ES101

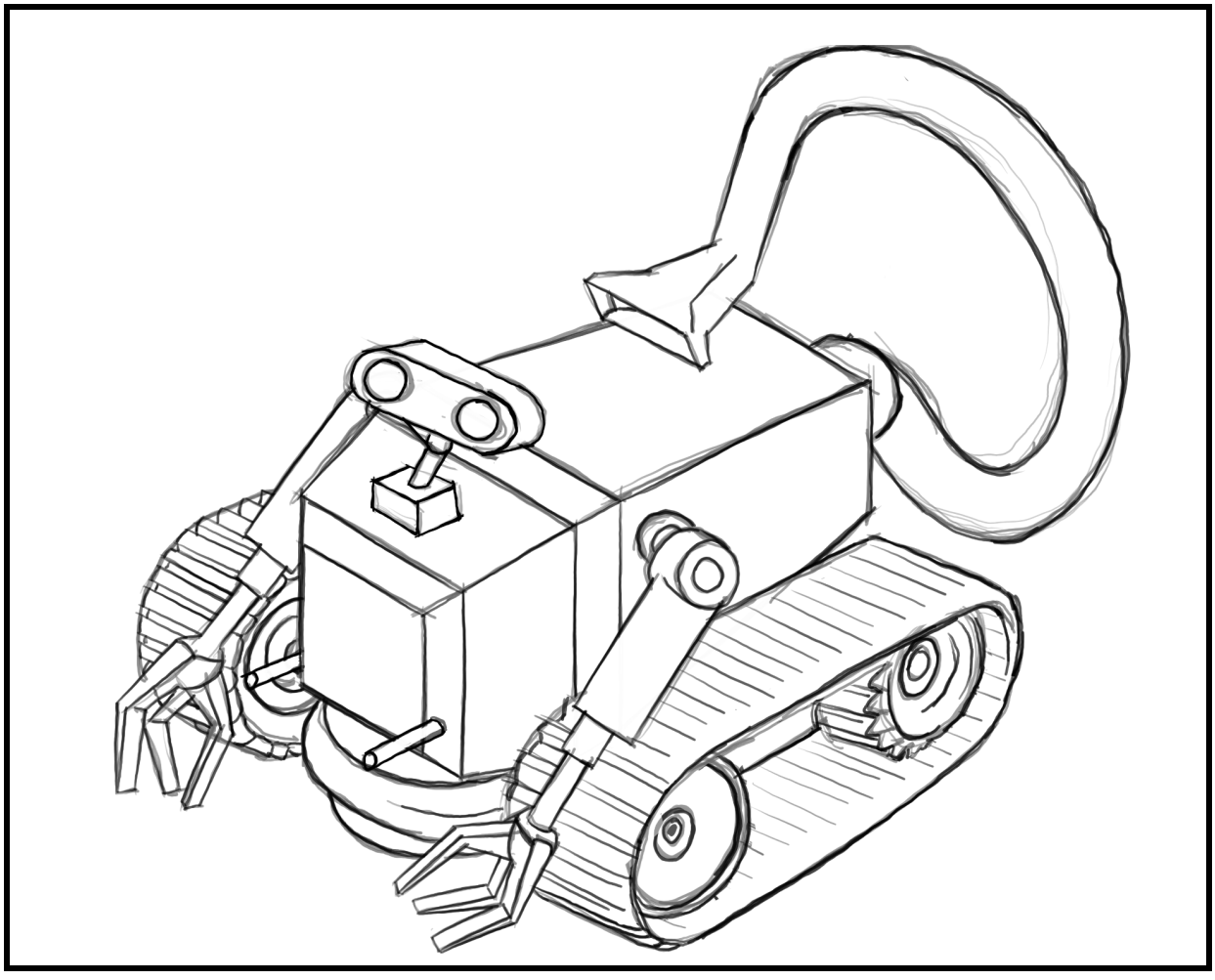
Engineering Graphics

SPARC-BOT

(Scorpion-Styled Precision Agile Robust Cleansing Bot)

Final Sketches

Group - 9



SPARC-BOT

SPARC-BOT

Term: Summer 2023

Group 9

Submission Date: 8th June 2023

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General Modifications

Several modifications have been made to enhance its aesthetics and functionality for the proposed SPARC-BOT. One of the primary modifications is related to the body dimensions. Taking inspiration from the designs of existing cleaning robots and vacuum cleaners, the SPARC-BOT's dimensions have been designed to be similar but have been scaled down, ensuring that different parts of the model are distinctive.

Initially, a separate sprinkler system was considered for cleaning purposes. However, after careful consideration, it was decided to integrate the sprinkler within the body's dust compartment. This modification allows for a more compact design and efficient utilization of space. Additionally, a significant change has been made to the constraints of the wheels, The wheels are aligned with the side face of the body and connected to motors, ensuring smooth movement and stability. The alignment of the wheels' axle just below the body is another essential modification. This alignment optimizes the bot's performance on various surfaces, incredibly dusty or grainy, by minimizing any potential disruptions during movement.

To achieve a visually appealing and harmonious design, the dimensions of other components have been adjusted in proportion to the body. By scaling down or scaling up these parts, the overall aesthetics of the SPARC-BOT are improved while maintaining a coherent design language. This modification ensures that the various components are in harmony and create a visually balanced appearance.

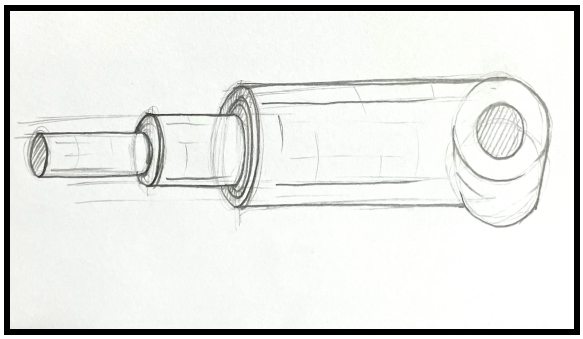
Furthermore, to enhance the authenticity and realism of the model, the Arduino board's original design and dimensions have been retained. The SPARC-BOT resembles a practical and functional cleaning robot by incorporating the actual shape of the Arduino board available in the market.

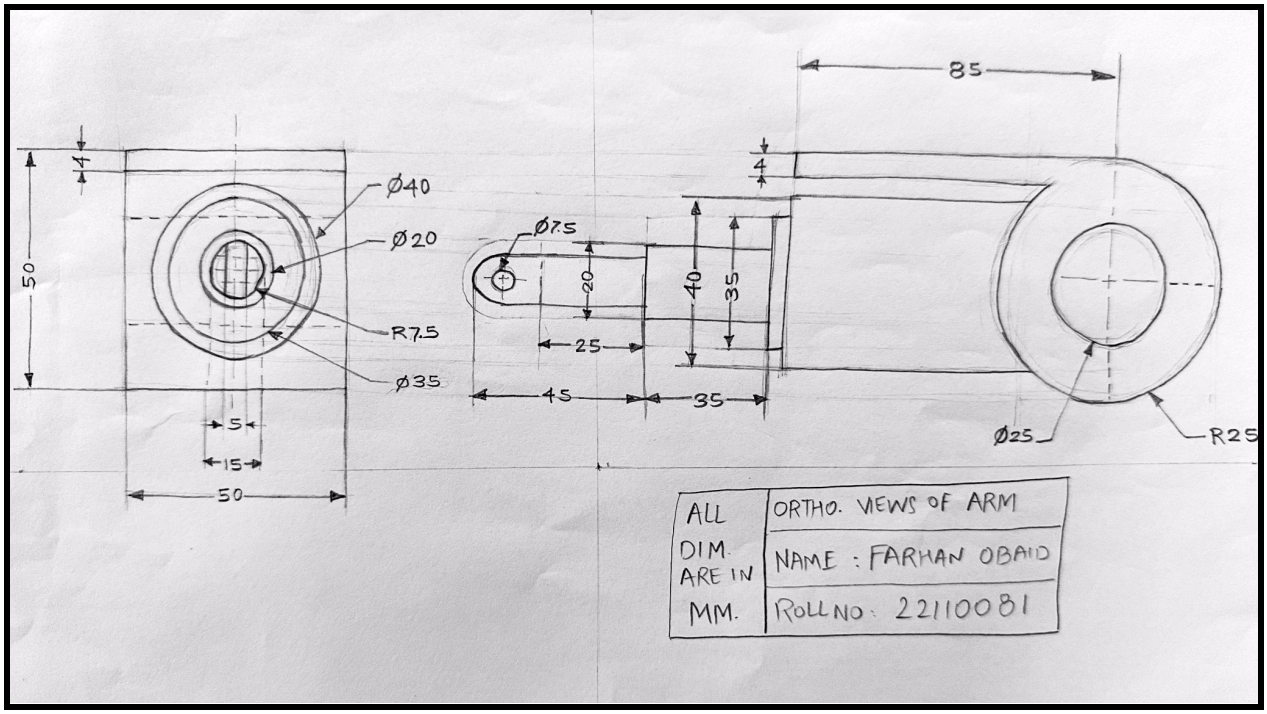
Throughout the design process, extrusions have been incorporated into the body to provide necessary constraints during assembly. These extrusions help align and secure different components, ensuring a robust and reliable construction.

Part Name - Claw and Hydraulic Arm

Farhan Obaid (22110081)

Hydraulic Arm





Reasons for the Selected Dimensions

The selected dimensions for the hydraulic arm of the SPARC bot were carefully chosen to optimize its functionality and efficiency. Each cylinder within the arm serves a specific purpose,

and its dimensions were determined based on the space requirements and desired range of motion. The largest cylinder in the hydraulic arm has a diameter of 40 mm. This cylinder is responsible for storing the mechanism for hydraulic operation, which allows for controlled extension and retraction of the other cylinders. By allocating a larger diameter to this cylinder, it ensures sufficient space to accommodate the necessary hydraulic components and their associated mechanisms.

The other cylinders in the hydraulic arm are primarily used for extension. To minimize the space they occupy and maximize the available room for the hydraulic mechanism, these cylinders have been given minimal diameters of 20 mm and 15 mm. This decision allows for efficient use of space within the arm structure while maintaining the necessary functionality.

The length of the largest cylinder is 85 mm. This dimension is specifically chosen to ensure effective movement of the entire hydraulic arm. By retracting the other cylinders entirely within this 85 mm length, the arm can achieve a compact position, enabling efficient storage and maneuverability. The length of other inner cylinders is 35 mm and 45 mm, explicitly chosen to ensure the inner cylinder's easy storage, movements, and functionality inside the largest cylinder.

The widths of the outer and inner cylinders are 40 mm, 35mm, and 20mm are all taken relative to the lengths of the largest and inner cylinders to ensure consistency in size and shape of the hydraulic arm, which ensures a stable and right size structure for the arm.

Furthermore, the largest cylinder has a 7.5 mm diameter hole that serves as the axis for the movement of the claw. This hole allows the claw to pivot and provides the necessary range of motion for gripping and releasing objects. It enables precise control and manipulation of the claw during the cleaning process.

Additionally, the largest cylinder features a 25 mm diameter hole for further connection to the upper arm, which then connects to the body of the SPARC bot. This connection ensures the hydraulic arm is securely attached to the rest of the bot's structure, providing stability and structural integrity during operation.

