - 2

Design of a mobile robot with a robotic arm utilizing microcontroller and wireless communication

By- I.B.Alit Swamardika

The purpose of this study is to design a prototype of a mobile robot equipped with a robotic arm which can be controlled by wireless technology. In this scheme, the mobile robot in the form of 6 Wheel Drive Robot equipped with robotic arm 6 Degree of Freedom and is controlled wirelessly through remote control based on XBee Pro Series 1. Data on the remote is sent serially via XBee transmitter, processed on the receiver, and then used as a reference to control the robot. The tests on the forward, backwards, turn left, turn right, stop and linear movement of the robot was performed successfully, which elevates the robot deployment potentials. The Six Degree of Freedom (6 DOF) has enabled the robotic arm to perform the designed movements very well. Furthermore, the mobile robot successfully follows the command from each input variable resistor via the remote control to move the robotic arm. The mobile robot and the robotic arm movement can successfully be done simultaneously, which elevates its potentials for deployment.

Hardware:

- Microcontroller Arduino Mega 2560 as a data processor and robot controllers.
- Wireless communications module XBee-PRO as sender and recipient of the data instructions.

Software:

- The Arduino IDE is used to create the program in the microcontroller.

Paper - 3

Pick and Place Robot with Wireless Charging Application

by N. Firthous Begum, P

Mankind has always strived to give life-like qualities to its artifacts in an attempt to find substitutes for himself to carry out his orders and also to work in a hostile environment. The popular concept of a robot is of a machine that looks and works like a human being. The industry is moving from the current state of automation to Robotization, to increase productivity and to deliver uniform quality. One type of robot commonly used in industry is a robotic manipulator or simply a robotic arm known as a pick and place robot. It is an open or closed kinematic chain of rigid links interconnected by movable joints. In this paper pick and place, Robot is designed which performs its operation by using android via object detection application and PIC microcontroller. This application has been programmed in java language. In the transmitter part, the voice input is given by using HM2007 to the microcontroller by using RF module. In the receiver section, the RF receiver will receive this voice input and it will be given to the microcontroller. Simultaneously the object to be picked will be done by using an android application where the camera of the android mobile will capture the objects. The output from the mobile will be sent through Bluetooth to the microcontroller and that will allow the motor to move in order to pick the object. In this paper, wireless charging application is also implemented by using electromagnetic induction concept that allows the robot to charge itself whenever the onboard battery goes low. Keywords: robotics, pick and place robots, wireless charging application, android object detection application.

In the proposed system, a humanoid robot is implemented which performs the task initiated by the user without human assistance by voice input. The pick and place robot eliminates the need for sensors which are used to detect object and object detection application is developed using java language. The input voice is given to the microcontroller and sent to the receiver using an RF transmitter. Simultaneously the object picking is done by using an android application where the camera of android mobile will detect and capture the image of the object. The output from the android mobile is sent to the microcontroller through Bluetooth and it allows the motor to move in order to pick the object by using the motor drive. Wireless charging is implemented on the principle of electromagnetic induction.

Paper - 4

Development of real-time tracking and control mobile robot using video capturing feature for unmanned applications

By-P. Velrajkumar, S. Solai Manohar, C. Aravind, A. Darwin Jose Raju and R. Arshad

A wireless tracking and controlling mobile robot using video capturing features (VCF) for unmanned applications is presented. It is wheel-based and Radiofrequency (RF wireless communicated) is used for communication between the controller and the robot. The available motions of the robot are forward, backward, right, left and the combination of these movements. Besides, a camera is built in the robot for tracking. The video captured by the camera is displayed in the computer or Laptop by using the Window Media Encoder (WME) software that is able to be controlled by using Windows GUI remote control. It is built for the purpose of viewing the places that humans cannot reach. Same with other robots which are built to work in dangerous environments, it can be used to explore the situation of dangerous places that humans cannot reach, for example, the natural disaster area, cave, underground and so on. On the other hand, it can also serve as an investigation robot in the military field. It suits the task of searching for an ambush or sneaking into an enemy base to gather information.

This research presented the controlling and tracking of mobile robots using Video Broadcast Feature and Audio Broadcasting Feature for the unknown environment applications. It is an android based autonomous robot with Bluetooth and Wi-Fi that is used for communication between the robot and a remote controller. The robot is self -powered with 9V supply to power up the microcontroller, motors and transmitter for audio broadcast. The microcontroller used to control the robot remotely in the Arduino, it has built-in input and output ports. For the real-time audio transmitter, it will detect voice and any kind of audio using a mini electric microphone to transmit a signal when detected through a transmitter circuit that is designed to transmit the sound with the specified frequency range.

This robot has real-time video broadcasting capability to watch the activities that take place in other places. The real-time video coverage is broadcast by using smartphones that use broadcasting software. The video is transmitted using the internet medium for longer range receiving destination. The designed mobile robot can be used for surveillance purposes or military purposes for spying.

CHAPTER 3.0

HARDWARE

3.1 Functional Hardware Requirements

Functional Requirement defines a function of a software system and how the system must behave when presented with specific inputs or conditions. These may include calculations, data manipulation and processing and other specific functionality.

The different Functional Requirement used are as follows:

- Arm
- Gripper gears
- Gripper fingers
- Arm base
- Control Device
- Electronic speed controllers
- Transmitter and receiver
- Rechargeable battery
- Pi Cam
- Raspberry Pi
- Mini Breadboard

3.2 Non-Functional Requirements

Non-functional requirements are the requirements which are not directly concerned with the specific function delivered by the system. They specify the criteria that can be used to judge the operation of a system rather than specific behaviours. They may relate to emergent system properties such as reliability, response time and store occupancy. Non-functional requirements arise through the user needs, because of budget constraints, organizational policies, the need for interoperability with other software and hardware systems or because of external factors such as product Requirements. Non-functional requirements are also called the qualities of a system. These qualities can be divided into execution quality & evolution quality. Execution qualities are security & usability of the system which are observed during run time, whereas evolution quality involves testability, maintainability, extensibility or scalability.

