IC 201P – Design Practicum

Project Title
Humanoid Robotic Face Assistant - Persona

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Certificate

This is to certify that the work contained in the project report entitled "**Humanoid Robotic Face Assistant - Persona**", submitted by Group-35 to the Indian Institute of Technology Mandi, for the course IC 201P – Design Practicum, is a record of bonafide research works carried out by Group-35 under our direct supervision and guidance.

Dr. Varun Dutt — Signature and Date

Dr. Mrityunjaya Doddamani — Signature and Date

Acknowledgement

We would like to express our sincere gratitude towards **Dr. Varun Dutt** and **Dr. Mrityunjay Doddamani** for their valuable guidance and support throughout the development of this project. Their insights and technical expertise have been instrumental in shaping our ideas and transforming them into reality .

We would like to thank the course coordinator, **Dr. Prateek Saxena** and our teaching assistant, **Mr. Shubham Chauhan** for their guidance and encouragement throughout this project.

Abstract

Humanoid robots are the field which is increasing in popularity day by day. Many groups are working on some issues like interacting, learning and controlling for applying them in human robotics.

Humanoid robots with artificial intelligence is very captivating field for people, since robots are introduced. We can introduce new ideas without any limitations to implement them .

In this product the basic idea is the techniques which are used in human-human interaction, they can be used as an initiative for human-robot interaction.

Different types of sensor and microcontrollers are used to grasp the user's means and voice interpretation.

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(source :- all figure are from google images)

Abbreviations

- AI: Artificial Intelligence
- ML: Machine Learning
- Nao: New Autonomous Robot
- Pepper: Personal Assistant Robot
- IEEE: Institute of Electrical and Electronics Engineers
- CAD: Computer-Aided Design
- CAM: Computer-Aided Manufacturing
- PCB: Printed Circuit Board
- MCU: Microcontroller Unit
- CPU: Central Processing Unit
- ROS: Robot Operating System
- API: Application Programming Interface
- IR: Infrared
- PID: Proportional-Integral-Derivative

Chapter 1

Introduction

Robots are machines designed to perform tasks automatically or with minimal efforts . They can be programmed to perform a wide range of tasks , from manufacturing and assembly line work to space exploration and military operations .
The field of robotics has advanced rapidly in recent years, and robots are now being developed with increasingly sophisticated capabilities.

Humanoid robots are complex artificial machines . The growing interest in humanoid robots accompanied by the latest and ever-increasing technological advancement in the field of robotics, locomotion, and AI , has boosted up their development over the past decade.

1. Background of the problem

Since the development of humanoid robots has been an ongoing research topic in robotics . Nowadays humanoid robots are used in different sectors like in research, education, personal assistant, entertainment, public relation, manufacturing, health care centers, etc.

Despite of many challenges, Humanoid robots have made significant progress in recent years. There are a number of commercially available humanoid robots, including the **Pepper** and **Nao robots** from Softbank robotics, and the **Atlas robot** from **Boston dynamics.**

2. Scope of the problem

Humanoid Robots are being used in a variety of applications from research labs and classrooms to retail stores and airports.
Basically the product is working on the Principle of artificial intelligence and with ML model so according to the data, the product can be used in many places, like in hospitals, Schools, universities, and many more.

3. Problem Statement

One of the major issues faced by large institutes, such as universities, is the difficulty in locating specific offices or obtaining necessary information in a timely manner. The lack of insightful resources further complicates the issue. To address this problem, we propose the development of a humanoid robot capable of providing comprehensive information on various aspects of the organization, including but not limited to, the locations of offices, labs, sports facilities, and hostels, academic curricula, eligibility criteria for scholarships, and professor details. The robot will be designed to provide formal greetings and expressions to create a professional environment. Additionally, the robot will serve as a one-stop-shop for obtaining pertinent information related to the organization, making it easier for individuals to navigate and access necessary resources. In doing so, the humanoid robot will provide an efficient and effective solution to a longstanding problem that has hindered the productivity of large institutions.

4. Beneficiaries(Intended market)

It has been forecast that robots will penetrate 21st century society not only in secondary industries but also in the service industry.
Here are some of the benefits of our product:

- It can be used at bigger or higher institutions.
- Can be used at malls for specifying different sections.
- Can be used at airports for greetings and basic information about counter section , security side etc.
- It can be used for childrens in schools like an oh-bot
- Can be programmed for personalized interaction in hospitals .

5. Organization of this report

The report is organized in the form of various chapters from chapter 1 to 5. The report opens with an abstract and acknowledgements to all the persons involved.
Then we define the product. Later chapters introduce the market research done . While picking the Problem, comparison of existing solutions and our solutions . Then we define our design- how we propose the solution and our solution . Then we define our design - how we propose the solution , i.e, the technical details, including electrical part, mechanical part, algorithm and code. Finally, the manufacturing process, assembly tells how the product will be assembled in person. At last, the report ends with the conclusion.

Chapter - 2

Market Research

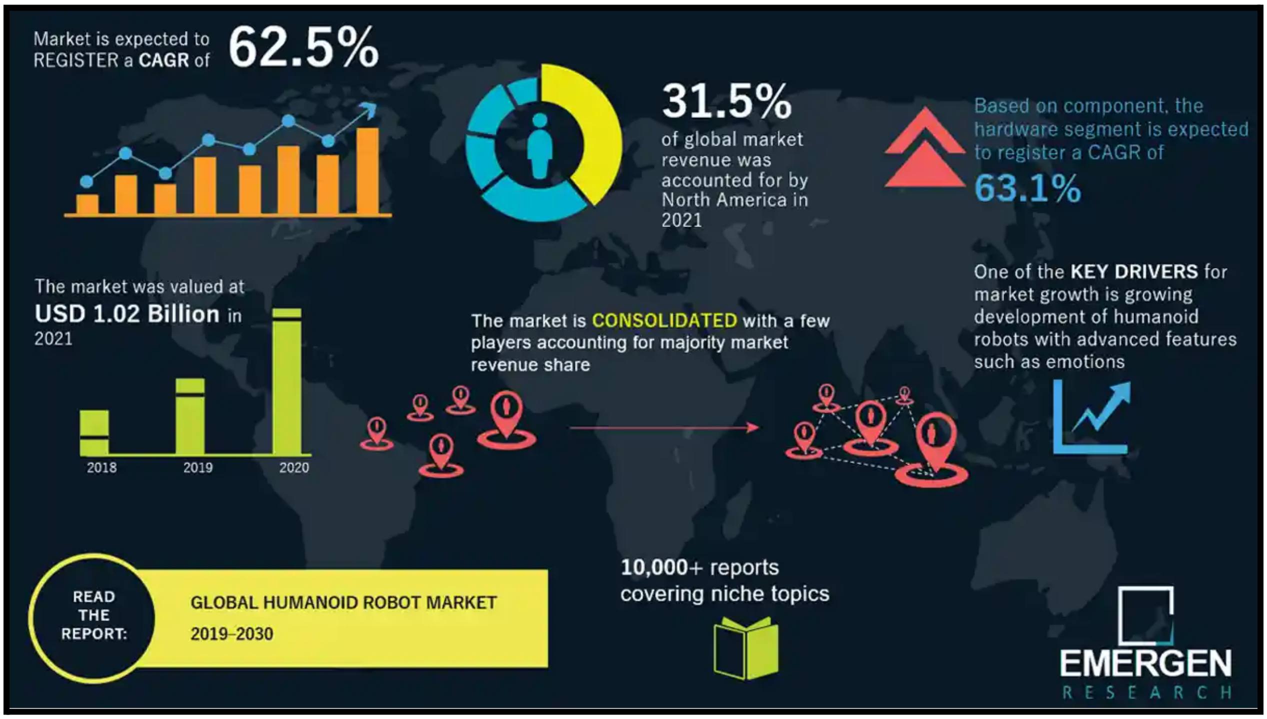


Figure 2.1 :- Market research

According to market research, the global humanoid robot market is expected to grow at a significant rate in coming years.
Here are some key findings from market research reports on humanoid robots:

- **Market size:** The global humanoid robot market size was estimated at USD 1.62 billion in 2022 and it is expected to reach around USD 28.66 billion by 2032.
- **Regional Growth:** The Asia-pacific region is expected to be the fastest growing market for the Humanoid robots, driven by the increasing population of automation technologies in countries such as China, Japan, and South korea
- **Key Players:** Some of the key players in the Humanoid robot market include Softbank Robotics, Hanson Robotics, Toyota motors corporation, and Honda Motor co.Ltd.

- **Challenges:** Despite the growing demand for humanoid robots, there are still a number of challenges that must be overcome, including high costs, technical limitations, and ethical concerns related to the use of robots in sensitive areas such as healthcare and education.

Existing Products - Features and Shortcoming

- **Ohbot :** It is a programmable robot with a modular design that allows for customization and expansion. Ohbot's software includes a speech recognition module that allows it to respond to voice commands and engage in conversations and is not that costly.
  However, its features are limited. Its programming interface is cumbersome and unintuitive, which makes it difficult for users to create complex behaviors or interactions. Ohbot's movement capabilities are limited, as it can only tilt and rotate its head. Additionally, the robot's motor and electrical components are not well-protected, which can lead to damage from dust, moisture, or other environmental factors.