A quarter cut-out is incorporated in the larger cylinder to facilitate effective locking of the hydraulic arm. This cut-out allows for secure engagement and disengagement, preventing unintended movements and ensuring stability.

Materials to be Employed

When considering materials for constructing the hydraulic arm of the SPARC bot, several factors should be considered, including strength, durability, weight, and cost. Here are some materials that can be used to make the hydraulic arm:

1. **Aluminium Alloy**: Aluminium alloys are lightweight, strong, and corrosion-resistant, making them an excellent choice for the hydraulic arm and claw. They offer a favorable strength-to-weight ratio, facilitating efficient movement and reducing energy consumption. Aluminum alloys are also readily available and cost-effective.
2. **Stainless Steel**: Stainless steel is known for its high strength, durability, and corrosion resistance, making it suitable for the hydraulic arm and claw. It provides excellent

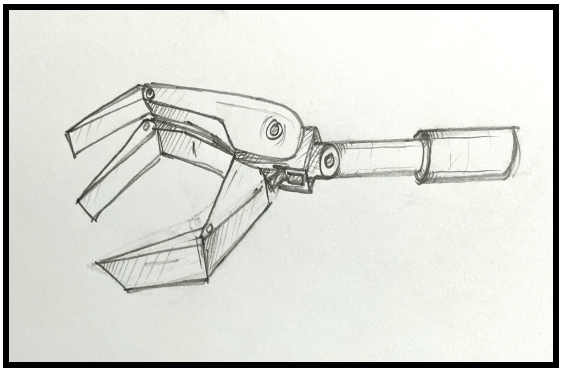
structural integrity and can withstand the forces exerted during gripping and lifting tasks. Stainless steel is commonly used in applications where hygiene and cleanliness are essential.

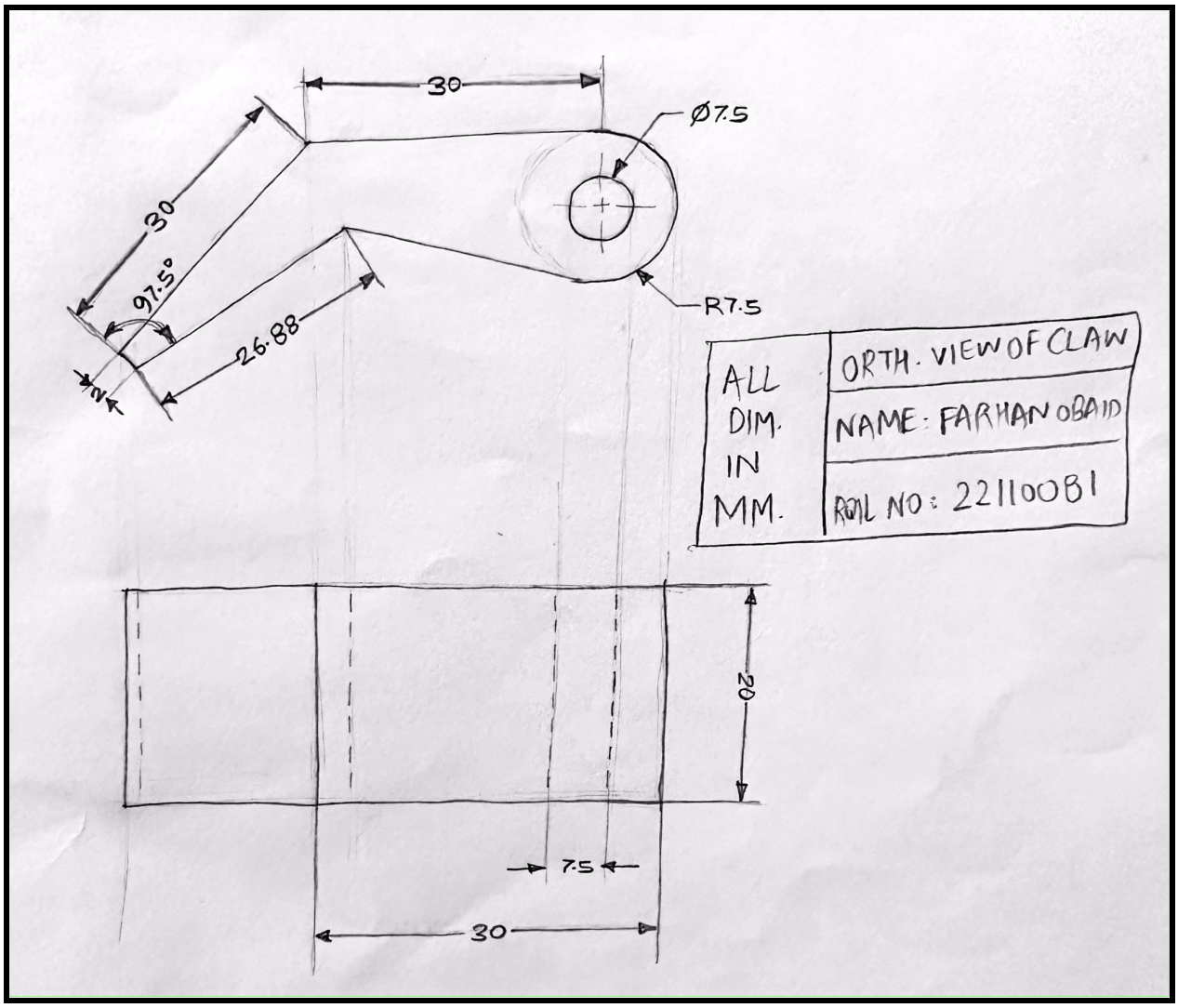
3. **High-Density Polyethylene (HDPE)**: HDPE is a thermoplastic material known for its lightweight nature, durability, and chemical resistance. It is commonly used in constructing hydraulic cylinders and components due to its low friction properties and ability to withstand pressure and wear. HDPE is cost-effective and easy to work with.

Considering the various factors involved in constructing the SPARC bot's hydraulic arm, a recommended fabrication material would be Aluminum Alloy.
Aluminum alloys possess a combination of desirable properties that make them well-suited for hydraulic arm applications. Here are the reasons for choosing aluminum alloy as the final material:

1. **Lightweight**: The reduced weight allows for more effortless movement and maneuverability of the SPARC bot, conserving energy and improving overall efficiency.
2. **Strength and Stiffness**: Aluminium alloys offer good strength and stiffness characteristics, providing structural integrity and rigidity to the hydraulic arm.
3. **Corrosion Resistance**: Aluminium alloys exhibit excellent corrosion resistance, This property ensures the longevity and durability of the hydraulic arm, even in demanding environments.
4. **Availability and Cost-effectiveness**: Aluminium is widely available and has a relatively low cost compared to other materials with similar properties. This makes it an attractive choice from a practical and economical standpoint.
5. **Machinability**: Aluminium alloys can be easily shaped, cut, and formed into the desired dimensions and complex geometries required for the hydraulic arm.

Claw





Reasons for the Selected Dimensions

The claw's design for the hydraulic arm has been meticulously crafted to achieve optimal functionality and versatility in object manipulation. The dimensions of the claw play a crucial role in ensuring its ability to effectively pick up items of varying sizes and shapes while prioritizing safety and precision.

The claw fingers are set at 60 mm long, providing a balanced approach to gripping capabilities. This length allows for a sufficient grasp on objects, ensuring a secure hold without compromising the claw's maneuverability. Incorporating a 30-degree dip in the claw gives it additional flexibility to adjust and adapt to different objects during the picking process. This feature enhances the claw's ability to handle items of various heights and contours.

Furthermore, the dipped upper finger of the claw is designed to be extended by 30 mm on the outside and 26.88 mm on the inside, enabling it to grip and hold objects of all shapes and sizes. This extension capability dramatically enhances the claw's overall functionality, expanding its range and ensuring its effectiveness in diverse cleaning scenarios.

To facilitate seamless movement and articulation, the claw features a central hole with a diameter of 75 mm. This hole serves as the axis for the claw, allowing it to slide freely and rotate within the designated range. This design choice enables the claw to adapt to different angles and orientations, enhancing its dexterity and agility during object manipulation.

An additional circular gap of 15 mm is provided outside the hole, ensuring structural integrity and stability for the claw. This space acts as a reinforcement, maintaining the overall strength and rigidity of the claw while accommodating the necessary dimensions for the central hole. By incorporating this boundary, the claw achieves a robust construction capable of withstanding the forces exerted during the cleaning process.

In terms of width, the claw possesses a dimension of 20 mm. Combined with the other three pairs of claws, this width results in a total width of 60 mm. This ample width gives the claw a substantial gripping area, enabling it to handle objects of various sizes and configurations. The comprehensive profile of the claw ensures a secure hold and minimizes the risk of things slipping or being inadequately gripped during cleaning operations.

To prioritize safety and prevent unintended damage, the tip of the claw is designed with a 2 mm blunt edge. This choice eliminates the risk of sharp or pointed ends that could harm or cut objects or surfaces while cleaning. The blunt edge maintains a gentle yet firm interaction with the items picked up, ensuring a careful and non-intrusive approach.

Materials to be Employed

When considering materials for constructing the claw of the SPARC bot, several factors should be considered, including strength, durability, weight, and cost. Considering the specific requirements and intended use of the claw part of the SPARC bot's arm, the suitable material options to consider are:

1. **Polycarbonate (PC):** Polycarbonate is a strong, transparent thermoplastic known for its impact resistance and durability. It offers high tensile strength and can withstand repeated use and gripping forces. Polycarbonate is also available in various colors, allowing for customization options.
2. **Polypropylene (PP):** Polypropylene is another thermoplastic material suitable for the claw part of the SPARC bot's arm. PP is a lightweight material with good chemical resistance, flexibility, and elasticity.
3. **Acrylonitrile Butadiene Styrene (ABS):** ABS is a versatile thermoplastic widely used in various applications, including robotics. It offers several desirable properties for the claw part.