The different Non-Functional Requirement used are as follows:

- Arm Module
- Wheels
- Base body Kit
- Arm body kit
- Wires
- Switches
- Buttons

3.3 Hardware Components:

The machines, wiring, and other physical components of a computer or other electronic system are called hardware components. A hardware platform is a set of compatible hardware on which software applications can be run. Each specific hardware platform has its own machine language, and programs must be built specifically for a platform that involves a standardized type of processor and associated hardware pieces. The components we are using here are:

3.3.1 Raspberry Pi

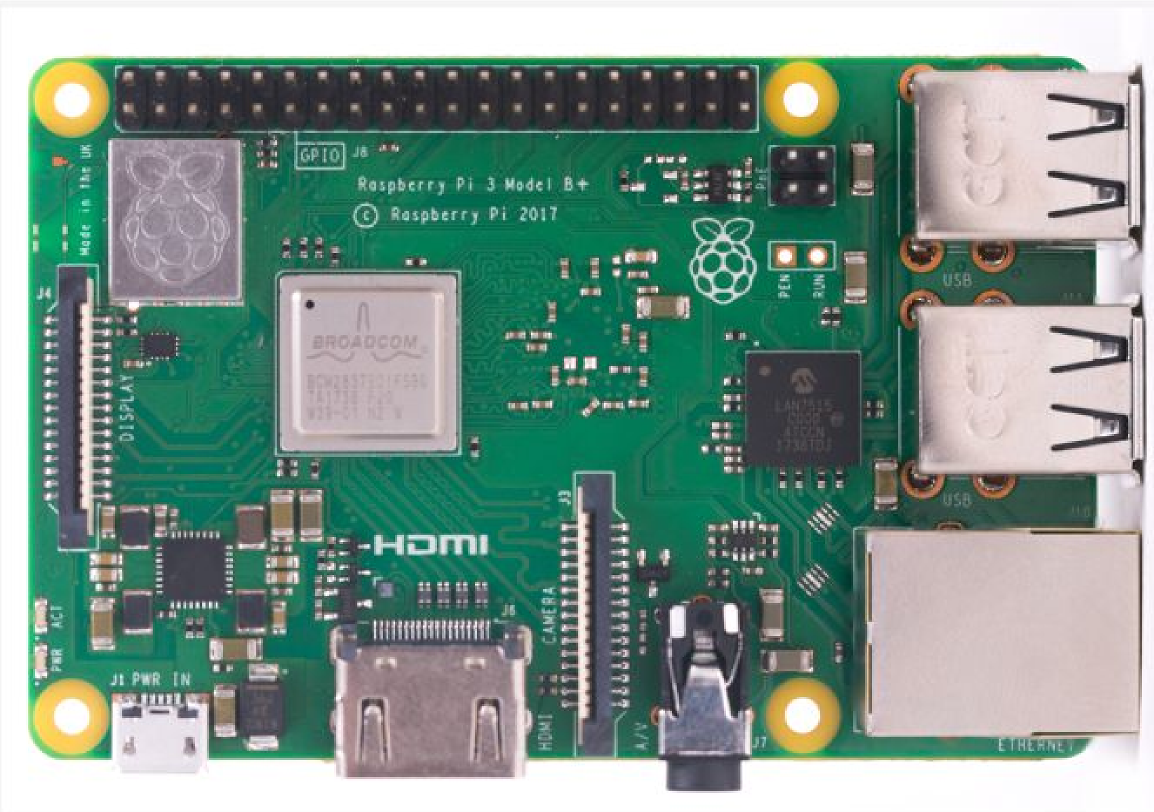

Fig 3.1 Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing and to learn how to program in languages like Scratch and Python. It’s capable of doing everything you’d expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

Raspberry Pi is an ARM-based credit card sized SBC (Single Board Computer). Raspberry Pi runs Debian based GNU/Linux operating system Raspbian. The Broadcom BCM 2837 SoC (System on Chip) is used in it. System on the chip means a chip that holds all of the necessary hardware and electronic circuitry for a complete system. SoC includes on-chip memory

(RAM and ROM), the microprocessor, peripheral interfaces, I/O logic control, data converters, and other components that comprise a complete computer system.

Features:

- **Processor:** Raspberry Pi-3 uses a Broadcom BCM2837 SoC with 1.2GHz 64 bit quad-core ARM Cortex-A53 processor.
- **Performance:** The Raspberry Pi 3, with a quad-core Cortex-A53 processor, is described as 10 times the performance of a Raspberry Pi 1. This was suggested to be highly dependent upon task threading and instruction set to use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2.
- **Overclocking:** The CPU chips of the first and second-generation Raspberry Pi board did not require cooling, such as a heat sink unless the chip was overclocked, but the Raspberry Pi 2 and Raspberry Pi 3 SoC may heat more than usual under overclocking. Most Raspberry Pi chips could be overclocked to 800 MHz, and some to 1000 MHz. In the Raspbian Linux distro, the overclocking options on boot can be done by a software command running "sudo raspi-config" without voiding the warranty. In those cases, the Pi automatically shuts the overclocking down if the chip reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings (voiding the warranty); an appropriately sized heat sink is needed to protect the chip from serious overheating. In an attempt to maximize the performance of the SoC without impairing the lifetime of the board new versions have come into existence, which contains the option to choose between overclock presets. This is done by

monitoring the core temperature of the chip, the CPU load, dynamically adjusting the clock speeds and the core voltage. The overclock preset for Raspberry Pi 3 is 1100MHz ARM, 550 MHz core, 500MHz SDRAM, 6 overvolt.

- **Real-Time Clock:** Raspberry Pi doesn't have a built-in real-time clock, so they don't know the time of the day. A program running on it can get time from a network time server. To provide consistency of time for the file system, it automatically saves the time it has on shut down and re-installs that time on booting.

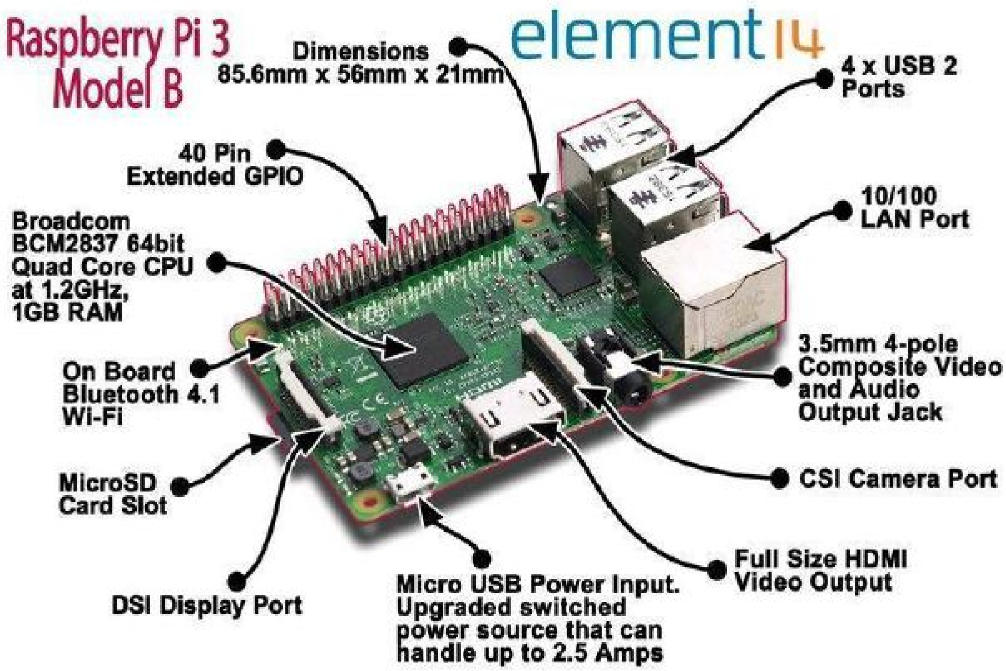

Fig 3.3 Component Description of Raspberry Pi

- **RAM:** Raspberry Pi 3 has 1GB of RAM which has higher than the previous versions.
- **GPU:** The Graphical Processing Unit of Raspberry Pi 3 can operate at 250 MHz for video core 4, at 300 MHz for the 3D part, 400 MHz for a video part.