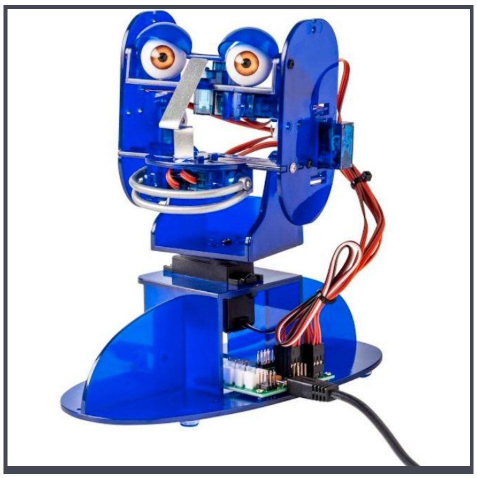


Figure 2.2 :- Ohbot

- **Picoh :** Picoh is a compact, portable robot that can easily fit in a backpack or briefcase.
  Picoh's software includes facial recognition and emotion detection modules, allowing it to respond to human expressions and gestures.Picoh can be programmed through the ohbot.
  Picoh's movement capabilities are limited, as it can only tilt and rotate its head.
  Picoh’s Speech recognition module has no limit as it is open source.Unlike most robots, Picoh is not ambulatory. It is just an expressive little head mounted on a small pedestal. Furthermore, Picoh's build quality is subpar, leading to frequent malfunctions and breakages.

Figure 2.3 :- Picoh

Chapter-3

Conceptual Design

The course of design practicum can be described as a beautiful journey. It gave us the opportunity to get to know our batchmates and to learn a lot. During this period, we discussed many ideas, agreed upon some, rejected some, and also had many brainstorming sessions to shortlist the ideas and decide the best one to work upon. Brainstorming sessions didn't come to an end after idea selection; we continued with those whenever there was any problem, any issue or any concern related to purchasing . In this chapter we describe our journey through idea generation, proposition, and selection .

1) Idea generation

Our ideation process starts with identifying 100 problems that are around us or the ones we usually face by a majority of these peoples.

Each one of us contributed around 20 problems and they were all listed down in a diary .

Then we started by elimination, we first eliminated the problems that were difficult to solve at our level or would require more funding, then we also eliminated those problems which don't require an immediate solution or solving them won't make much of a difference or a social impact.

Then we boiled down to 6 major problems after multiple meetings, brainstorming and eliminating.

We analyzed those problems in depth, we looked for the existing solutions, stakeholders, beneficiaries, ease to solve the problem, pros and cons, motivation to solve the problem, other issues connected with them and also looked for a chance to innovate.

Then we had a discussion with our mentors. Our mentors analyzed all the aspects and helped us boil them down to one issue.

After finally having our final problem, we looked for the current existing solutions for the problem statement at stake.

This was our voyage of ideation. In the next sections, we will present the decision matrix for the problems and ideas as well. We will all present the final solution in the upcoming sections.

2) Decision Matrix

A Decision Matrix, also known as a criteria matrix, is a tool used to evaluate and prioritize different options based on a set of criteria. It is commonly used in decision-making processes, especially in situations where there are multiple options to choose from.
A decision matrix can be useful in a variety of contexts, such as when making business decisions, choosing between different job candidates, or selecting a new product or service. It provides a systematic way to evaluate options and can help ensure that all relevant factors are taken into account. In a report, a decision matrix can be included to demonstrate the decision-making process and rationale behind a particular choice, providing transparency and accountability. Eventually, we end up with 4 major problem :

1.) Holographic Fan with an inbuilt game functioning in it. (H fan)
2.) Drone Delivery System. (DDS)
3.) Spectacle which adjusts its focus according to a person's eye defect. (Spectacle)
4.) Humanoid interaction Robot which can answer asked queries about college. (Robot)

To create a decision matrix for evaluating the six ideas, we will use the following criteria:
1. Market demand - How much demand is there for the product/service?
2. Technical feasibility - How feasible is it to create the product/service?
3. Profitability - How profitable is the product/service likely to be?
4. Competitive Advantage - Does the product/service offer a unique advantage over existing solutions in the market?
5. Social Impact - How much social impact does the product/service have?

Using the above criteria, we can create the following decision matrix:

Ideas	Market Demand	Technical Feasibility	Profitability	Competitive Advantage	Social Impact
Holographic Fan	4	1	1	1	3
Drone Delivery	4	2	3	2	2
Spectacle	1	3	4	2	4
Humanoid interactive Robot	4	4	5	3	4

Table 3.1 :- Decision matrix

We have rated each of the six ideas on a scale of 1 to 5 (with 5 being the highest) for each of the criteria. After considering all the criteria, we can see that the Standing AI robot (Idea 4) has the highest score of 14, followed closely by Drone Delivery (Idea 2) with a score of 13. Based on this decision matrix, we can recommend Idea 4, the Standing AI robot, as the best idea to pursue.

3) Final Proposed Solution for the problem

After extensive brainstorming sessions and discussions, our team has arrived at a proposed solution for the problem at hand - the development of a humanoid robot capable of answering questions posed to it. This project involves the integration of several advanced technologies and engineering principles to create a robot that can effectively process and respond to voice inputs.

The creation of a humanoid robot involves a complex design process, which requires careful consideration of various factors. Our team decided to utilize 3D printing technology to construct the robot's body, ensuring that it is lightweight and durable. We also incorporated advanced sensors such as cameras, microphones, and speakers into the design, which will allow the robot to receive and process voice inputs effectively.

To achieve this, we will integrate these sensors into a program that is trained using machine learning techniques. Additionally, we will leverage the power of artificial intelligence to further enhance the accuracy of the robot's responses. To enable seamless communication between the different components, we will utilize an array of hardware components including Arduino, Raspberry Pi, Node MCU, and a WiFi module.

In conclusion, the development of a humanoid robot involves an intricate design process that requires a combination of advanced technologies and skilled engineering. Our project aims to leverage cutting-edge technologies to create a highly functional and intelligent robot that can effectively interact with humans in a variety of contexts.

Chapter - 4

Embodiment and Detailed Design

1) Product Architecture

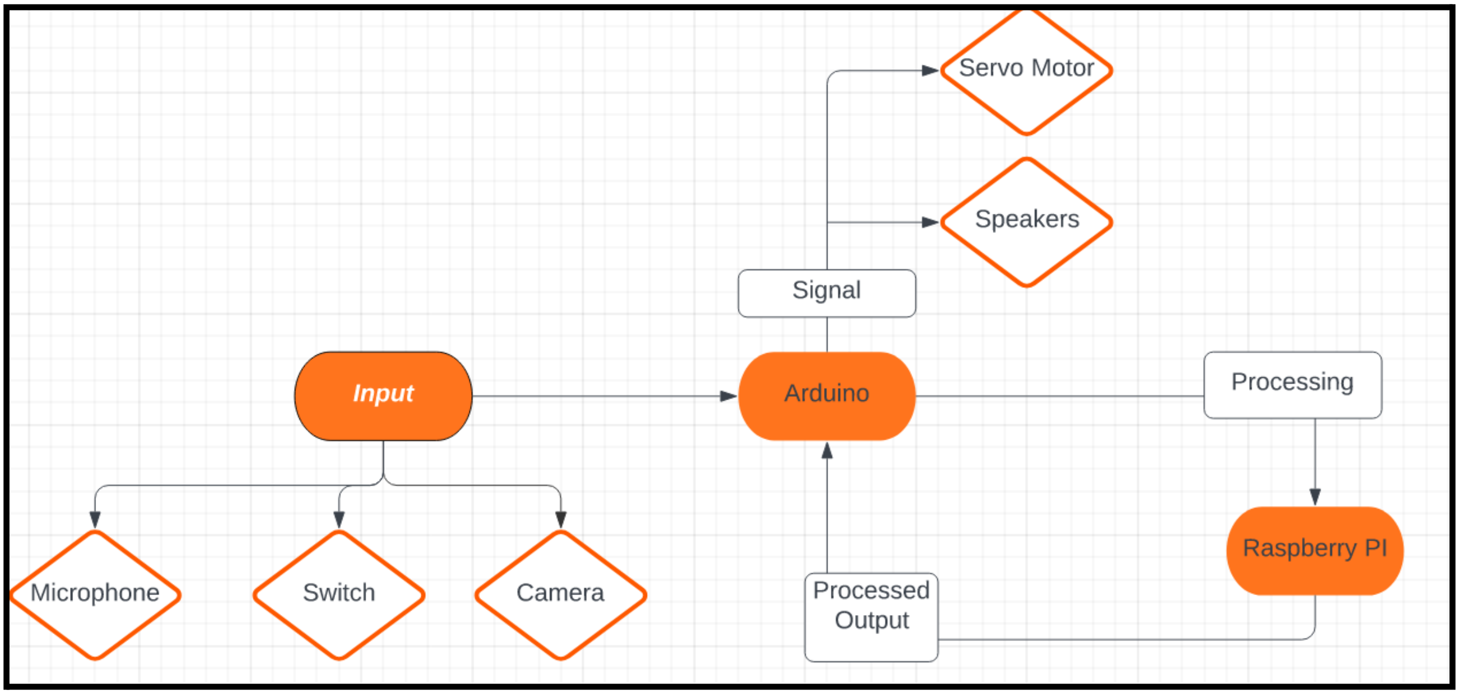


Figure 3.1 :- Block Diagram of Bot

Upon analyzing the above block diagram of the product, it can be seen that the system utilizes various input sources such as a switch, microphone, and camera, which are integrated with an Arduino microcontroller board. The Arduino is responsible for scanning the input signals and transmitting them to a Raspberry Pi for further processing. The Raspberry Pi is utilized to process the input signals and provide output signals, which are then transmitted back to the Arduino for final processing. The Arduino is responsible for providing the necessary information to control the movement of the servo motors, including eye movement, neck movement, and jaw movement, as well as the speaker.