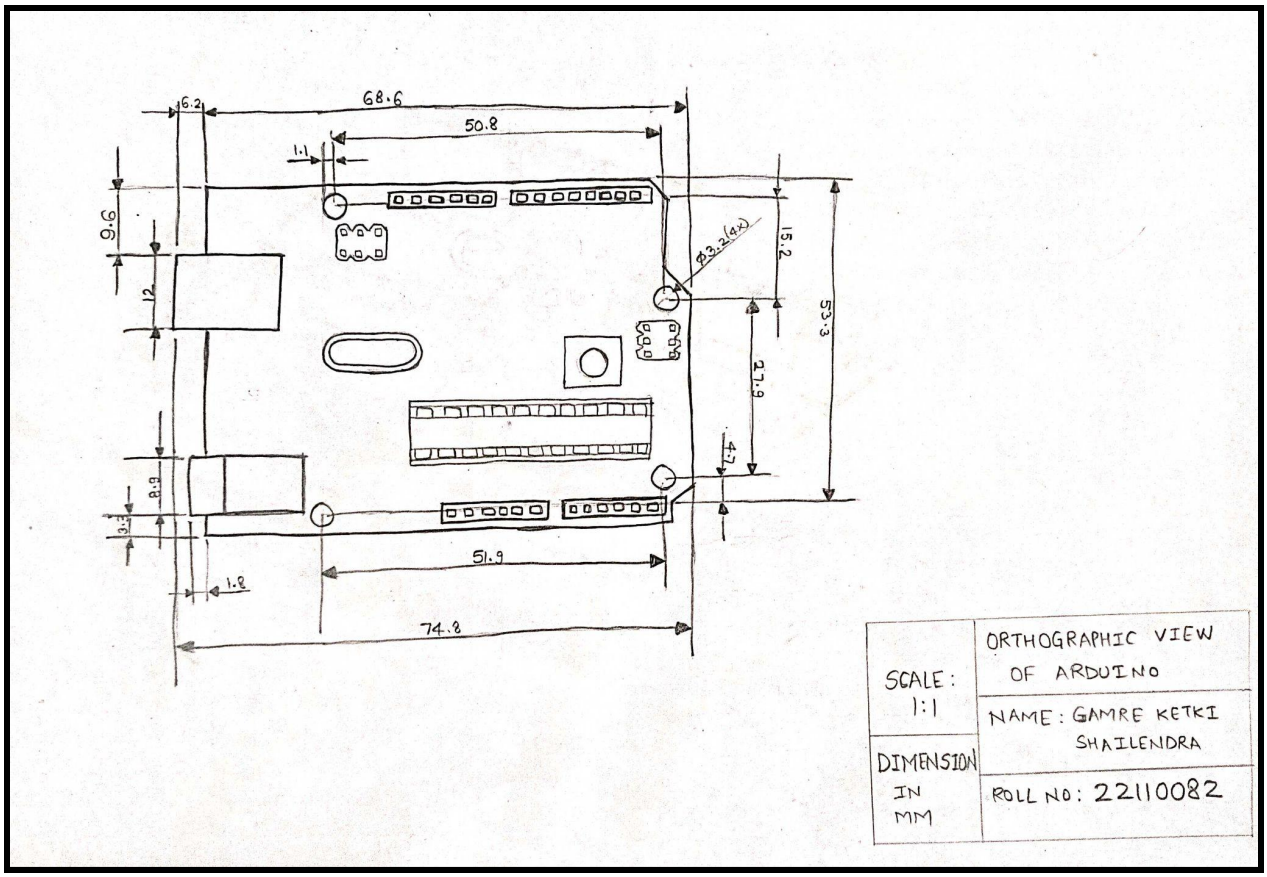
Considering the various factors in constructing the SPARC bot's hydraulic arm, a recommended fabrication material for the claw part would be **ABS.** The properties that make ABS suitable for making the claw part of the hydraulic arm are as follows:

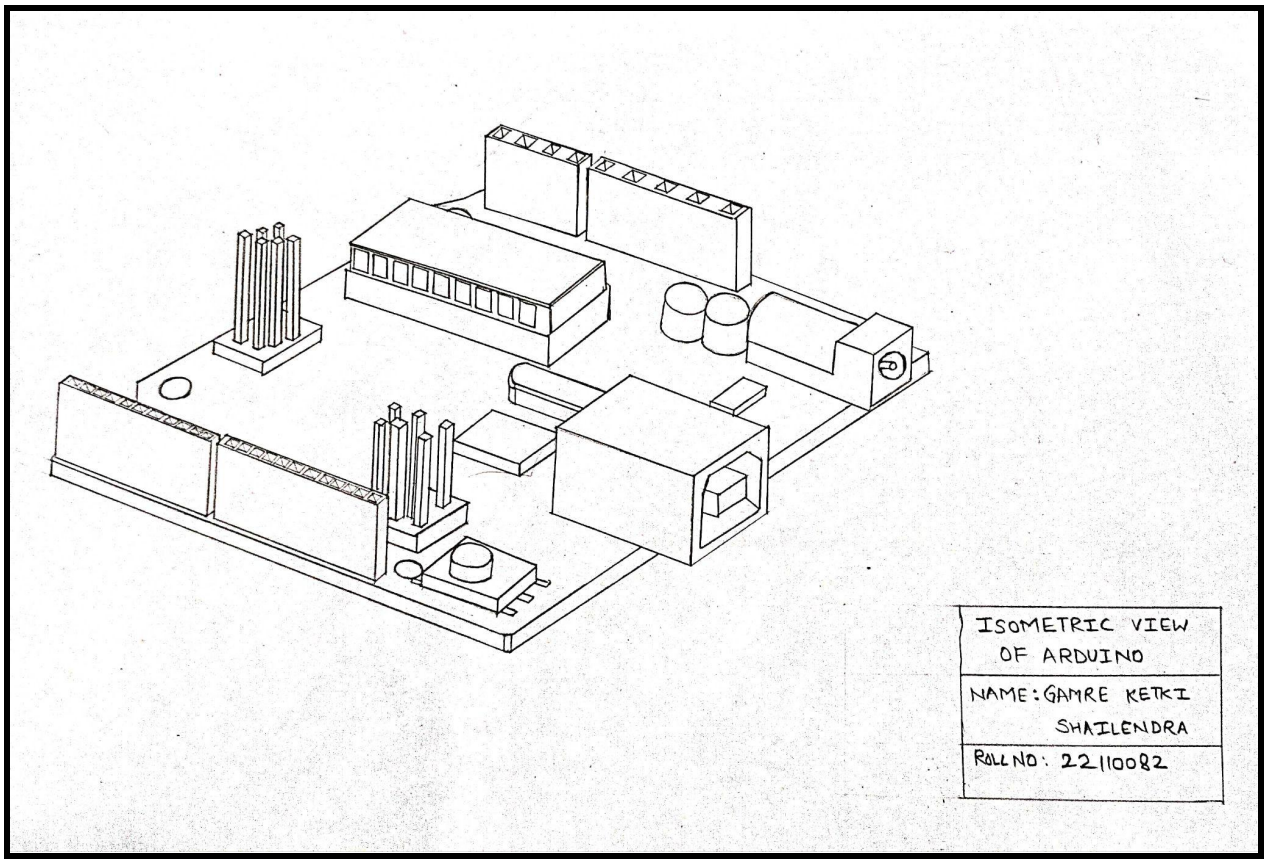
1. **Strength and Durability**: ABS provides good strength and durability, effectively allowing the claw to handle gripping forces and repetitive movements.
2. **Impact Resistance:** ABS has excellent impact resistance, which is beneficial for the claw when manipulating objects or encountering obstacles during cleaning tasks.
3. **Low Friction:** ABS has relatively low friction properties, aiding in specific object gripping and minimizing slippage.
4. **Ease of Machining:** ABS is relatively easy to machine, making it a convenient choice for manufacturing claws with complex shapes and design requirements.
5. **Cost-effectiveness:** ABS is a cost-effective material option, which can be advantageous for projects with budget constraints.

Part Name - Arduino Uno Board

Gamre Ketki Shailendra (22110082)

Arduino Uno Board





Reasons for the Selected Dimensions

1. **Board Dimensions:** The length of the Arduino Uno board is 74mm, and its breadth is 53.3mm with an extrusion of 1.6mm. These dimensions are scaled down from the standardized dimensions to be normalized to the bot's body. The board has to be fitted inside the bot's body to ensure that all the commands of the function to be performed by the bot are initially provided to the bot. Therefore, selecting these dimensions is based on compactness and ensuring the compatibility of various shields and accessories.
2. **USB Connector:** The USB connector is of length 12mm, breadth 21mm, and height 10.9mm. These dimensions provide a standard size compatible with commonly available USB cables. This ensures convenient connectivity and allows users to interface the Arduino Uno with other devices and systems efficiently.
3. **Pins:** The analog input pins are of length 50.8mm, breadth 1.8mm, and height 10.9mm. These dimensions are selected as they are the standard dimensions for the input pins of any circuit. The wires which would be connected to the Arduino have these constraints. Therefore, the analog and digital pins are dimensioned in a universally normalized way.

4. **Power Port:** The power port's dimension is such that its length is 24.18mm, its breadth is 8.9 mm, and its height is 10.9 mm. It is chosen to accommodate commonly used power connectors and provide a secure and reliable connection. This size ensures compatibility with various power sources and allows for easy integration into different projects.