- **Networking:** The Raspberry Pi 3 is equipped with 2.4 GHz Wi-Fi 802.11n (150 M bit/s) and also has 10/100 Ethernet port.
- **Peripherals:** The Raspberry Pi contains 4 USB ports which are used to connect external devices like keyboard, mouse in order to work it as a generic computer. It may also contain USB storage, USB to MIDI converters, and virtually any other device/component with USB capabilities. Other peripherals can be attached through the various pins and connectors on the surface of the Raspberry Pi.
- **CSI Port:** The Raspberry Pi 3 has a Camera Serial Interface which facilitates the connection of a small camera to the main board BCM2837 processor. This port provides electrical bus connection between two devices. The video inputs are given through CSI port.
- **HDMI Port:** High Definition Multimedia Interface is a proprietary audio/video interface for transferring uncompressed video data and compressed or uncompressed digital audio data from an HDMI-compliant source device, such as a display controller, to a compatible computer monitor, video projector and digital television. The video outputs are taken through an HDMI port.

PIN CONFIGURATION:

Below shows pin configuration of Raspberry Pi 3. It contains 26 GPIO pins, 4 DC power supply pins out of which 2 are 3.3 V each and remaining 2 are 5 V each, 8 pins for ground and 2 pins for ID_SC. GPIO stands for General Purpose Input Output. These pins are used for purposes other than those specified above.

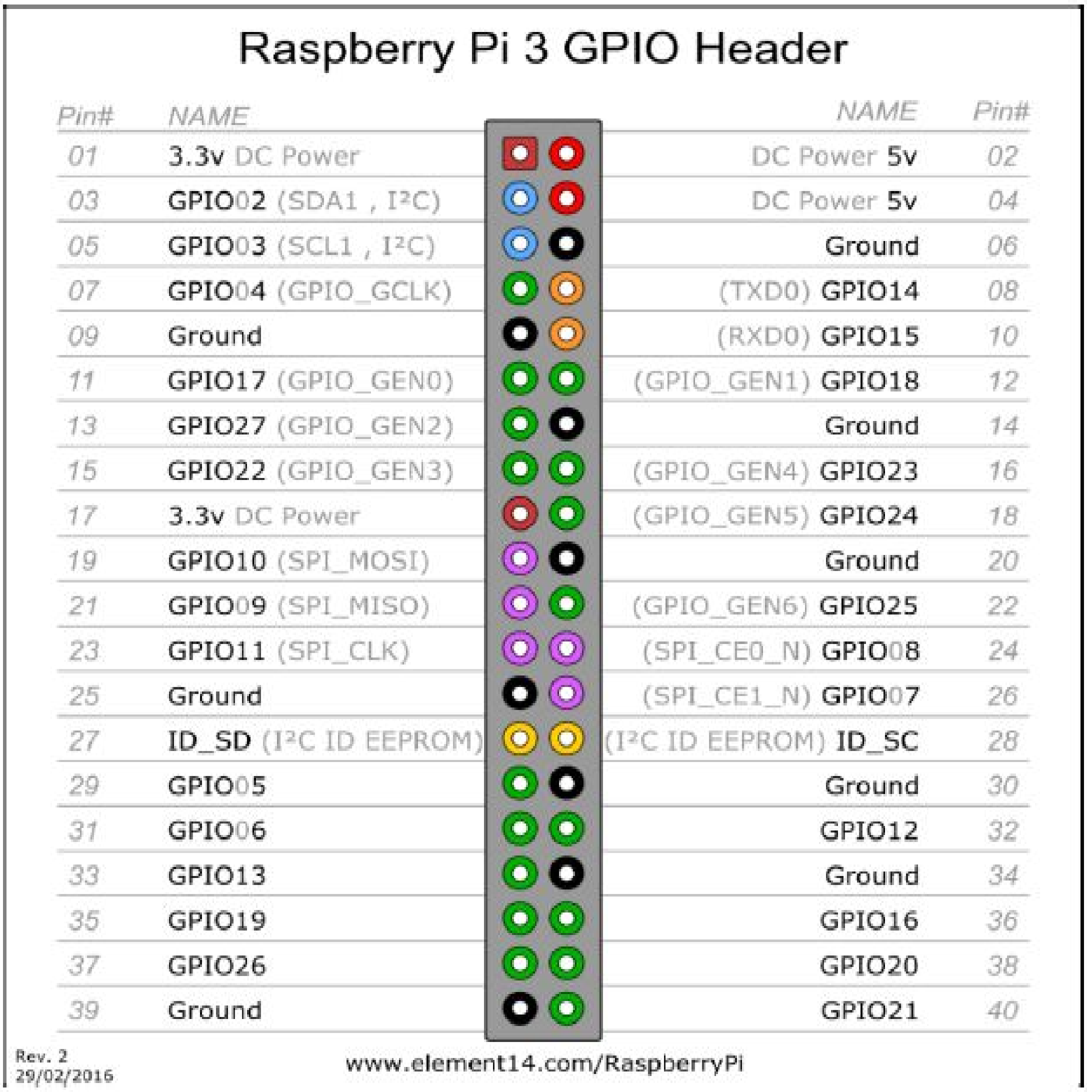

Fig 3.4 Pin Configuration of Raspberry Pi

Raspberry Pi Hardware Setup

The Raspberry Pi board contains a processor, graphics chip, program memory (RAM), various interfaces and connectors for external devices. RPi operates in the same way as a standard PC, requiring a keyboard for command entry, a display unit and a power supply.

Operating System SD Card:

As the RPi has no internal mass storage or built-in operating system it requires an SD card preloaded with a version of the Linux Operating System.

One can create their own preloaded card using any suitable SD card (4GBytes or above) one has in hand. It is suggested to use a new blank card to avoid arguments over lost pictures.

Keyboard and Mouse:

Raspberry Pi 3 contains 4 USB ports, out of which two ports are utilized to connect keyboard and mouse.

Display:

There are two main connection options for the RPi display, HDMI (High Definition) and Composite (Standard Definition).

- HD TVs and many LCD monitors can be connected using a full-size 'male' HDMI cable.
- Older TVs can be connected using Composite video.

Power Supply:

The entire Raspberry Pi unit is powered via the MicroUSB connector. By using a USB connector one can supply 700mA at +5V dc.