In addition, it is worth noting that the use of multiple input sources and the integration of both Arduino and Raspberry Pi boards provides for a comprehensive and complex system that is capable of processing multiple types of input signals. Furthermore, the servo motors utilized in the system offer a high degree of precision and control, which is essential for the system to operate effectively. However, it is important to consider the potential limitations of the system, including potential issues with signal processing and motor control, which may impact the overall performance and reliability of the product.

2) System-Level Design

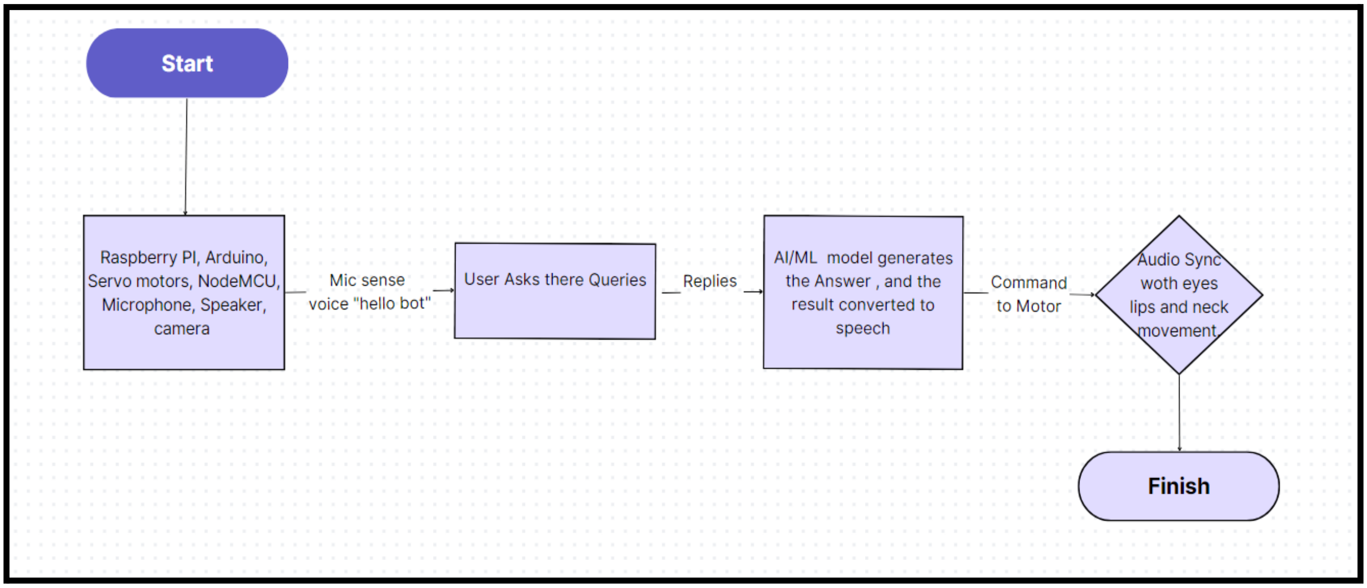


Figure 3.2 :- Module Interaction and WorkFlow diagram

The circuit design incorporates an on/off switch to enable the operation of the product, and provides a stable power supply to the Raspberry Pi, Arduino, and servo motors. The circuit receives input signals, which are processed by an AI/ML model, generating commands that are sent to the Arduino. The Arduino then generates signals to control the movement of the servo motors, thereby synchronizing the audio with the movements of the eyes, jaw, and neck of the product.

In addition, it is worth mentioning that the design of the circuit plays a crucial role in ensuring the proper functioning of the product. Factors such as voltage regulation, current limiting, and component selection are essential in achieving a reliable and efficient circuit design. Furthermore, the implementation of safety measures, such as short-circuit protection and thermal management, should be taken into consideration to prevent potential hazards and ensure longevity of the product.

3) Design Configuration :-

a.) Arduino

Arduino is an open-source electronics platform that includes a microcontroller, development environment, and community of users and developers. It is widely used in various fields, such as robotics and automation, due to its flexibility and ease of use. Arduino provides a compact and versatile solution for prototyping and building electronic projects, which can be powered by USB, batteries, or external power supplies. It is also highly customizable and can be expanded with additional shields that extend the functionality of the board. Overall, Arduino provides a user-friendly and accessible platform for prototyping and building electronic projects.

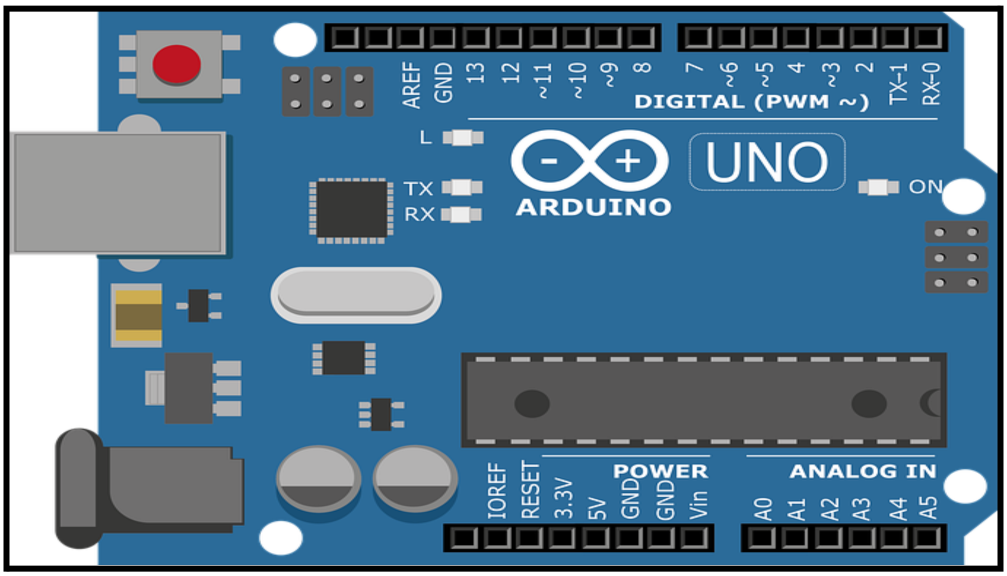


Figure 3.3 :- Arduino

b.) Tinker board

The Tinker board is a single - board computer(SBC) developed by Asus. It is designed as a powerful alternative to Raspberry Pi, offering improved hardware specifications and expandability options. Provides Class leading performance with its powerful and modern quad-core ARM -based processor . Tinker Board's GPU and fixed -function processors allow for a wide range of uses, computer vision, gesture recognition, image stabilization and processing as well as computational photography and more.

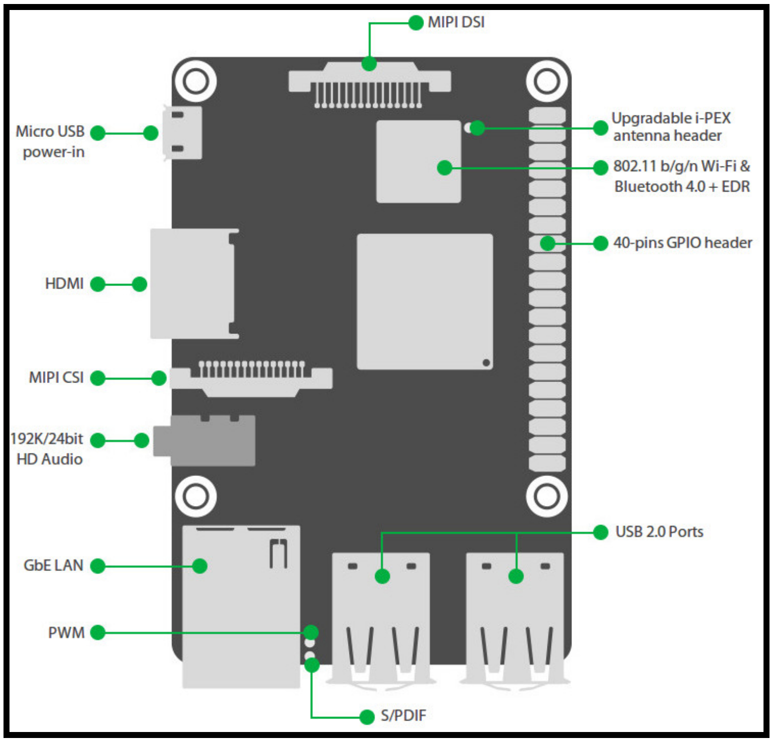


Figure 3.4 :- Asus tinker board

c.) Servo motors(SG90)

A servo motor is a rotary actuator that is widely used in the field of robotics and automation. The SG90 is a small, low-cost servo motor that is capable of precise angular positioning. It operates on a closed-loop control system, which enables accurate control of the motor's position, speed, and torque. Its design typically consists of a motor, a gearbox, and a feedback potentiometer, which provide high accuracy and reliable performance.