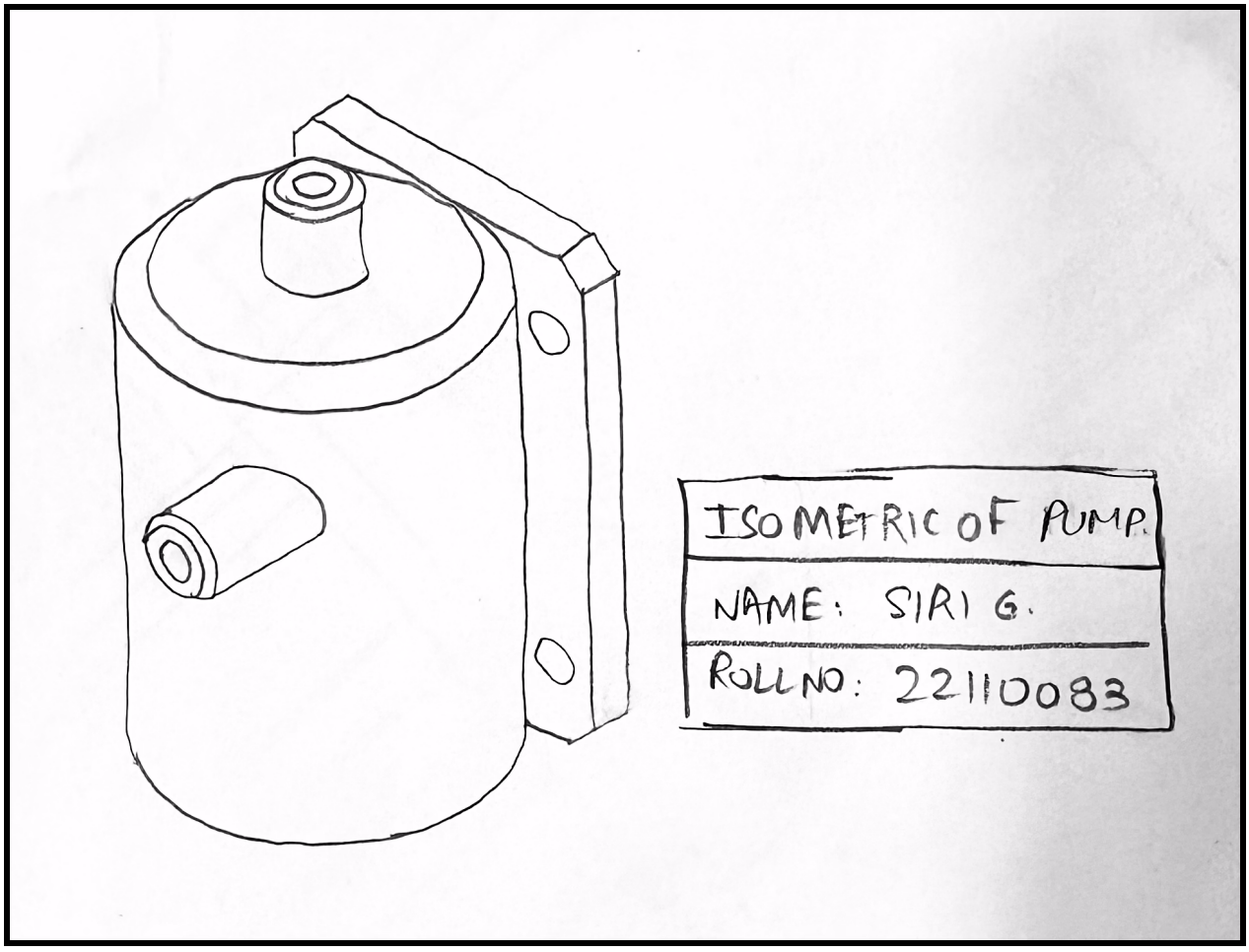
Materials to be Employed

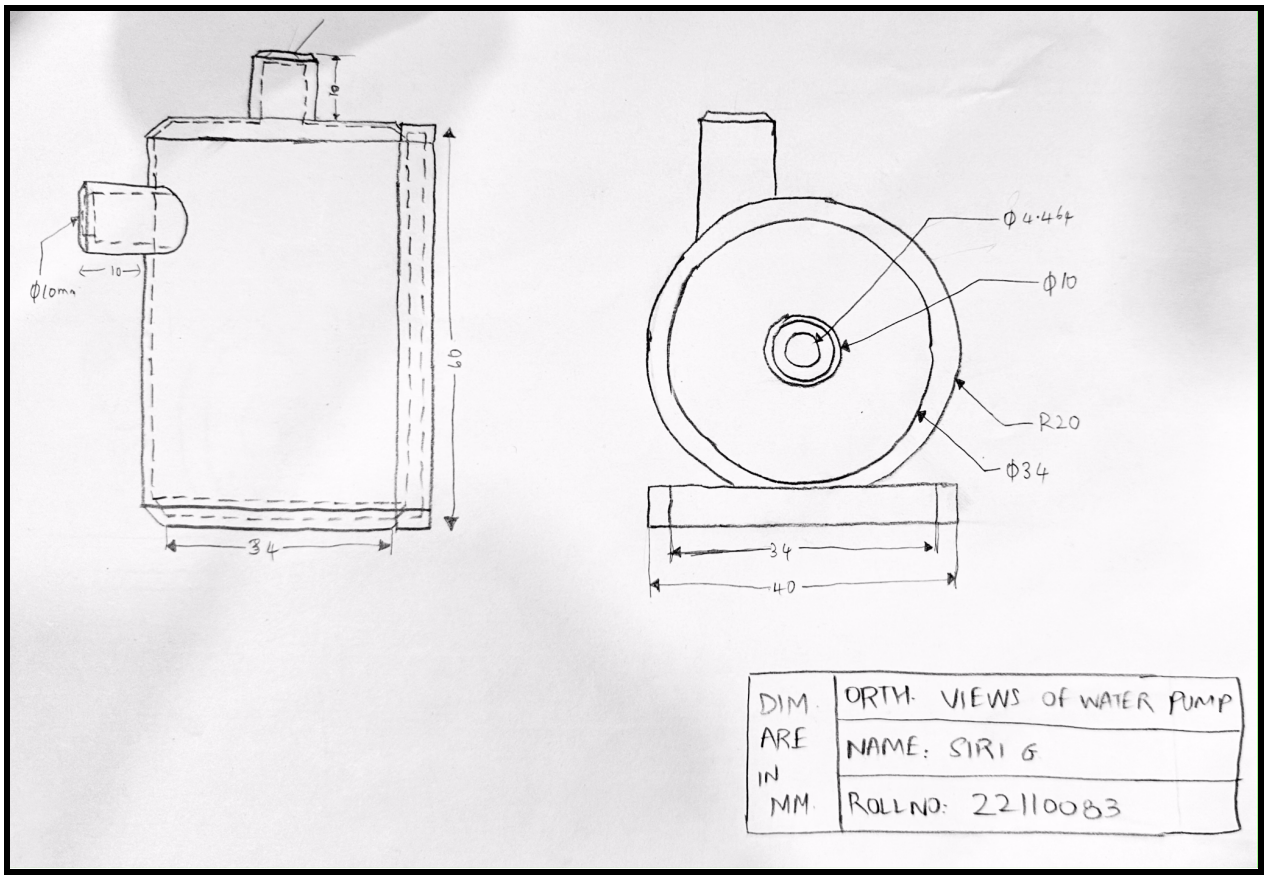
1. **FR-4 (Flame Retardant 4) Epoxy Fiberglass Laminate:** The main body of the Arduino Uno is a PCB made of FR-4 (Flame Retardant 4) epoxy fiberglass laminate. This material provides excellent electrical insulation and mechanical strength required for the board's operation.
2. **Silicon Wafers:** The microcontroller chip used in the Arduino Uno is typically an Atmel ATmega328P or a compatible variant. The chip uses silicon wafers, which undergo a complex semiconductor manufacturing process. The silicon is doped with impurities to create transistors, diodes, and other components within the chip.
3. **Brass or Stainless Steel:** The connectors and pins on the Arduino Uno are made of metal, typically brass or stainless steel. These materials provide good conductivity and durability, ensuring reliable connections and longevity of the board.
4. **Ceramic:** Capacitors and resistors on the Arduino Uno board are commonly made using ceramic materials. Ceramic capacitors utilize ceramic dielectric materials, while resistors have a ceramic core with a thin film of resistive material. These materials offer stability, precision, and good electrical properties.
5. **Gallium Arsenide (GaAs) or Gallium Phosphide (GaP):** The LEDs on the Arduino Uno are made using semiconductor materials, typically gallium arsenide (GaAs) or gallium phosphide (GaP). These materials emit light when current passes through them, allowing the LEDs to display status indicators.
6. **Semiconductor:** The voltage regulator on the Arduino Uno is typically a three-terminal linear regulator. It consists of semiconductor components, such as transistors, diodes, and resistors, along with a heatsink to dissipate excess heat.
7. **Plastic or Metal:** The USB port and power supply connectors are made of plastic or metal, providing durability and good electrical contact. The metal connectors may have gold plating to enhance conductivity and prevent corrosion.

Part Name - Water Pump and Vacuum Pump

Gangannagudem Siri (22110083)

Water Pump





Reasons for the Selected Dimensions

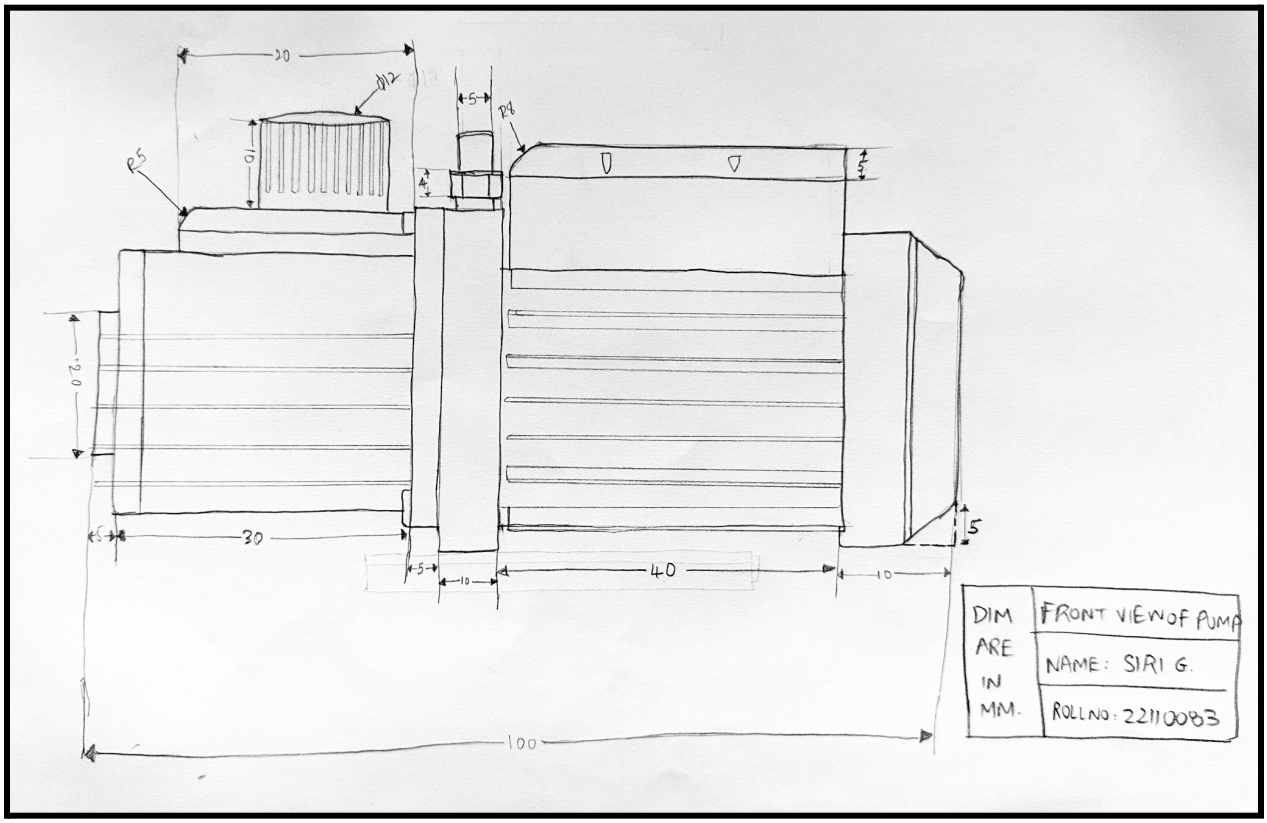
1. **Base dimensions:** It is a rectangular base with a 40 mm length and 40mm breadth. It is designed such that the cylindrical housing of the water pump can be placed on it. The base also contains four holes of 5mm diameter 2 on each side to fit the pump into the body of the sparc-bot. The edges are chamfered by 3mm to remove the sharp edges.
2. **Cylindrical part**: The diameter of the cylinder is 40 mm, and it is of length 60mm. The dimensions of the overall motor pump are made such that it fits into the body and holds enough water to pressurize and supply to the sprinkler and the cleaning mop. The cylinder is a hollow thickness of 1.25mm which is adequate to hold the water. The cylinder's diameter is chamfered by 3mm for smoother transitions. The cylinder inside contains an impeller, shaft, and motor are not shown as they are not required, but the cylinder dimensions are enough to hold them.
3. **Inlet and Outlet ports:** The inlet and outlet ports allow water into the pump and supply out water, respectively. They are made of equal dimensions. The outer diameter of the ports is 10mm, and the inner diameter is 4.464mm. The ports are chamfered by 1mm for smoother transitions.