Internet and BlueTooth Connection:

The Raspberry Pi 3 contains onboard Wi-Fi and BlueTooth module and 10/100 Ethernet port. The internet connection is established through Ethernet/LAN port or by Wi-Fi module.

Expansion and Low-Level Peripheral:

In order to make use of the low-level interfaces available on the RPi, then have a suitable plug for the GPIO header pins.

3.3.2 Motors used

A servo motor is a motor whose shaft turns to position something based on a control signal. They are typically used to steer remote control airplanes by adjusting the wing flaps, flight position for drones, controlling valves used in flow control or continuous drive of wheels for robots. They can be used to position or adjust almost anything you can think of. They consist of a plastic housing which contains a DC motor, a control circuit and a few gears for torque. We use the following motors:

1. **MG996R Servo motor**

   MG996r is an upgraded version of MG995 servo. The new PCB and IC control system which makes it far more accurate. Its internal gearing and motor are also upgraded to improve dead bandwidth and centering.

Figure 3.3.2a MG996r Servo motor

Specification:

- Weight: 55
- Dimension: 40.7×19.7×42.9mm

- Stall torque: 9.4kg/cm (4.8v); 11kg/cm (6.0v)
- OperatingSpeed:0.19sec/60degree(4.8v);0.15sec/60degree (6.0v)
- Operating voltage: 4.8~ 6.6v
- Gear Type: Metal gear
- Temperature range: 0- 55deg
- Servo Plug: JR (Fits JR and Futaba)
- Dead band width: 1us
- Servo wire length: 32cm
- Current draw at idle 10mA
- No load operating current draw 170mA
- Stall current draw 1400mA
- servo arms & screws included and fit with Futaba servo arm. It's universal "S" type connector that fits most receivers

2. **TowerPro SG90 Servo**

Wire Description: RED–Positive, Brown–Negative and Orange–Signal

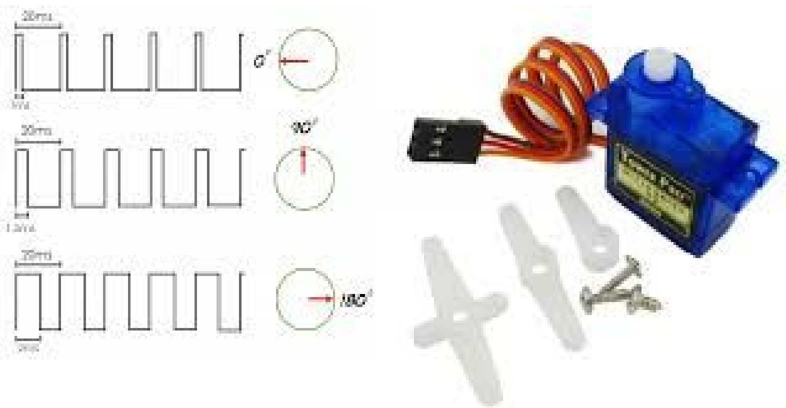

Figure 3.3.2b SG90 Servo Motor

Specifications:

- Modulation: Analog
- Torque: 4.8V: 25.00 oz-in (1.80 kg-cm)
- Speed: 4.8V: 0.12 sec/60°
- Weight: 0.32 oz (9.0 g)
- Dimensions: Length:0.91 in (23.0 mm)
- Width: 0.48 in (12.2 mm)
- Height: 1.14 in (29.0 mm)
- Motor Type:3-pole
- Gear Type: Plastic
- Rotation/Support: Bushing
- Rotational Range: 180°
- Pulse Width: 500-2400 µs
- Connector Type: JR

CHAPTER 4.0

SOFTWARE

The implementation phase of the project is where the detailed design is actually transformed into working code. Aim of the phase is to translate the design into the best possible solution in a suitable programming language. This chapter covers the implementation aspects of the project, giving details of the programming language and development environment used. It also gives an overview of the core modules of the project with their step by step flow.

The implementation stage requires the following tasks.

- Careful planning.
- Investigation of system and constraints.
- Design of methods to achieve the changeover.
- Evaluation of the changeover method.
- Correct decisions regarding the selection of the platform
- Appropriate selection of the language for application development

4.1 Software Used:

4.1.1 Autodesk Inventor:

Autodesk Inventor is one of the world's most used **3D** mechanical CAD design software **for** creating **3D** digital prototypes used **in** the design, visualization, and simulation of products **for** mechanical design. Autodesk Inventor allows 2D and 3D data integration in a single environment, creating a virtual representation of the final product that enables users to validate the form, fit, and function of the product before it is ever built. Autodesk Inventor includes powerful parametric, direct edit and freeform modelling tools as well as multi-CAD translation capabilities and in their standard DWG drawings. Inventor uses a shape manager.

4.1.2 OpenVSLAM:

OpenVSLAM is based on an indirect SLAM algorithm with sparse features, such as ORB-SLAM, ProSLAM, and UcoSLAM. One of the noteworthy features of OpenVSLAM is that the system can deal with various types of camera models, such as perspective, fisheye, and equirectangular. If needed, users can implement extra camera models (e.g. dual fisheye, catadioptric) with ease. Visual SLAM systems are essential for AR devices, autonomous control of robots and drones, etc. Simultaneous localization and mapping (SLAM) systems have experienced a notable and rapid progression through enthusiastic research and investigation conducted by researchers in the fields of computer vision and robotics. OpenVSLAM can accept images captured with perspective, fisheye and equirectangular cameras. Refer the further sections-5.2.1 for algorithm and design flow.

The main contributions of OpenVSLAM are:

- It is compatible with various types of camera models and can be customized for optional camera models.
- Created maps can be stored and loaded, then OpenVSLAM can localize new images using prebuilt maps.
- A cross-platform viewer running on web browsers is provided for the convenience of users.

4.1.3 OpenCV:

OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in commercial products. The OpenCV project was initially an Intel Research initiative to advance CPU-intensive applications, part of a series of projects including real-time ray tracing and 3D display walls.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high-resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