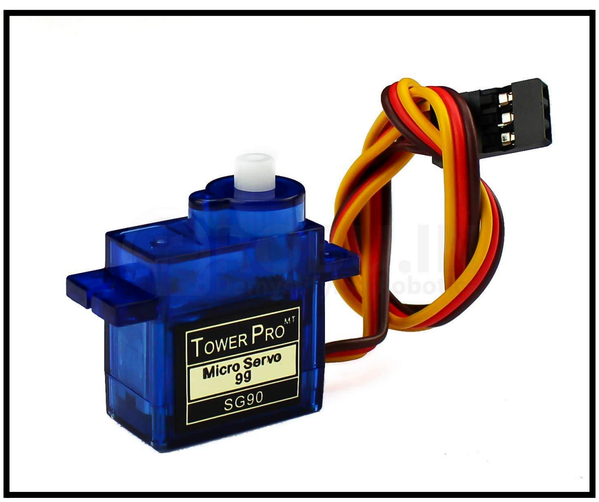


Figure 3.5 :- Servo motor(SG90)

d.) Servo motor(MG995)

The MG995 servo motor is a high-torque rotary actuator that is commonly used in applications requiring powerful motion control, such as industrial automation and robotics. Its design includes a coreless motor, metal gears, and a feedback potentiometer, providing precise and robust operation. The MG995 operates on a pulse-width modulation (PWM) signal, which allows for easy and precise control of its position, speed, and torque. Its versatile design allows it to be used in a wide range of applications, such as CNC machines, robotic arms, and camera gimbals.

Figure 3.5 :- Servo motor(MG995)

e.) NodeMCU ESP8266

NodeMCU ESP8266 is a low-cost Wi-Fi microcontroller that allows for easy implementation of internet-connected projects. It features an integrated Wi-Fi module, 32-bit processor, and multiple GPIO pins. Its compact size and low power consumption make it an ideal choice for IoT applications such as home automation, smart farming, and industrial monitoring. The NodeMCU ESP8266 is programmed using the Arduino IDE and supports Lua scripting language. Its open-source hardware and software design make it accessible and customizable for various projects.

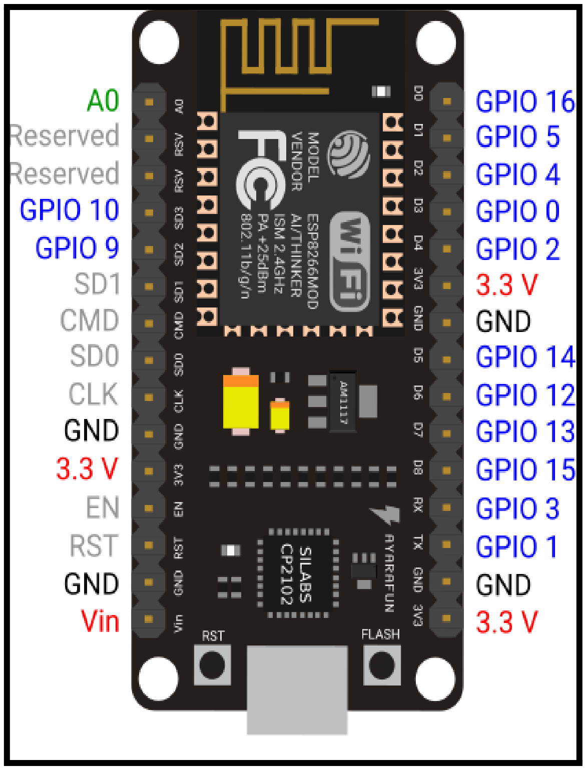


Figure 3.6 :- NodeMCU ESP8266

f.) R PI camera Rev 1.3

The camera connects to the BCM2835 processor on the Pi via the CSI bus, a higher bandwidth link which carries pixel data from the camera back to the processor. This bus travels along the ribbon cable that attaches the camera board to the Pi. The sensor itself has a native resolution of 5 megapixels and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p30, 720p60 and 640x480p60/90 video.

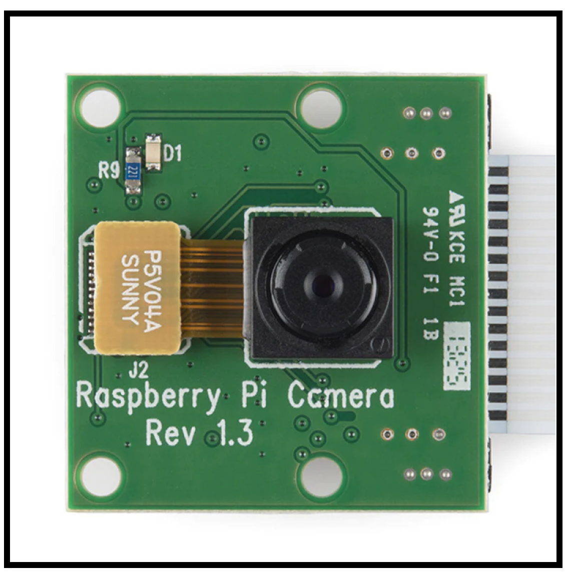


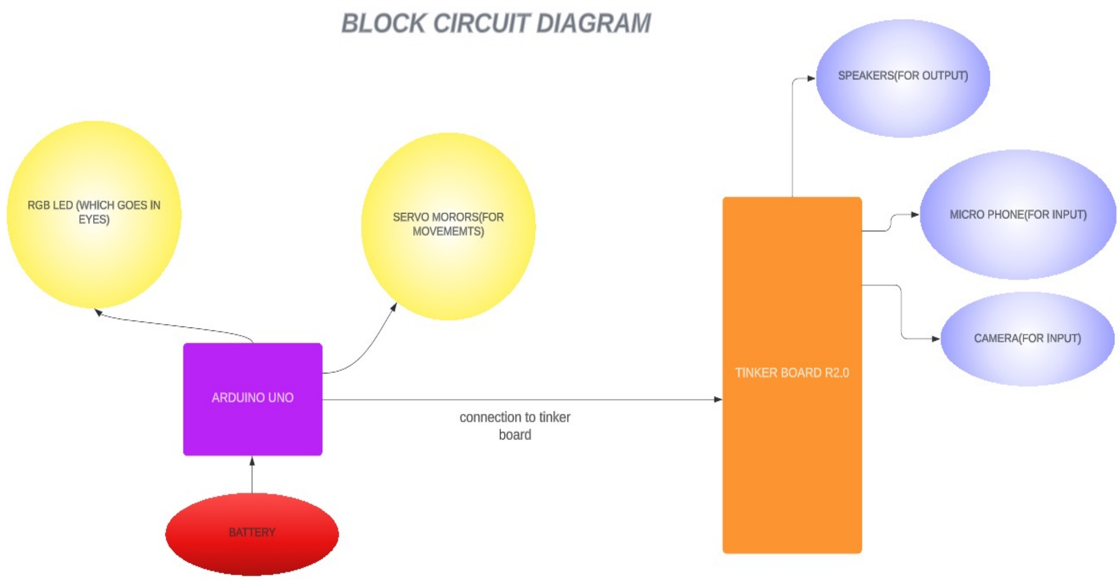
Figure 3.7 :- R PI camera Rev 1.3

4) Detailed Design :-

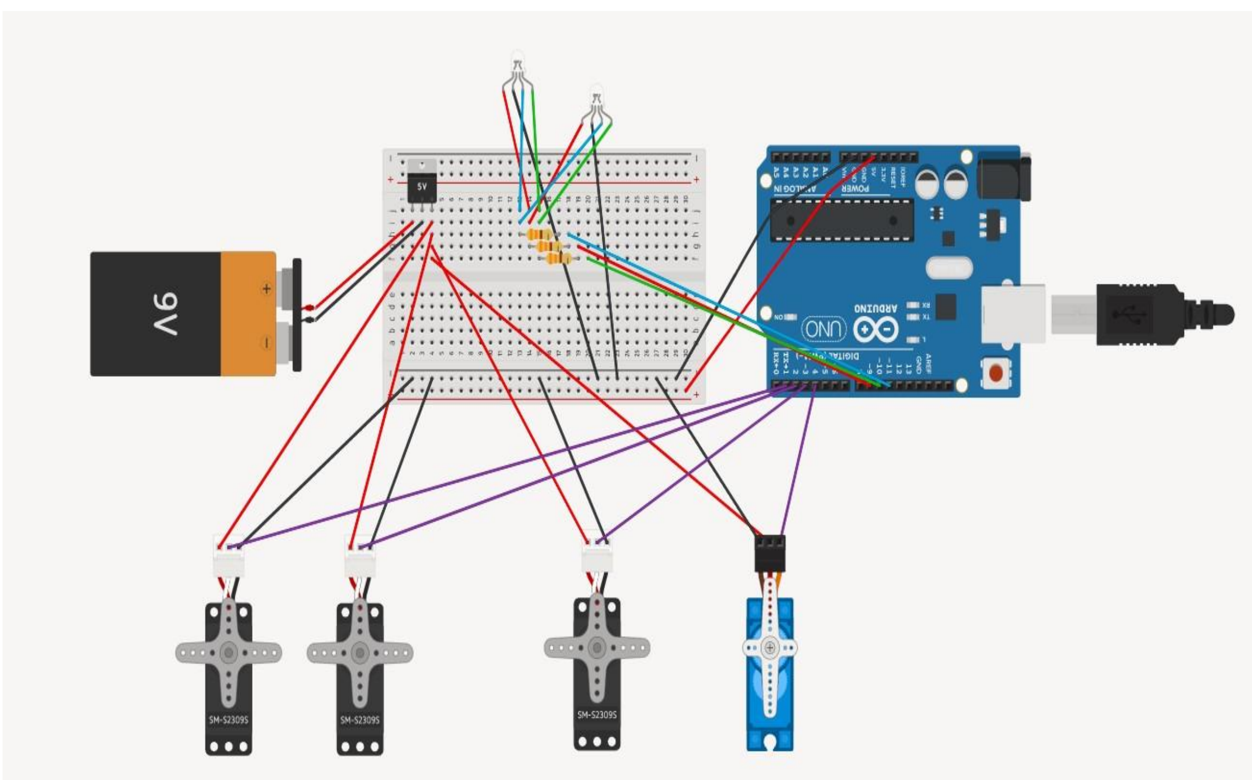
This includes the following aspects

- **Electrical/Electronic Aspect**
  In the electrical part we are to design circuit such that it coordinates the movements proposed in the model and also takes the input from the user and give the output accordingly .i.e,
  We are to take input from a microphone and give output via speaker
  In the movement part we have 3 main aspects i.e, eye,jaw and neck movements .
  For eye movements we've used 2 SG90 servos
  For jaw movement we've used 1SG90 servo
  And for neck movement we've used 1 MG966r servo.
  The SG90 ones are commonly used for low torque applications.the torque produced in this is 1.8kg/cm
  The MG966r is used for high torque applications .the torque produced in this is 11kg/cm
  For controlling all the components (servos ,speaker microphone etc) we used an arduino uno for giving signals to these components .
  The problem with this is the Arduino itself cannot power all these components so we used an external battery to power these things and using a breadboard we can give the power supply to all these components .
  Further for processing of input and giving output instructions is a microcontroller.