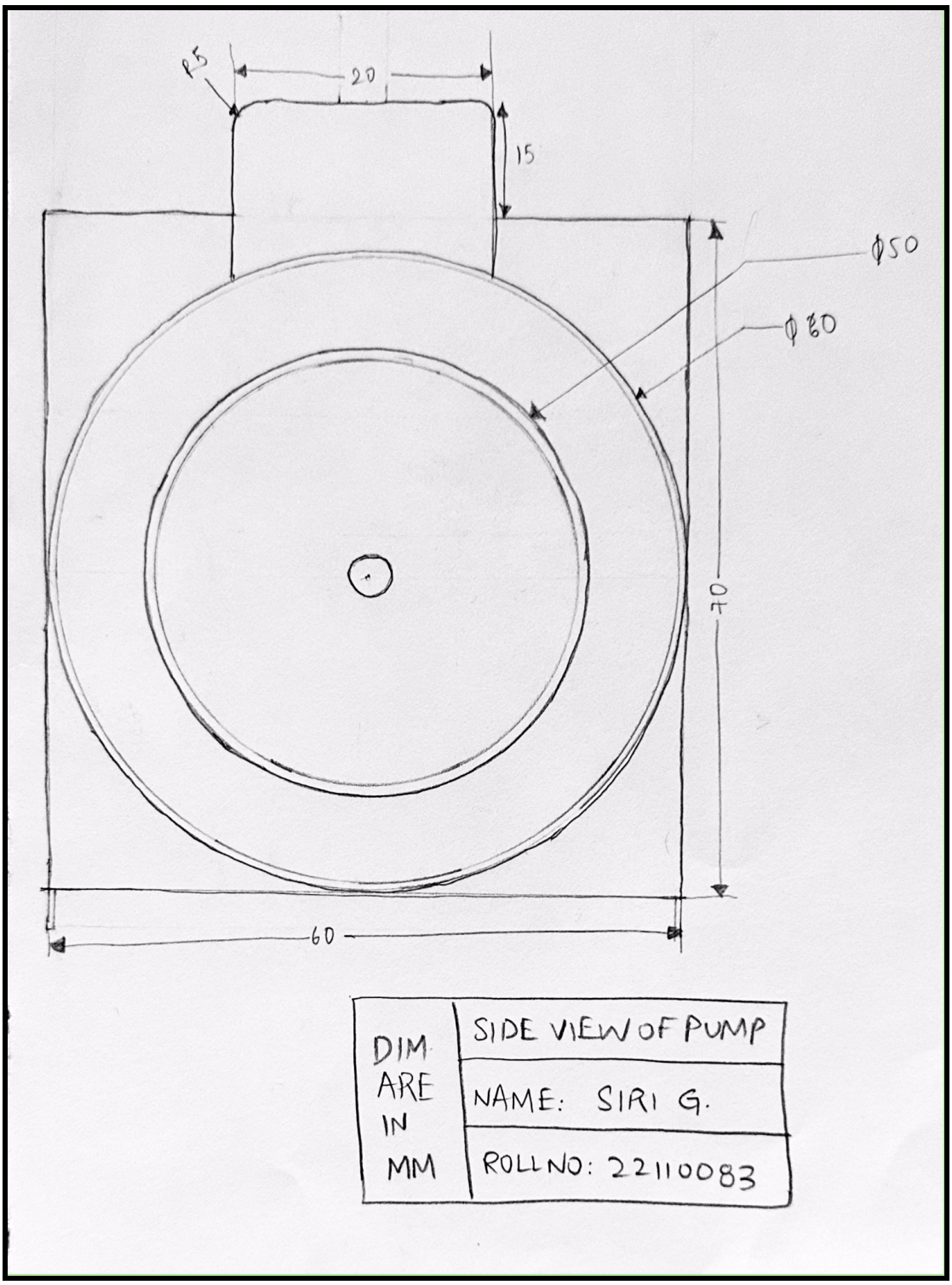
Materials to be Employed

The materials used for the water pump used in the cleaning process are typically selected to meet the basic requirements while keeping the cost and weight of the pump. Here we use the water pump to supply water to the sprinkler and cleaning mop.

1. **PVC(Polyvinyl Chloride):** PVC is a thermoplastic material that may be utilized for pump housing or casing. It provides water resistance and can withstand exposure to mild cleaning agents.
2. **Thermoplastics**: Certain thermoplastic materials, such as polypropylene (PP) or polyethylene (PE), are commonly used for the impeller and shaft in water pumps as they are corrosion resistive, lightweight construction, and cost-effective.
3. **Aluminum**: Aluminium is lightweight and commonly used for motor housings in water pumps. It offers good corrosion resistance and efficient heat dissipation. Aluminum motors are often cost-effective and suitable for smaller, portable cleaning mop pumps.

Vacuum Pump

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NAME: SIRI G.
ROLL NO: 22110083

Reasons for the Selected Dimensions

The dimensions of the Vacuum pump are such that it fits perfectly into the body of the SPARC-BOT.

- **Body dimensions:** The body of the vacuum pump is of length 100mm, width 60mm, and height 70mm. It is dimensioned so that it can be used to create a vacuum in it and used for vacuum tubes and hydraulic arms. It is divided into two sections: the motor and impeller used to create a vacuum and the other that contains the vacuum.
- **Outlet port:** It is connected to the hydraulic arms and vacuum tube to suction dust from the tube. It is also used to help the arms to hold and transfer objects. It is a circular port diameter of 20mm. It is fixed upon the body. And the inner parts are dimensioned according to the requirements.
- **Fillets and Chamfering:** It is required for the assembly of several parts and also for fluid flow. It also makes the model aesthetic and distributes stress evenly along edges without allowing any cracks.

Materials to be Employed

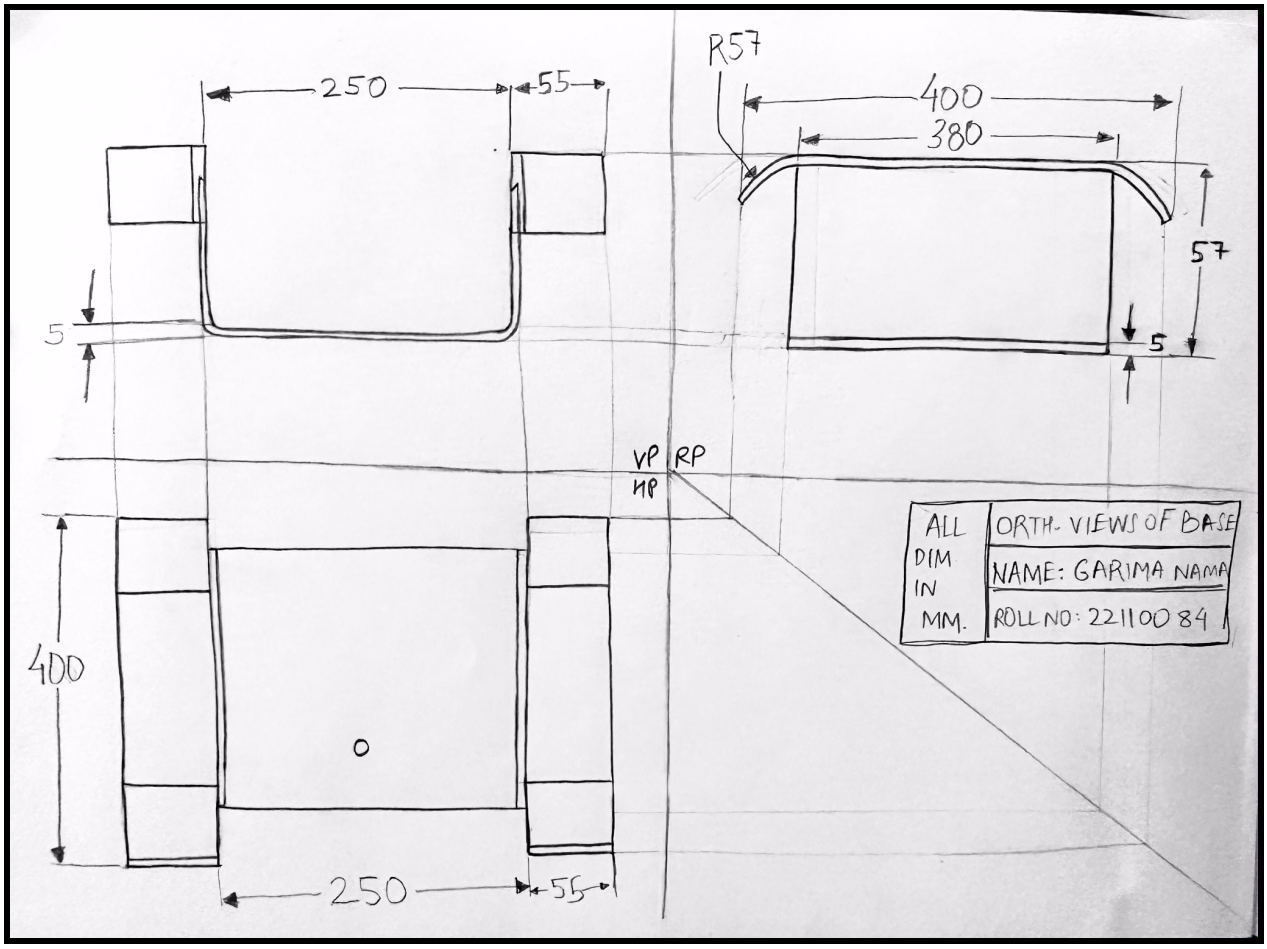
Several factors to consider for a vacuum pump used in a SPARC BOT for picking materials, such as chemical compatibility, mechanical strength, vacuum sealing capability, and wear resistance. The following materials can be used.

- **Stainless Steel**: Stainless steel is durable, corrosion-resistant, and offers excellent mechanical strength. It is commonly used in vacuum pump housings, impellers, and other components that require high-strength and chemical compatibility.
- **Ceramics:** Ceramic materials, such as alumina or silicon carbide, can be utilized for vacuum pump components requiring high-temperature stability and wear or corrosion resistance.
- **Aluminum**: Aluminium is lightweight and offers good mechanical strength, making it suitable for inlet ports in applications where weight reduction is desired.

Part Name - Body Base

Garima Nama (22110084)

Body Base



Reasons for the Selected Dimensions

- **Length and Breadth:** The body base's measurements of 250 mm in length and 380 mm in breadth were chosen to give enough surface area for stability and weight distribution. These measurements enable a broad foundation that can sustain the weight of the water tank and the sprinkler system, preventing tipping or instability during operation.
- **Thickness:** The body base's thickness of 5 mm strikes a compromise between structural integrity and weight optimization. It is strong enough to resist the rigors of outdoor use, including impacts and vibrations while being lightweight enough for simple maneuverability.
- **Height:** The chosen height of 57 mm enables the inclusion of critical components and systems, such as the height adjustment mechanism, and allows the wheel diameter to compensate within that. The 57 mm height starts from the rim of the axle and extends even 2 mm beyond the wheel's rim (radius 60 mm). The base dimensions are fully constrained to allow for the apt assembly of the SPARC-BOT.