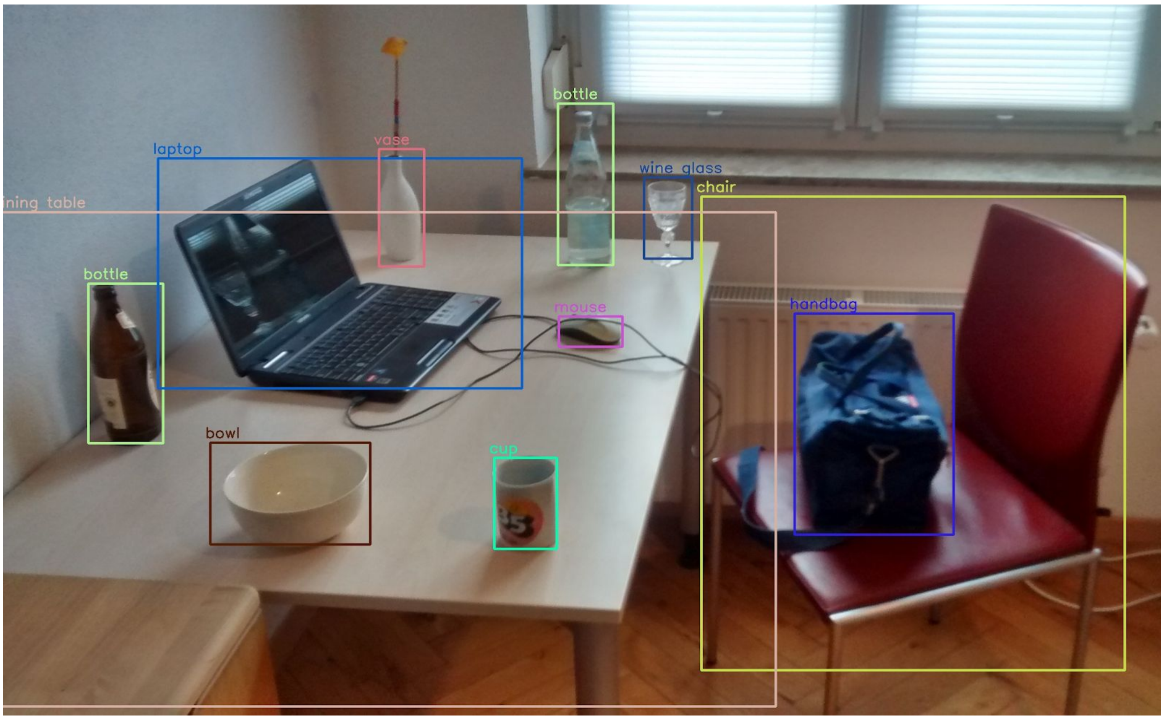

Fig. Object detection using opencv python

CHAPTER 5.0

DESIGN AND IMPLEMENTATION

Our robot consists of a base with wheels and an arm attached on its top. The design for each part is shown in the below sections. Figure 5.3 describes the 3D model of the robot designed using Autodesk Inventor.

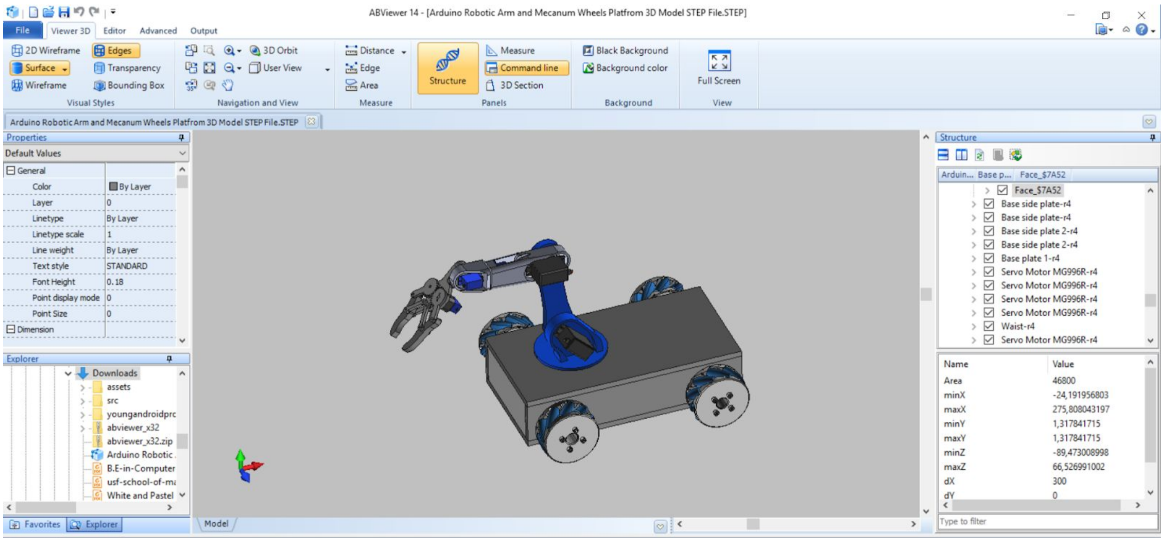

Fig 5 3 Model Design of the Robot

5.1 Mechanical Structure

Fig 3D-view (Opaque) of Robot5.1.1 Design Process

- Design Flow diagram

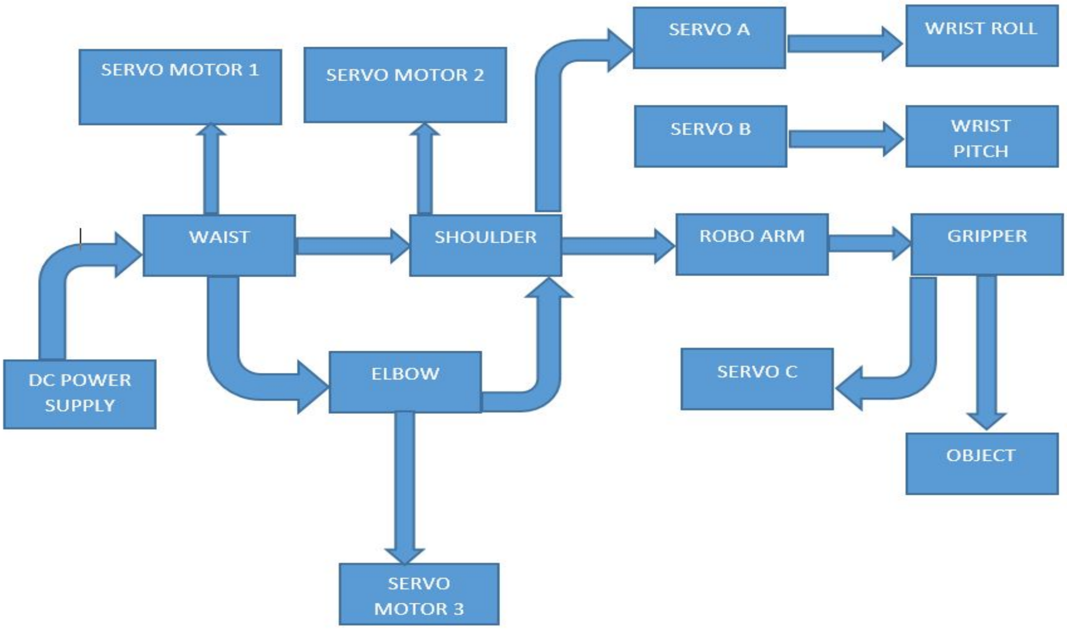

Fig 5.1 Block Diagram of Links in the robot

The first servo of the robot arm will be directly mounted on the top cover of the mecanum wheels platform and using a 10mm drill to make several holes. A rasp is used to cut through the holes and then the opening for the servo is fine-tuned. The servo is secured to the top plate using four M3 bolts and nuts.