  We use a micro controller because of their Versatility and Flexibility,ease of coding , real time responsive interaction and power efficiency.
  We are using an Asus tinker board for this part of circuit operation.



Circuit diagram (arduino)



- **Software Part**

  The software part of a humanoid robot includes a wide range of components that enable the robot to perceive its environment, make decisions, plan actions, and execute tasks. Here are some of the key software components that are typically included in a humanoid robot:

  1. Operating System: The operating system is the foundation of the robot's software stack. It provides basic services such as process management, memory management, and device drivers.

  2. Perception System: The perception system allows the robot to sense its environment through various sensors such as cameras, microphones, and tactile sensors. The perception system processes the sensor data to extract meaningful information about the environment.

  3. Control System: The control system is responsible for generating the robot's movements. It takes input from the perception system and uses that information to generate commands to the robot's actuators.

  4. Planning System: The planning system is responsible for generating high-level plans for the robot's actions. It takes input from the perception system and generates a sequence of actions that the robot should take to achieve its goals.

  5. Decision-Making System: The decision-making system is responsible for making decisions based on the robot's current state and the goals it needs to achieve. It takes input from the planning system and decides which actions the robot should take next.

  6. Communication System: The communication system allows the robot to communicate with humans and other robots. It includes natural language processing, speech synthesis, and gesture recognition.

  7. Learning System: The learning system allows the robot to learn from experience and improve its performance over time. It includes machine learning algorithms for tasks such as object recognition, speech recognition, and motion planning.

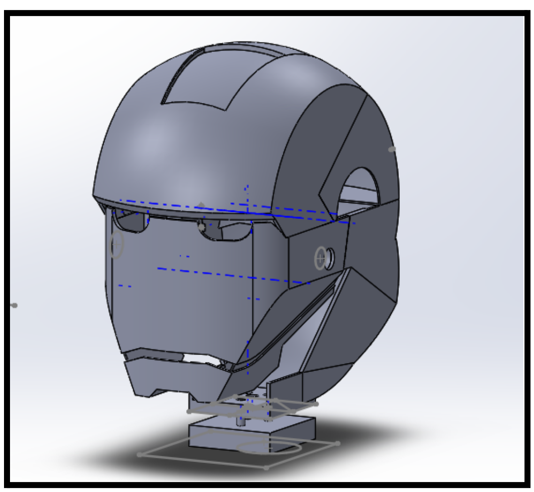
Overall, the software part of a humanoid robot is a complex system that requires expertise in robotics, artificial intelligence, and software engineering.

We have integrated ChatGpt into a humanoid robot which significantly enhanced the robot's conversational abilities and made it more interactive with humans.

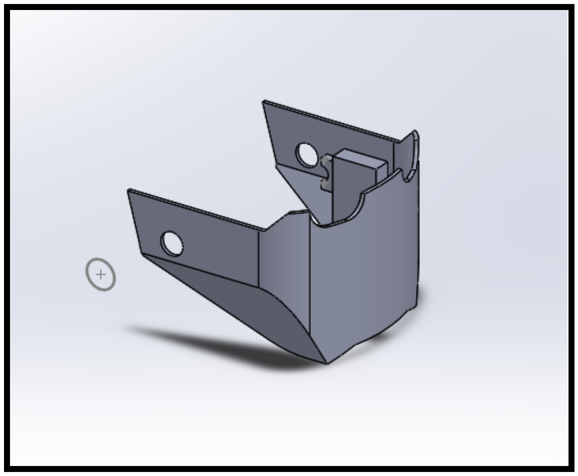
We are using some inbuilt libraries in python which are mentioned below:

- Pyfirmata: PyFirmata is basically a prebuilt library package of python programs which can be installed in Arduino to allow serial communication between a python script on any computer and an Arduino.
- Pyaudio: *PyAudio* provides Python bindings for PortAudio v19, the cross-platform audio I/O library
- Pyttsx3*:* *pyttsx3* is a text-to-speech conversion library in Python
- Openai: The *OpenAI Python library* provides convenient access to the *OpenAI* API from applications written in the *Python* language
- SpeechRecognition: *SpeechRecognition* distributes source code, binaries, and language files from CMU Sphinx.
- Conversation is also logged into a file.
- Multithreading is done to execute all the functioning at a time

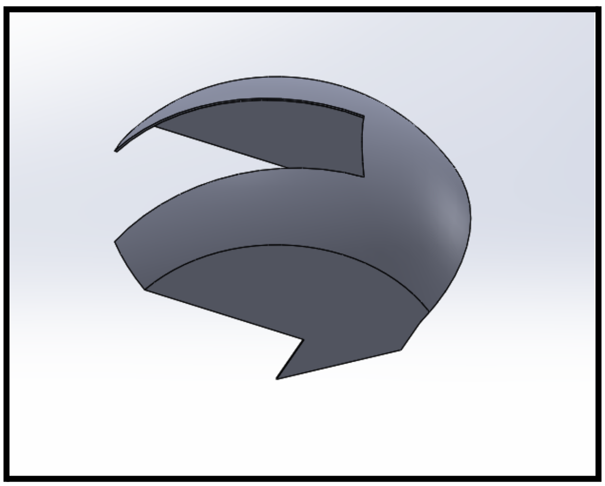
- **Mechanical Aspect**
  - **3d view :-**