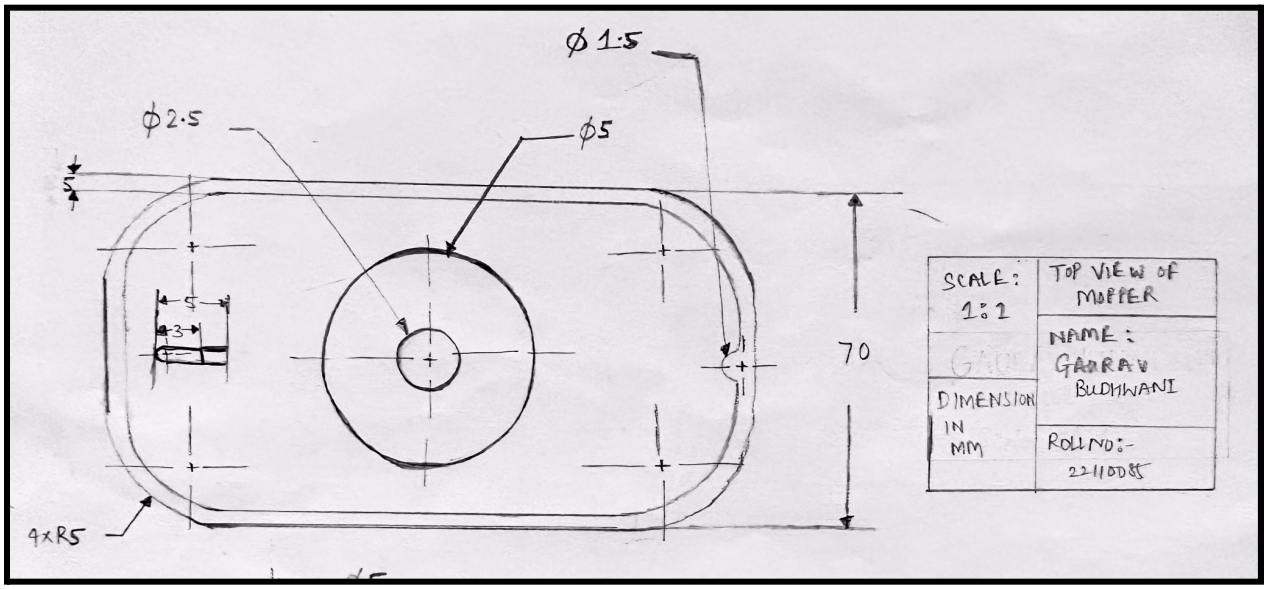
Materials to be Employed

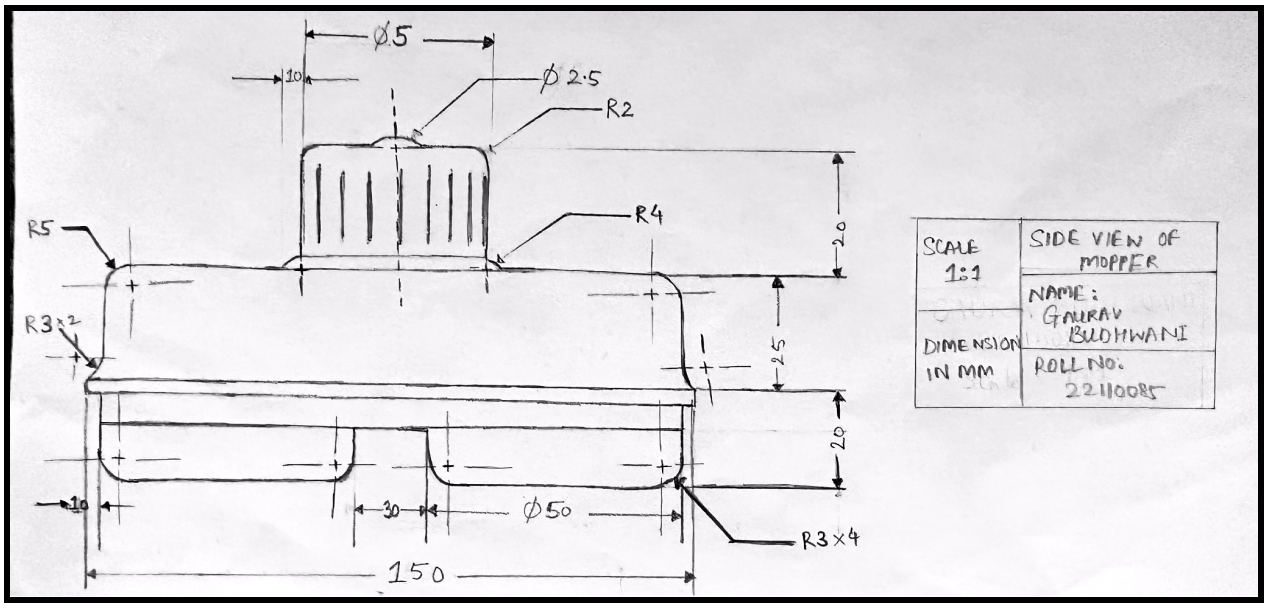
- **High-Strength Plastic Composite:** A high-strength plastic composite provides lightweight characteristics, corrosion resistance, and cost-effectiveness benefits. It has enough structural integrity to support the system's weight while keeping the total weight reasonable for simple maneuverability. The plastic composite may also be molded into complicated forms, including unique design aspects.
- **Aluminum Alloy:** Aluminum alloys are well-known for their high strength-to-weight ratio, making them ideal for weight reduction and durability applications. Using aluminum alloy for the body foundation offers a lightweight yet durable design that allows for simple maneuverability and resistance to knocks and vibrations. Furthermore, aluminum alloys are very corrosion-resistant, ensuring durability and appropriateness for outdoor use.
- **High-Density Polyethylene (HDPE):** HDPE is a long-lasting and lightweight thermoplastic with strong chemical resistance and impact strength. It is resistant to UV rays and moisture, making it appropriate for outdoor use. HDPE is readily molded or produced, giving design and customization versatility. It is also a low-cost material alternative.
- **ABS (Acrylonitrile Butadiene Styrene):** ABS is a famous thermoplastic well-known for its toughness, impact resistance, and simplicity of production. It is dimensionally stable and chemically resistant. ABS is lightweight and can be molded into intricate shapes, making it ideal for the body's foundation. However, it may not be as strong as some other materials suggested.

Part Name - Cleaning Mop Assembly

Gaurav Budhwani (22110085)

Cleaning Mop Assembly





Reasons for the Selected Dimensions

- **Length and Body Distribution:** The mopper's overall length of 25 cm is compact and manageable, enabling it to navigate efficiently through tight spaces. The length distribution along the height of the mopper ensures a balanced design. The 2 cm top compartment accommodates the necessary components for the mopper to work efficiently, while the 2.5 cm body section allows additional structural support.
- **Mopping Circles:** The 2 cm section containing the two mopping cloths of fiber radius 25 cm, separated by a distance of 30 cm, is strategically designed for optimal cleaning performance. The radius has been set high to cover a wider area, reducing the required cleaning time. The separation distance between the circles ensures adequate coverage without interference, preventing any overlapping or missed spots. The selected dimensions aim to maximize the mopper's functionality. The compact size and length allow the mopper to access confined spaces and effectively clean various surfaces.
- **Fillets:** Fillets are curves added to the corners or edges of a part, providing smoother transitions and reducing stress concentrations. Including fillets in the mopper's design helps enhance its structural integrity, ensuring durability and longevity.

Materials to be Employed

- **Plastic:** Many parts of the robot's body, including the outer casing, may be made of durable and lightweight plastics such as ABS (Acrylonitrile Butadiene Styrene) or polycarbonate. These materials are chosen for their strength, impact resistance, and ease of molding into complex shapes. Plastic is a popular choice for the body and casing of window cleaning robots due to its advantageous properties. ABS and polycarbonate are known for their high strength-to-weight ratio, meaning they provide durability while keeping the overall weight of the robot relatively low.

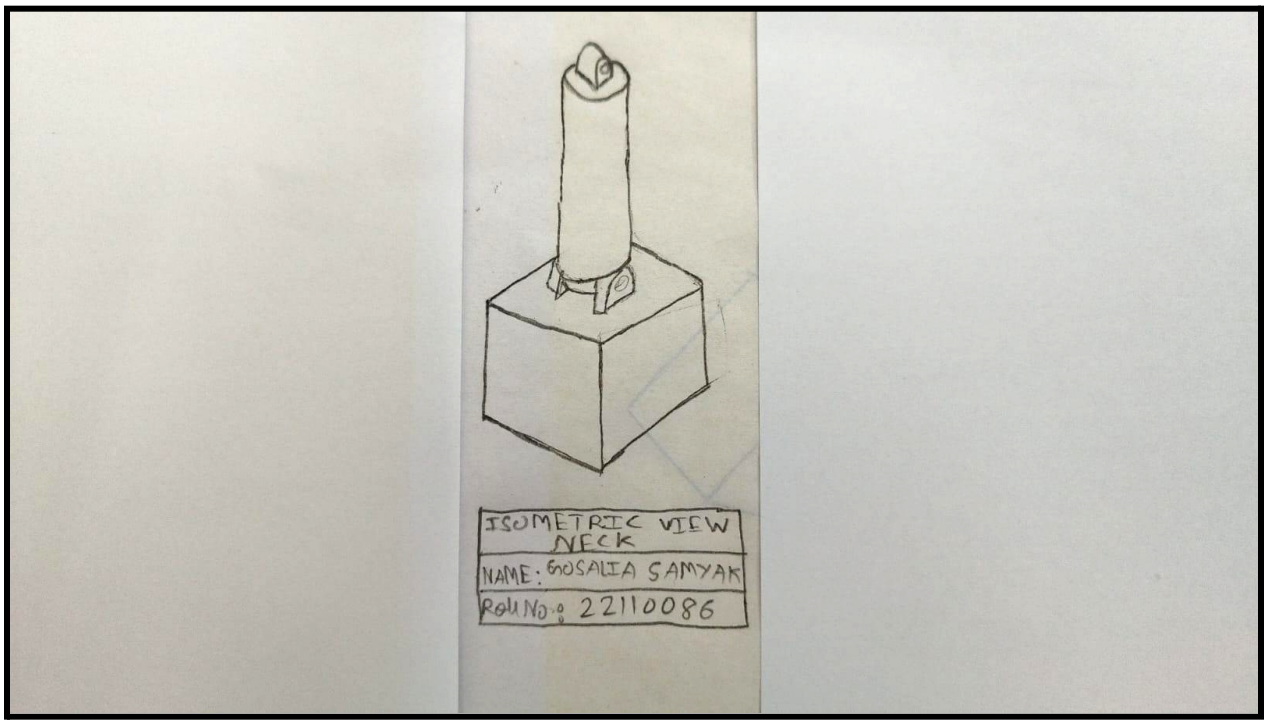
- **Microfiber or Cleaning Pads:** The cleaning mechanism of window cleaning robots involves using microfiber cloths or specialized cleaning pads. Microfiber is a synthetic material that attracts and traps dust, dirt, and grime effectively. The cleaning pads may have an adhesive backing or be attached using Velcro for easy replacement. Microfiber is an ideal material for window-cleaning robots due to its exceptional cleaning capabilities. Microfiber cloths consist of ultrafine fibers that are highly effective in attracting and trapping dust particles, dirt, and grime from the glass surface.