On the output shaft of this servo, using the round horn that comes as an accessory with it, we need to attach the next part, which is the waist of the robot arm. However, we can notice that in this way the part stays around 8mm above the plate. So, therefore, attach two pieces of 8mm MDF boards, so the waist part can slide on them and it also helps the joint be more stable. The round horn is secured to the waist part using the self-tapping screws that come as accessories with the servo, and then it is secured to the servo shaft using the appropriate bolts that also come with the servo. Next, we have the shoulder servo. Simply put it in place and secure it to the 3D printed part using self-tapping screws. The round horn goes on the shoulder, and then the two parts are secured to each other using a bolt on the output shaft of the servo. Before securing the parts, we need to make sure that they have a full range of motion. Also, add a rubber band to the shoulder joint so that it gives a little bit of help to the servo because this servo carries the weight of the rest of the arm as well as the payload.

5.1.2 Robot Design

1. **Gripper**

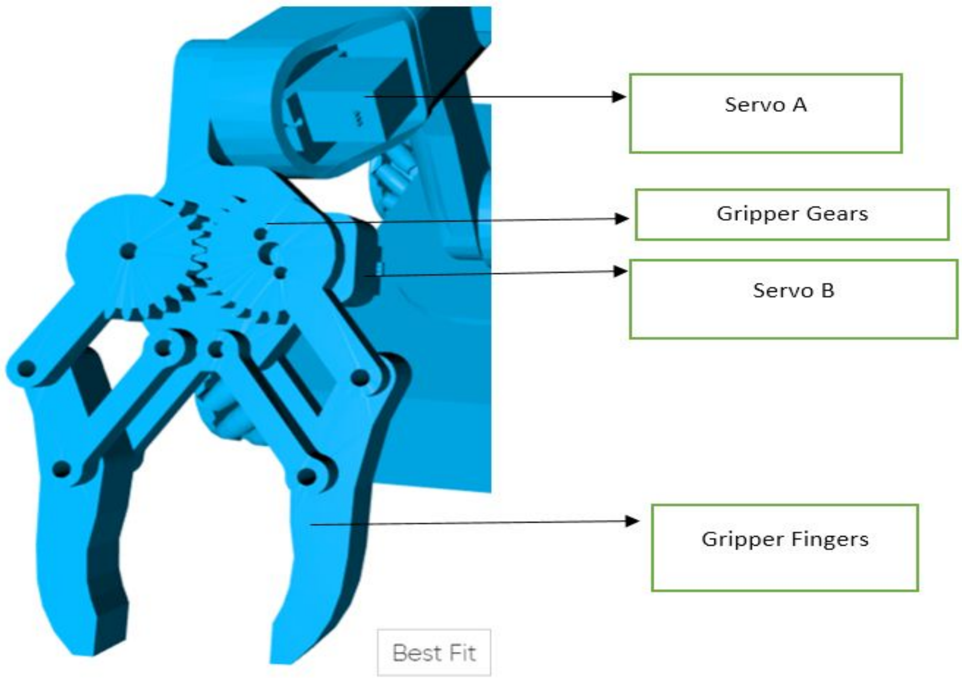

Fig 5.3a Gripper

2. Arm-1

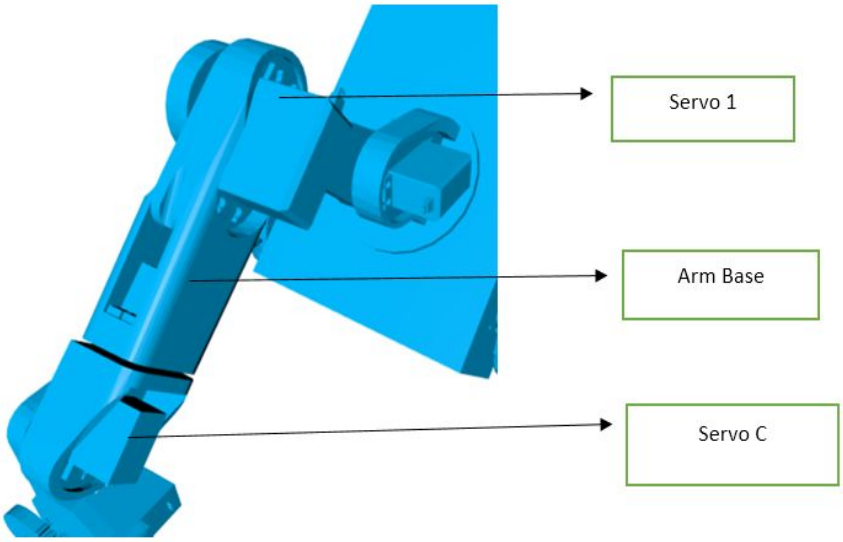

Fig 5.3b Arm1

3. Arm-2

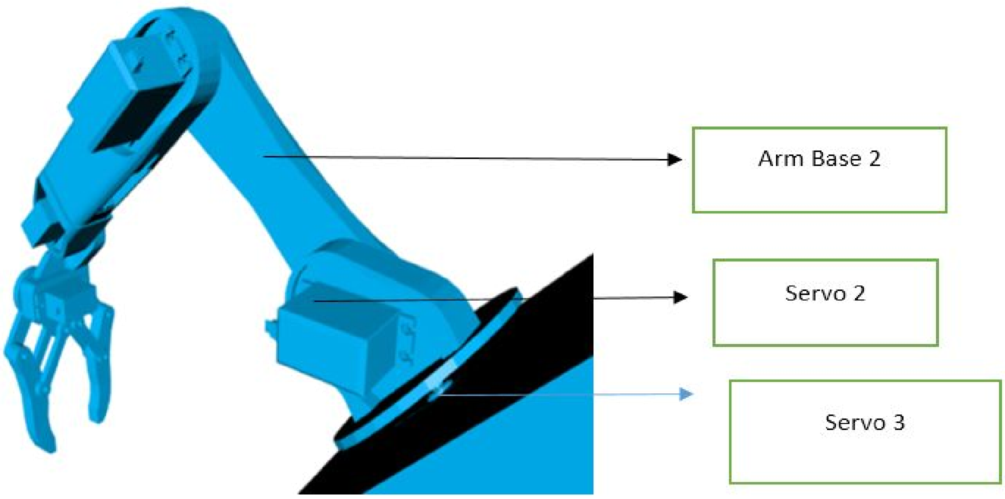

Fig 5.3c Design of Arm 2

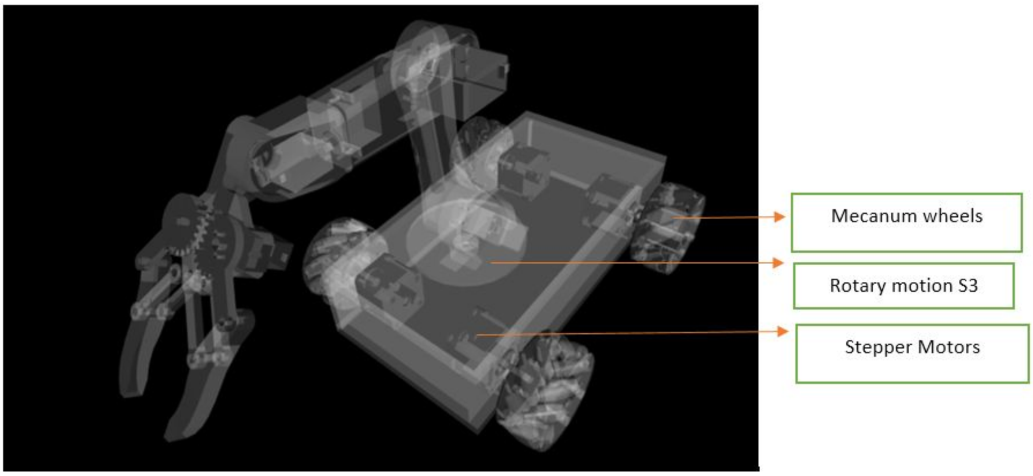

Fig 5.3e 3D view (Transparent)

5.1.3 Connections