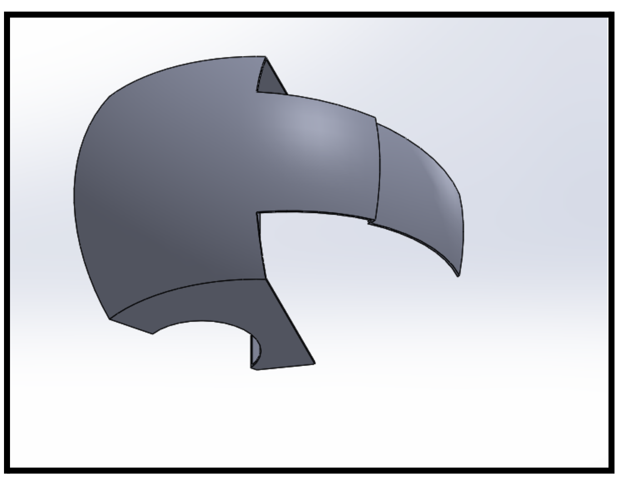
  - **Front part of the face :**



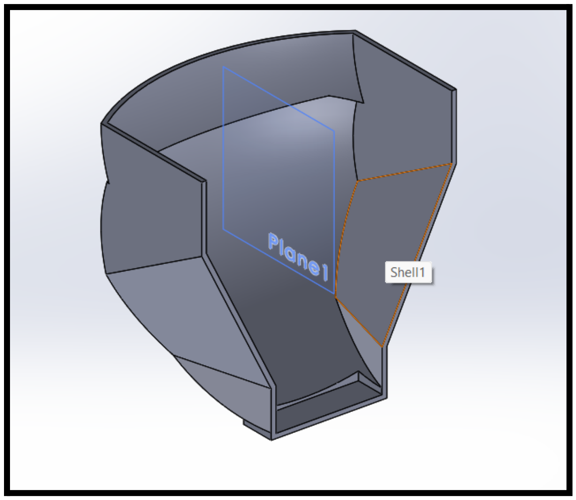
- **Back part of head :**



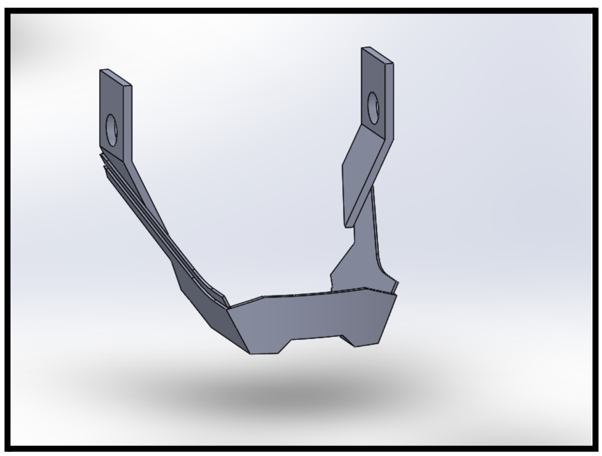
- **Front part of head :**



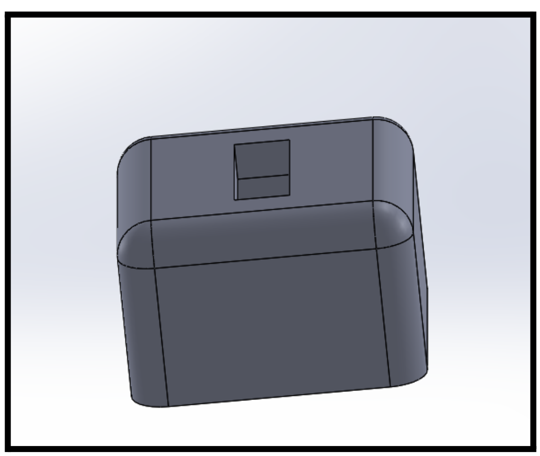
- **Back part of face :**



- **Lower jaw of face :**



- **Base Part:**



5) Results and Discussion

The report introduces the concept of humanoid robots and their increasing sophistication in recent years. The problem of difficulty in locating specific offices or obtaining necessary information in a timely manner in large institutions is identified, and the proposed solution is the development of a humanoid robot capable of providing comprehensive information about various aspects of the organization. The robot will also serve as a one-stop-shop for obtaining pertinent information related to the organization, making it easier for individuals to navigate and access necessary resources. The beneficiaries of the product include universities, malls, airports, schools, and hospitals.

Chapter 2 discusses the shortcomings of existing products such as Ohbot and Picoh. These products have limited features, including movement capabilities, speech recognition, and build quality, which do not justify their high costs.

The proposed solution involves the integration of several advanced technologies and engineering principles to create a robot that can effectively process and respond to voice inputs. The creation of a humanoid robot involves a complex design process, which requires careful consideration of various factors. 3D printing technology will be utilized to construct the robot's body, ensuring that it is lightweight and durable. Advanced sensors such as cameras, microphones, and AI-powered software will also be incorporated to improve the robot's functionality.

Overall, the proposed solution has the potential to provide an efficient and effective solution to a longstanding problem that has hindered the productivity of large institutions. The use of humanoid robots in different sectors is expected to increase in the future, making the development of such robots crucial for the service industry. The report is organized in the form of various chapters, which provide a comprehensive overview of the proposed solution.

Chapter - 5

Fabrication and Assembly

After making a well-versed plan, we moved towards the final part of your journey. Fabrication and Assembly.

This chapter describes the final phase of our project and the report. We present the bill of materials, drawings, material description, manufacturing process, assembly and integration, limitations and challenges, and plan, and finally end with our contributions as individuals followed by a conclusion.

1) Bill of Materials:-

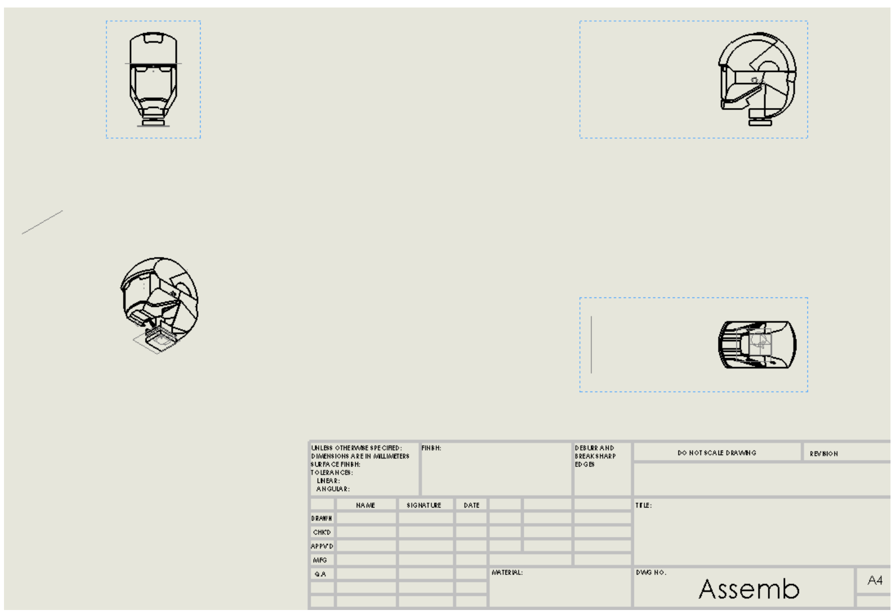
S.No	Item purchased	Quantity	Cost(in INR)
1.	eMCU ESP 8266Nod	1	350.00
2.	Buck Convertor LM2596	2	180.00
3.	Lithium Battery	1	1650.00
4	Lithium Battery Charger	1	530.00
5	Arduino Uno	1	1000.00
6	LED lights	15	15.00
7	Screw Driver Set	1	350.00
8	Cutter Plier Set	1	450
9	Screws Set	2	70.00
10	Switches	2	25.00
11	Touch Sensors TTP224 4 channel	1	135.00
12	Touch Sensors TTP223 1 channel	1	35.00
13	PLA Set	1	1200.00

S.No	Item purchased	Quantity	Cost(in INR)
14	Connector XT60	3	210
15	Microphone	1	600
16	R pi camera rev 1.3	1	500
17	Tinker board	1	N/A (borrowed)

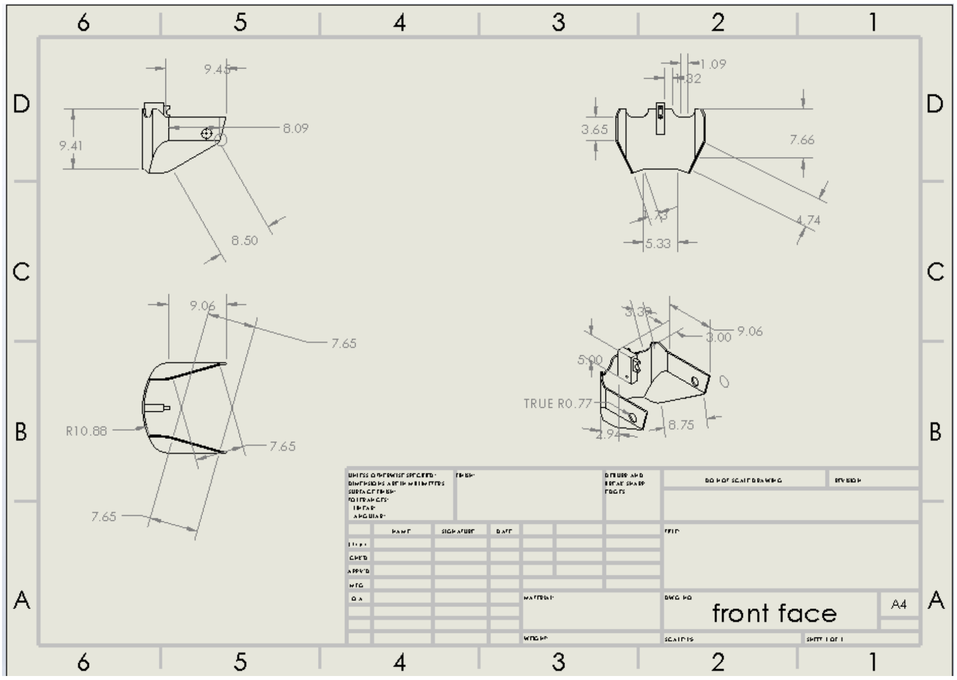
Table 5.1 :- Bill of material

*still some parts are left to be ordered

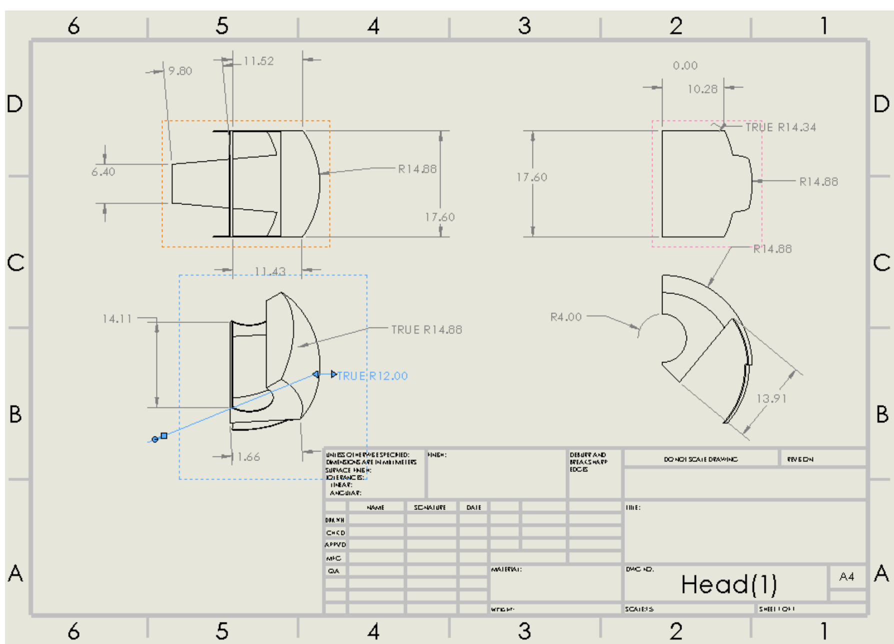
2) Mechanical Drawings :-



- **Front part of the face :**
  - Material: PLA
  - Manufacturing Process: 3D Printing
  - Drawing:

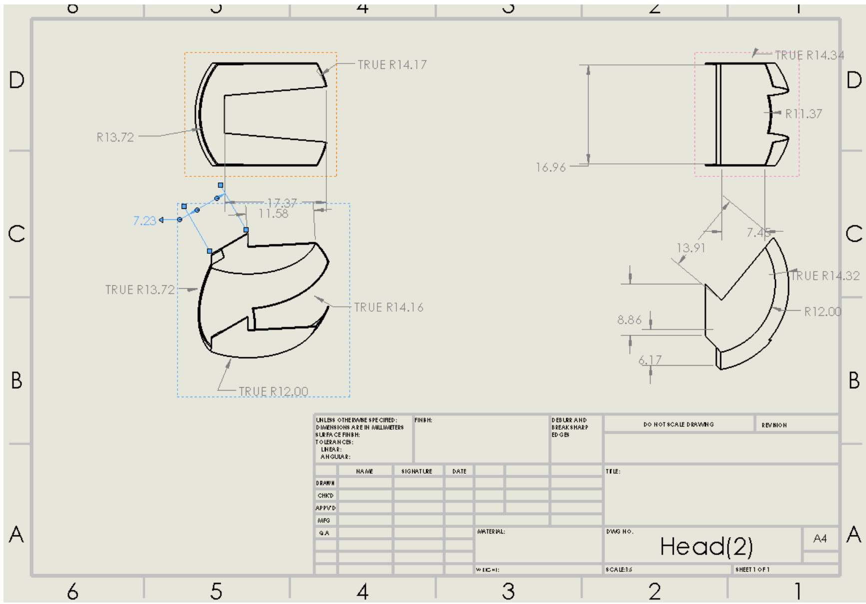


- **Back part of head :-**
  - Material: PLA
  - Manufacturing Process: 3D Printing
  - Drawing:

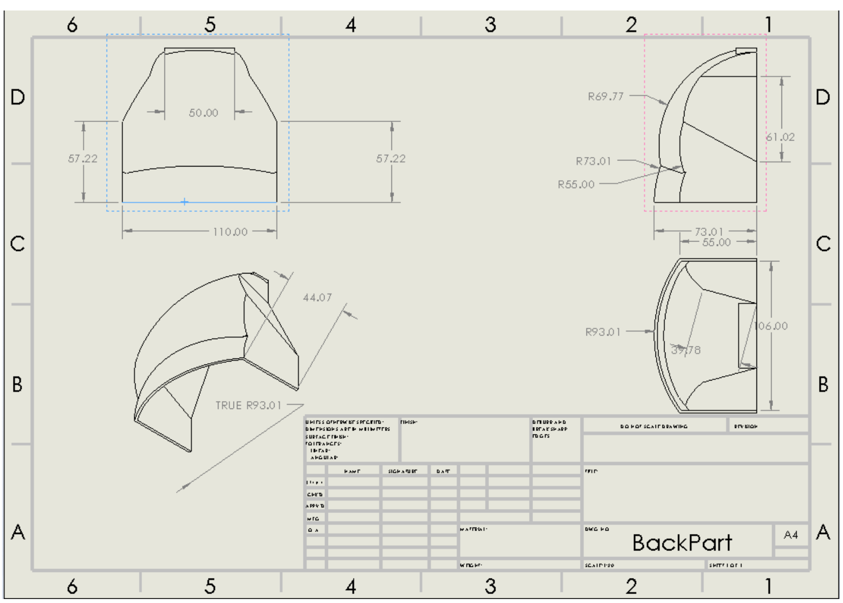


- **Front part of head :**
  - Material: PLA
  - Manufacturing Process: 3D Printing

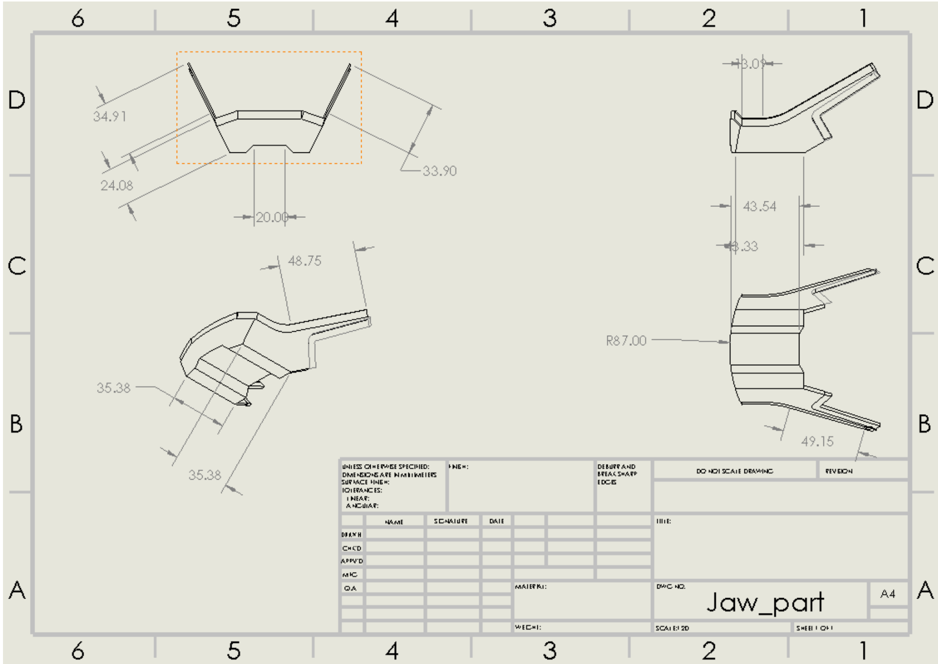
- Drawing:



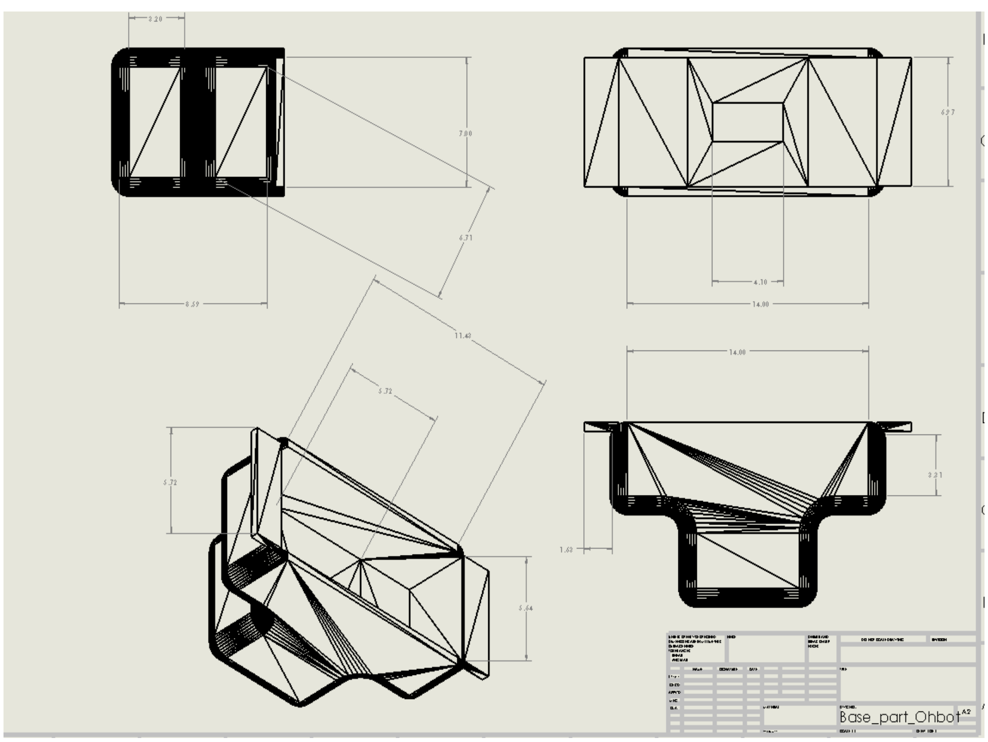
- **Back part of face :**
  - Material: PLA
  - Manufacturing Process: 3D Printing
  - Drawing:



- **Lower jaw of face :**
  - Material: PLA
  - Manufacturing Process: 3D Printing
  - Drawing:



- **Base Part:**
  - Manufacturing Process: 3D Printing
  - Material PLA
  - Drawing:



3) Material process description :-

- **Material used :-**

I. **PLA:** Polylactic acid is a biodegradable thermoplastic polymer derived from renewable resources. It is a popular 3D printing material used in many applications such as packaging, waste materials, medical contracts, and textile fibers. PLA has good mechanical properties and is oil resistant, but has a low melting point and is not suitable for hot applications. Its biodegradability makes it an environmentally friendly alternative to petroleum-based plastics, but must be disposed of to prevent contamination.
PLA is often used to make robotic parts, as it is a lightweight and strong material that can be easily molded into complex shapes using a 3D printer.