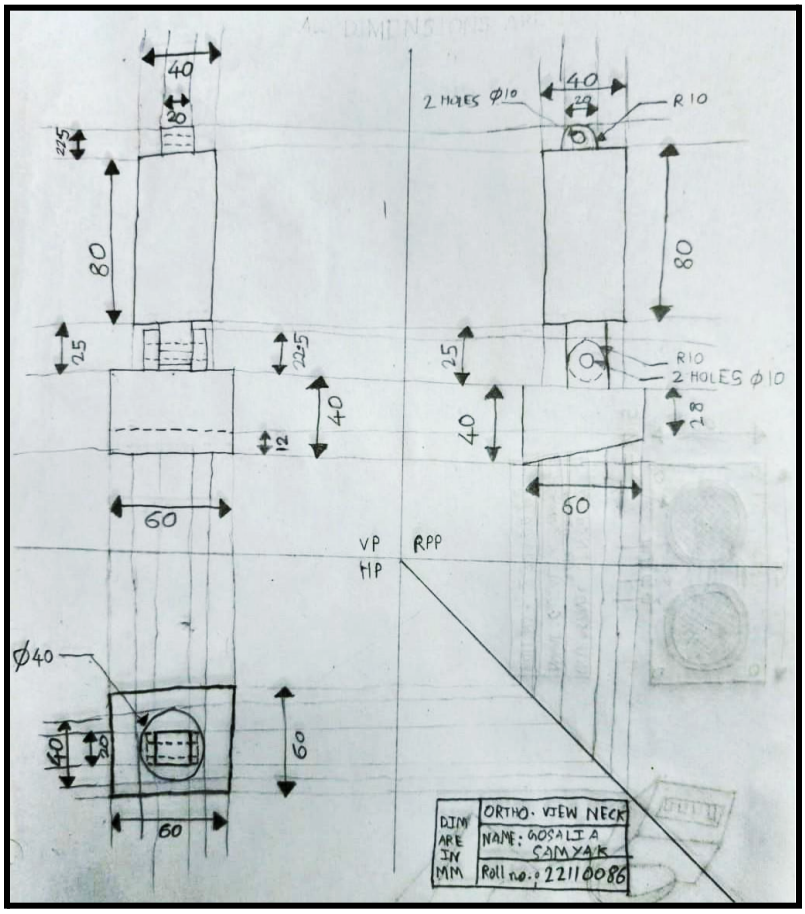
- **Brush or Squeegee Blades:** Some window cleaning robots may feature rotating brushes or squeegee blades to assist in cleaning. These components are typically made from durable materials like silicone or rubber to ensure efficient and streak-free cleaning. Brushes and squeegee blades are essential for effective and streak-free cleaning of windows. Silicone or rubber materials are commonly chosen for these components due to their durability and flexibility. They can efficiently remove stubborn dirt, grime, and water residue from surfaces without causing damage.

Part Name - Neck and Ultrasonic Sensors

Gosalia Samyak (22110086)

Neck





Reasons for the Selected Dimensions

- **Base Dimensions:** The base of the neck, with dimensions of length = 60mm and breadth = 60mm, provides a stable and robust foundation for the neck. The square shape offers structural support and helps distribute the load evenly, preventing excessive stress or instability during rotation. The selected dimensions ensure the base fits securely and aligns with the main body.
- **Height Dimensions:** The neck base has two heights: height 1 = 40mm and height 2 = 28mm. The slanted design of the neck is aligned with the slant of the main body, creating a cohesive and visually appealing aesthetic. The varying height allows for an ergonomic design, ensuring that the neck is at an appropriate angle for effective cleaning operations.
- **Cylindrical Section**: Above the base is a cylindrical section with a diameter of 40mm and a height of 80mm. This section serves multiple purposes within the neck part. Firstly, it acts as a transition between the base and the slot for attaching the eyes. The cylindrical shape provides structural support and stability, facilitating smooth rotation and minimizing potential wobbling or misalignment.

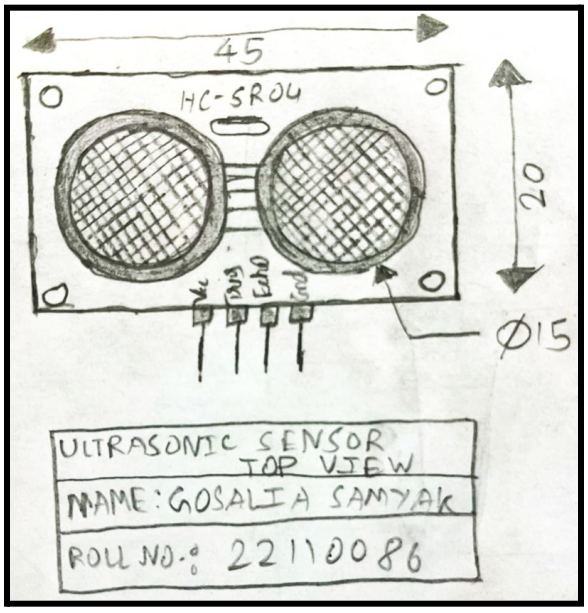
- **Slot for Eyes**: The slot for attaching the eyes is designed to accommodate the specific dimensions of the eyes. The dimensions of the slot are carefully set to ensure a secure and snug fit, preventing any unintended movement or detachment of the eyes during operation.

Materials to be Employed

Several materials can be considered for making the neck part of the SPARC-BOT, depending on factors such as strength, durability, weight, and cost as follows:

- **Aluminum**: Aluminum is lightweight, corrosion-resistant, and has an excellent strength-to-weight ratio. It is commonly used in robotics due to its versatility and ease of machining.
- **Stainless Steel**: Stainless steel offers high strength, durability, and corrosion resistance. It is suitable for applications where robustness and longevity are essential.
- **Plastics**: ABS (Acrylonitrile Butadiene Styrene) is a widely used thermoplastic known for its strength, impact resistance, and ease of fabrication. It is cost-effective and suitable for various robotic applications.

Ultrasonic Sensors



Reasons for the Selected Dimensions

- **Standard Sizes:** The dimensions of the ultrasonic sensor (length = 45mm, breadth = 20mm, receiver and transmitter diameter = 15mm) are commonly available in the

market. These standard sizes ensure easy accessibility and compatibility with existing components and mounting solutions. It becomes simpler to source and replace the sensors if needed by selecting a standard size, streamlining maintenance, and future upgrades.

- **Compatibility with Eye Dimensions:** The selected dimensions of the ultrasonic sensor are in sync with the dimensions of the eyes of the SPARC-BOT. A seamless integration can be achieved by aligning the sensor dimensions with the eyes, providing a visually cohesive and aesthetically pleasing design. The sensor's length and breadth are designed to match the eye's size, allowing for a snug fit and ensuring that the sensors are not obtrusive or protruding beyond the eye assembly.

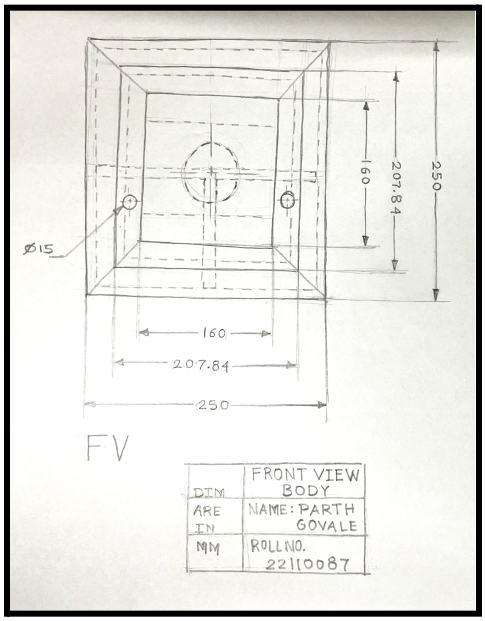
Materials to be Employed

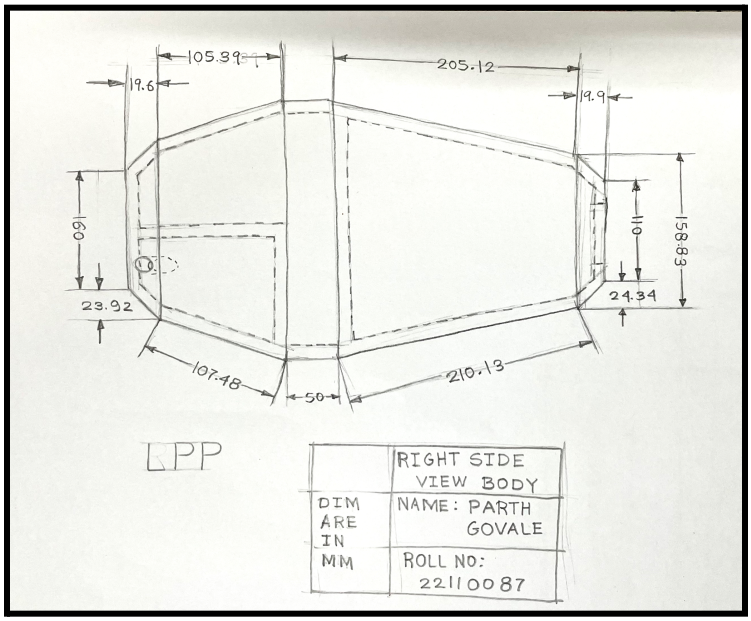
- **Housing/Enclosure and Circuit Board:** Plastic polymers like ABS, polycarbonate, or PVC provide mechanical strength, environmental protection, and insulation. Printed circuit boards (PCBs) made of fiberglass-reinforced epoxy resin (FR-4) house the internal circuitry, including signal processing and amplification components.
- **Piezoelectric Crystals:** Quartz or lead zirconate titanate (PZT) crystals are transducers for converting electrical energy into ultrasonic waves and vice versa.
- **Metal Components and Adhesive Materials:** Copper, brass, or stainless steel are used for connectors, terminals, and electromagnetic interference (EMI) shielding. Epoxy resins or cyanoacrylate adhesives provide a strong bonding between components for mechanical stability.

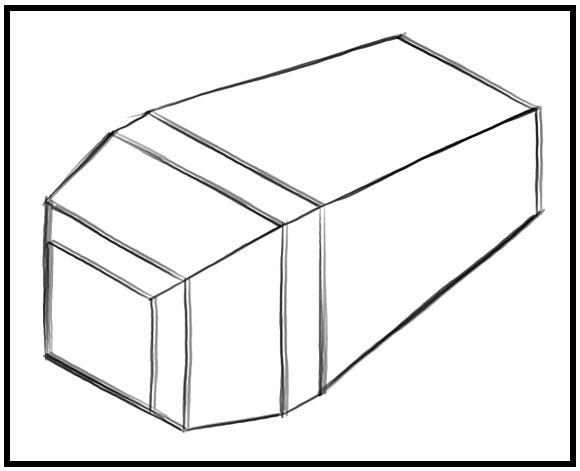
Part Name - Body Structure and Components

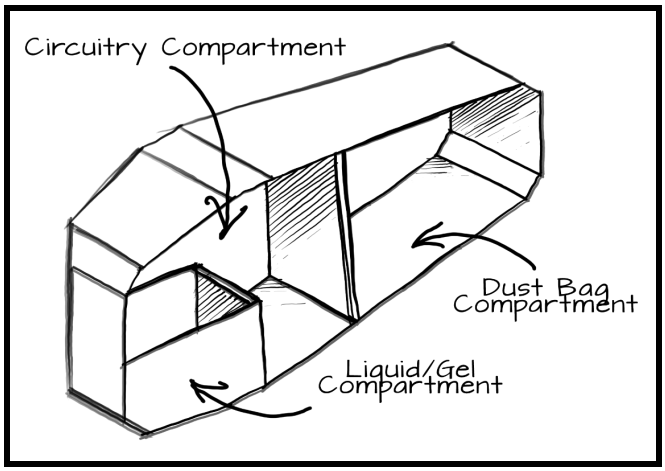
Govale Parth Vilas (22110087)