Include a 5V voltage regulator on Pi so that we can make this project, or connect the servo motors because they work at 5V. The voltage regulator is the LM350, which can handle up to 3 Amps of current. All six servos of the robot arm can draw from around 2 amps to 3 amps of current, which means that it can handle them but that will cause the regulator to heat up.

Servo motor connections to Pi: Connect the VCC and GND of the Tower Pro SG90 Servo Motor to +5V and GND pins of the power supply. Then connect the PWM Pin of the Servo Motor to Physical Pin 22 of Raspberry Pi i.e. GPIO25. Refer to the following figure.

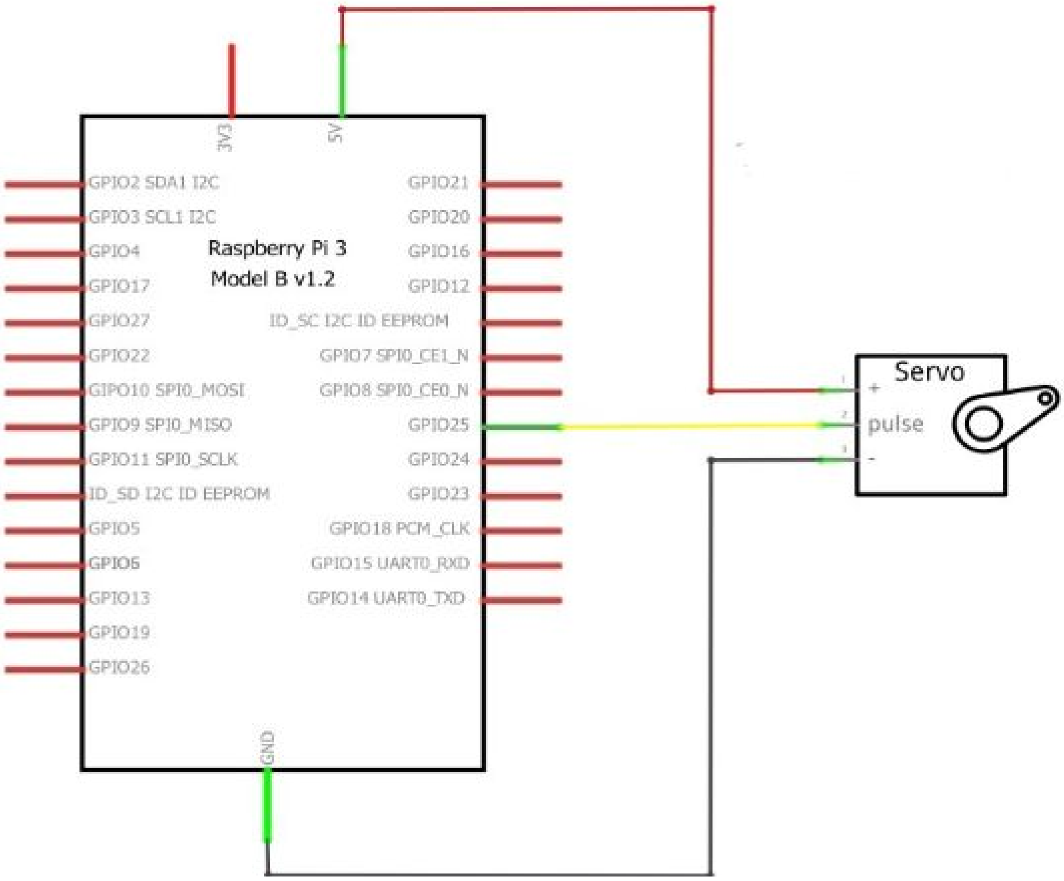

Figure 5.1.3 Servo Connections

5.2 Implementation

5.2.1 ALGORITHM - Room Mapping

The software of OpenVSLAM is roughly divided into three modules, as shown in Figure 5.2.1 tracking, mapping, and global optimization modules. The *tracking module* estimates a camera pose for every frame that is sequentially inputted to OpenVSLAM via key-point matching and pose optimization. This module also decides whether to insert a new keyframe (KF) or not. When a frame is regarded as appropriate for a new KF, it is sent to the mapping and the global optimization modules. In the *mapping module,* new 3D points are triangulated using the inserted KFs; that is, the map is created and extended. Additionally, the windowed map optimization called local bundle adjustment (BA) is performed in this module. *Loop detection, pose-graph optimization,* and *global BA* are carried out in the global optimization module. Trajectory drift, which often becomes a problem in SLAM, is resolved via pose-graph optimization implemented with g2o Scale drift is also canceled in this way, especially for monocular camera models.