II. **Approach to reduce the Carbon Footprint :** Carbon footprint is the measure of the amount of greenhouse gasses, mainly carbon dioxide, that are emitted by an individual, organization, event, or product. It is calculated by taking into account all the activities that generate carbon dioxide emissions, including energy consumption, transportation, and industrial processes. Reducing your carbon footprint is important to mitigate climate change and its impacts on the environment and human health.
In our project aimed at reducing the carbon footprint, we successfully implemented a strategy by incorporating different levels of porosity during the printing of various parts of our humanoid robot. Specifically, we utilized different porosity levels, with a 40% porosity setting utilized for areas that were not subjected to significant stress. This allowed us to achieve two key objectives; firstly, it ensured that the parts remained lightweight, and secondly, it resulted in a 40% reduction in material usage. Additionally, for parts that were expected to be subjected to higher stress levels, we employed a 60% porosity setting, which enabled us to reduce the material usage which indeed reduces our carbon footprint without compromising on the structural strength of the components. Our findings demonstrate the feasibility and effectiveness of this approach in achieving sustainable and eco-friendly manufacturing practices.

- **Manufacturing process :-**

Step 1: 3D Modeling
The first step is to create a 3D model of the humanoid robot using specialized software such as CAD (computer-aided design) software eg. Solidworks and Fusion 360 etc. This

software allows designers to create a digital model of the robot, which can be modified and optimized as needed.

Step 2: Slicing and G-code Generation

Once the 3D model is complete, it needs to be sliced into layers using specialized software. This software creates a series of 2D cross-sectional images, which are then used to generate G-code, a machine-readable language that tells the 3D printer how to print the object.

Step 3: 3D Printing

With the G-code ready, the 3D printer can begin printing the humanoid robot using PLA filament. The printer heats the filament and deposits it layer by layer, following the G-code instructions to build up the robot's structure. Depending on the complexity and size of the robot, the printing process can take several hours to complete.

Step 4: Post-Processing

Once the printing is complete, the robot may require some post-processing to remove any excess material or support structures. This can be done manually or with the help of tools such as sandpaper, files, or chemical solvents.

4) Assembly and Integration :-

In the final stage, the 3D printed components are assembled and combined with other essential components including motors, sensors, and electronics to develop a fully functional humanoid robot. This process may necessitate further design and fabrication steps, such as the creation of bespoke brackets or wiring harnesses, to achieve optimal integration and performance. Additionally, careful attention must be paid to ensure that all components are properly aligned and secured to guarantee reliable operation of the robot.

Overall, the process of manufacturing a humanoid robot using PLA material through 3D printing involves designing and modeling the robot, slicing and generating G-code, printing the parts using PLA filament, post-processing the parts, and finally assembling and integrating the parts into a functional robot. This process allows for high precision, customization, and ease of manufacture, making it an ideal choice for creating complex robot designs.

5) Limitations and Challenges :-

Here we present the contribution of each member towards the project:

- **Limitation** :
  I. Limited Material Properties : Although 3D printing allows for the use of various materials, including metals, plastics, and ceramics, it has limitations in terms of material properties such as strength, durability, and temperature resistance. This may limit the range of applications for 3D printed parts in certain industries.
  II. Limited Size : The size of 3D printed parts is limited by the size of the 3D printer's build volume, which may not be sufficient for producing large parts. This may result in the need for assembling parts, which can add complexity to the manufacturing process.
  III. Surface Finish : The surface finish of 3D printed parts may not be as smooth as those produced by traditional manufacturing methods, which may affect the aesthetic and functional properties of the parts.
- **Challenge :**
  A. Temperature Sensitivity : PLA material is sensitive to temperature changes and can deform at high temperatures. This limits its use in applications that require parts to withstand high temperatures.
  B. Brittleness : PLA material is relatively brittle compared to other materials such as ABS and nylon, which can limit its use in parts that require high impact resistance.
  C. Biodegradability : Although PLA material is biodegradable and eco-friendly, its biodegradability can be a challenge in certain applications, such as in parts that require long-term durability.

In conclusion, while 3D printing and the use of PLA material have numerous benefits, there are also limitations and challenges that must be taken into consideration when manufacturing complex designs such as humanoid robots. It is important to carefully consider the material properties and the intended application of the parts before deciding to use 3D printing and PLA material in production.

6) Scheduling plan :-

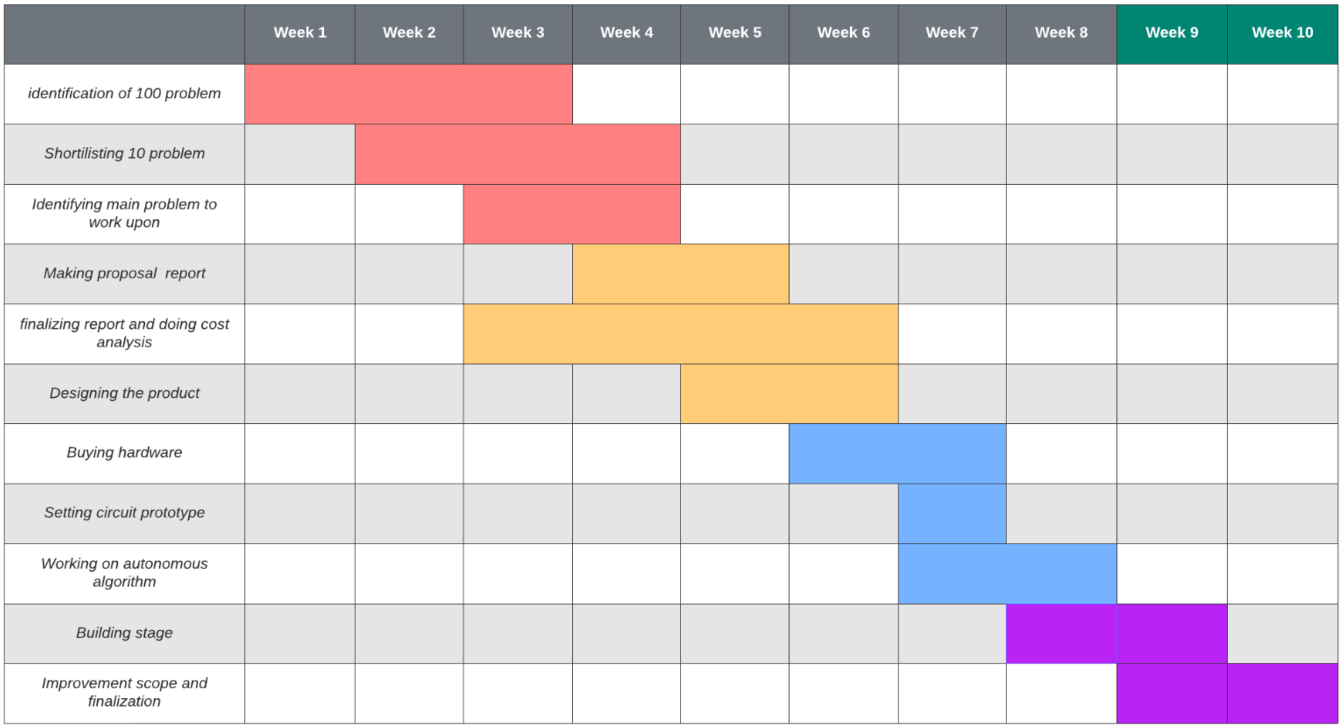


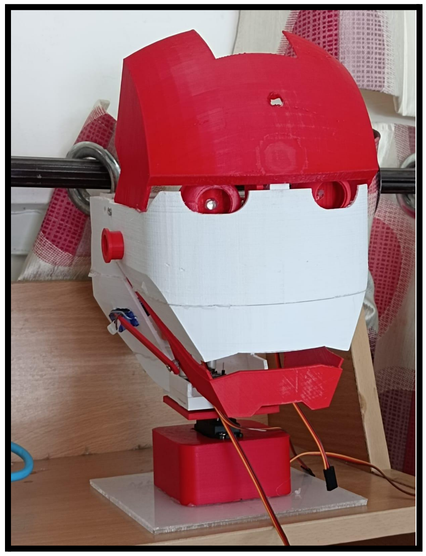
Table 5.2 :- Scheduling plan table

7) Contribution :-

Here we present the contribution of each member towards the project:

- Kanaram - Designing of parts and report, assembly, fabrication
- Sanidhya Singla - Designing of parts, report, fabrication
- Vivek - Circuit design of electrical parts and Designing of eye part.
- Jyoti baberwal - Report and Speech Recognition .
- Rajiv - Designing of parts, report, 3d printing, image processing.
- Gagan Gupta - 3D printing, integrating AI and building connections between hardware and processing parts, Multithreading and Synchronization of eye,lips,neck.

Prototype Image



Conclusion

The report outlines the development of a humanoid robot capable of providing comprehensive information on various aspects of an organization, such as the locations of offices, academic curricula, eligibility criteria for scholarships, and professor details. The proposed robot will be designed to provide formal greetings and expressions, serve as a one-stop-shop for obtaining pertinent information related to the organization, and provide an efficient solution to a longstanding problem that has hindered the productivity of large institutions. The report also discusses the limitations of existing products such as Ohbot and Picoh and proposes a complex design process utilizing advanced sensors and 3D printing technology.

The proposed humanoid robot is an innovative solution to the problem of locating specific offices and obtaining necessary information in a timely manner, which has hindered the productivity of large institutions such as universities. With its advanced features and sensors, the robot will be capable of providing comprehensive information and personalized interaction, making it an efficient and effective solution for navigating and accessing necessary resources. The proposed design process, utilizing 3D printing technology and advanced sensors, ensures that the robot is lightweight, durable, and capable of processing and responding to voice inputs. Overall, the development of this humanoid robot represents a significant step forward in the field of robotics, with potential applications in various sectors such as education, healthcare, and public relations.

Reference

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