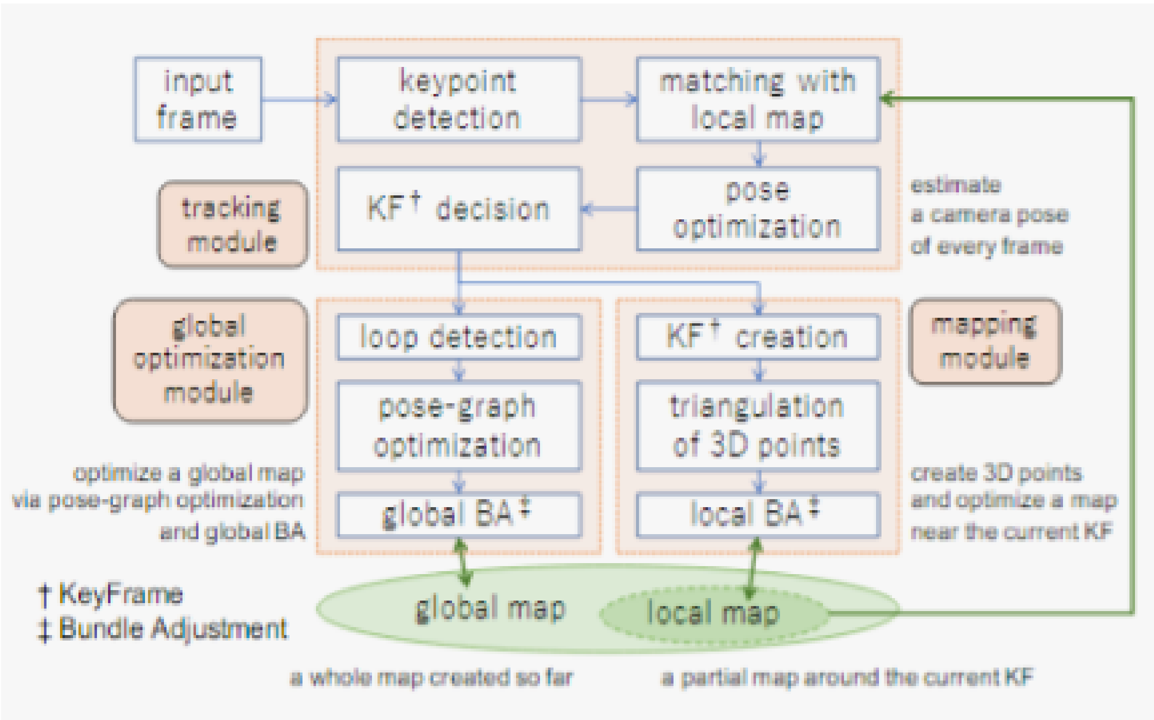

Figure 5.2.1 Flow chart of Robot Navigation

5.2.2 ALGORITHM-Object Detection

The flow diagram for real-time object detection using Raspberry Pi is shown below. The flow diagram starts with the user inputs to the robot, for instance, the object to be detected. As the Raspberry Pi receives the input from the user it starts the camera and ROS module which consists of OpenVSLAM and OpenCV modules. These two processes in real-time and returns information like object distance and location coordinates back to the

Pi. Further, The Pi sends commands to the motor for the designated process-pick and place.

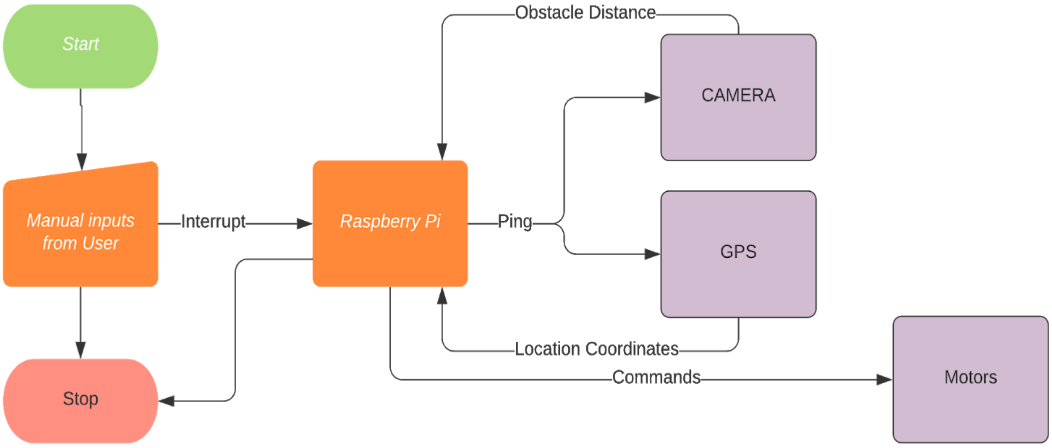

Figure 5.2.2 Flow chart of Object Detection

CHAPTER 6.0

RESULTS

The robot is able to localize and develop a map for the environment and travel from point A to B . It is also able to detect the desired object and use its arm to pick it up and move it from one position to the other. The movement of the robot's arm and body should be coordinated according to the readings given by both the cameras.

The robot is able to detect the landmarks in each frame that it captures using the pi camera. It then is able to measure and make note of the displacement in the area that it moves in, using this it plots a map of the area that it moves in; this has been made possible by the OpenVSLAM framework.

It is also able to collect information about the objects in the room and detect the desired object based on the database provided. This object detection is made possible by using OpenCV.

Once the object is recognized, the gripper opens up to the required size and clamps the object between it, it then moves towards the desired location and then carefully drops it.

CHAPTER 7.0

APPLICATIONS AND ADVANTAGES

This project has multiple and varied applications, but at the moment we are focusing on it coming of use to medical professionals, the elderly, and the disabled.

- It can be used to pick up objects based on the need, for eg - bringing water or medicines to someone sick.
- It can move files from one place to another in the workplace and can also deliver parcels to the intended recipients.
- The robot can be used by nurses to send medicines to patients at a specified time, thus reducing the load on the nurses.
- This can be used in quarantine zones to send materials, and later can be cleaned by sanitizing it. This will reduce the risk of infection and will keep people safe.
- Autonomous robots are helpful in busy environments, like a hospital. Instead of employees leaving their posts, an autonomous robot can deliver lab results and patient samples expeditiously. Without traditional guidance, these robots can navigate the hospital hallways, and can even find alternate routes when another is blocked. They will stop at pick-up points, and collect samples to bring to the lab.

CHAPTER 8.0

CONCLUSION AND SCOPE FOR FUTURE WORK

8.1 CONCLUSION

The main aim of this project is to make the lives of the disadvantaged and the elderly easier. Using a combination of mechanical, electronics and computer engineering we have come up with a robot that can be used in multiple domains, but in this particular scenario is being made to assist the medical industry, which by reducing the amount of human interaction can reduce the spread of infection and ease the amount of burden on the medical industry.

8.2 FUTURE WORK

The AGV (Autonomous Guided Vehicle) has the potential to be used in the medical industry to be used in nursing homes and in old age homes to be used by nurses and patients to move objects like medicines or water bottles etc. It can also be used to transport objects to people that are in quarantine and reduce the chance of infection spreading. There are chances that this robot can be used for military applications and even by our police for remote bomb deactivation. This can also be used as a personal robot and can be trained to do simple tasks such as getting the newspaper in the morning or even giving medicines to the family members at a specific time in the day.

There is scope for the AGV to be able to detect multiple objects and map multiple areas. The gripper arm can be modified according to the usage of the AGV and the size of the robot can be changed according to the load of the object it has to carry. A voice recognition feature can also be attached to the AGV, making it easy for individuals who find it difficult to operate mobile devices or disabled people who do not have the capability to operate the AGV manually.

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