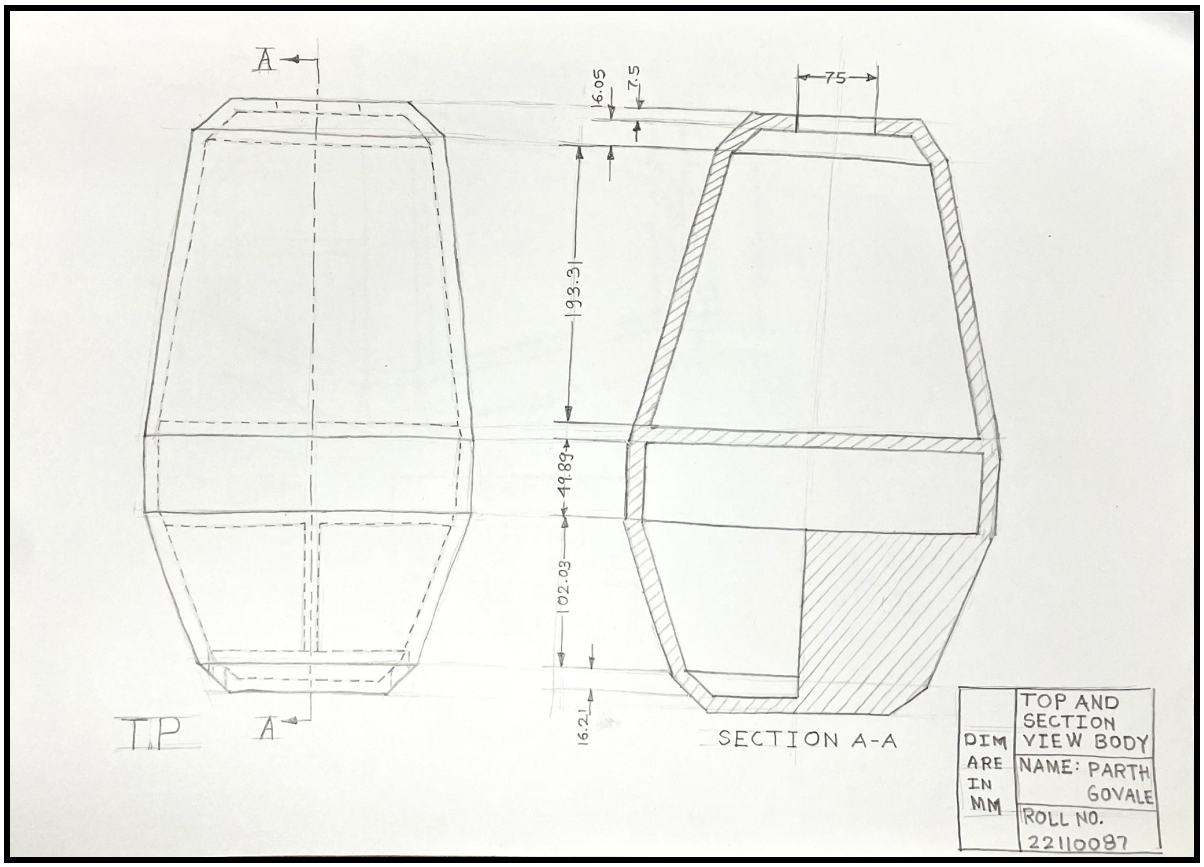
Body Structure and Compartments











Reasons for the Selected Dimensions

The dimensions of the body of the scorpion-inspired cleaner robot have been meticulously selected to address various design considerations and requirements. With a width of 250 mm, length of 400 mm, and height of 250 mm, the body balances, accommodating the necessary components and maintaining maneuverability in tight spaces. This carefully chosen size ensures that the body is manageable, allowing sufficient room for the components to be housed effectively and avoiding being overly large, enabling the robot to navigate through narrow areas easily.

One key aspect of the body design is the accommodation of the vacuum tube, which is essential for efficient dirt collection during cleaning operations. To facilitate this, a large hole with a diameter of 75 mm is strategically positioned at the back of the body. This aperture is the entry point for the vacuum tube, enabling it to efficiently suction and collect dirt and debris from the cleaned surfaces. The carefully chosen diameter ensures optimal performance and suction power, allowing the robot to fulfill its cleaning tasks effectively.

In addition to the vacuum tube hole, the front of the body features two small holes with a diameter of 15 mm. These openings are designed to be connected to water pumps, which play a crucial role in the robot's mopping function. The water pumps eject water and gel for effective

mopping, ensuring thorough and precise cleaning. The chosen dimensions of these holes are critical for achieving controlled and accurate water and gel dispersion, enhancing the overall effectiveness of the mopping process.

To ensure durability and a sleek profile, the robot's shell has been designed with a thickness of 7.5 mm. This thickness provides the necessary strength and structural integrity to withstand the demands of cleaning operations while also contributing to the aesthetic appeal of the robot. The carefully selected thickness balances protection and weight, ensuring the robot remains robust yet lightweight for efficient movement and operation.

To facilitate a secure connection to the base plate and provide stability during operation, two holes with a diameter of 5 mm have been incorporated at the bottom of the body. These holes are anchor points for attaching the robot to the base plate and cleaning the mop, ensuring a secure and stable connection. This design minimizes potential movement or instability during cleaning operations.

Within the body, specific compartments have been allocated dimensions that optimize their purposes. The dust bag compartment offers ample space for collecting dust and debris, making it suitable for cleaning larger homes or areas with high dust accumulation. Similarly, the water and gel compartments have dimensions that ensure efficient mopping capabilities and sufficient storage capacity for the required cleaning fluids.

Finally, the remaining space within the body houses the necessary circuitry components. This allocation allows for proper placement and organization of the electronic systems, ensuring efficient functioning and reliable control of the robot's operations. By dedicating sufficient space for the circuitry, the robot can effectively perform its cleaning tasks while maintaining the integrity and functionality of its internal electronics.

Materials to be Employed

The scorpion-inspired body for a cleaner robot would typically need a combination of materials that provide structural integrity, durability, and lightweight properties; you would need a combination of materials to achieve the desired functionality, aesthetics, and durability. Based on this, the following materials can be considered:

- **Lightweight and Strong Structural Frame:** Aluminum alloy or carbon fiber-reinforced polymer (CFRP) can be used for the framework and structural components. These materials offer high strength-to-weight ratios, providing stability and support while keeping the robot lightweight for agile movement.
- **Outer Shell/Casing:** ABS (Acrylonitrile Butadiene Styrene) or polycarbonate can suit the outer shell. These materials are durable, impact-resistant, and easily molded into complex shapes, allowing for the scorpion-inspired design and protecting the internal components.
- **Flexible Bumpers:** Rubber or silicone materials can be used for the bumpers, offering protection against collisions and improving traction when the robot encounters obstacles.

The most appropriate material for the scorpion-inspired cleaner robot's body is carbon fiber-reinforced polymer (CFRP). Here's why:

Reason for selecting CFRP:

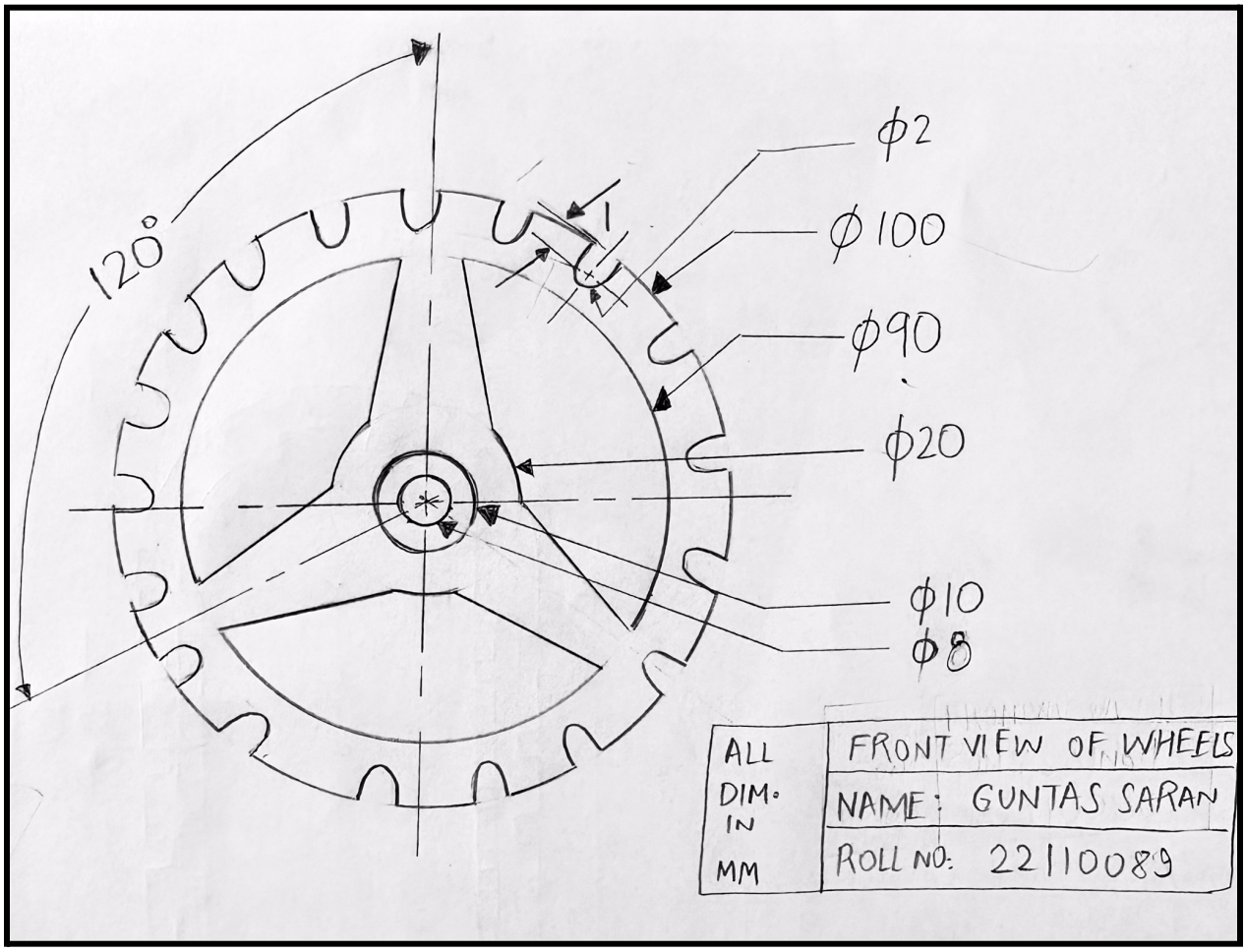
- **Strength and Lightweight:** CFRP offers exceptional strength and stiffness while significantly lighter than aluminum. This property ensures the structural integrity of the scorpion-inspired body while maintaining the robot's agility and maneuverability.
- **Versatility in Design:** CFRP can be easily molded into complex shapes, creating a sleek, intricate scorpion-inspired design. This material enables the formation of curved and angular surfaces, resembling the scorpion's body, enhancing the aesthetic appeal.
- **Resistance to Environmental Conditions:** CFRP exhibits excellent corrosion, chemicals, and moisture resistance. This property ensures that the robot's body remains durable and performs even in various cleaning environments.
- **Vibration Damping:** CFRP possesses good vibration-damping properties, reducing the noise and vibrations produced during the robot's operation. This feature contributes to a quieter cleaning experience, which is essential in home environments.
- **Durability:** CFRP has high resistance to impact and fatigue, making it suitable for the challenging conditions that a cleaning robot may encounter during its operational lifespan.

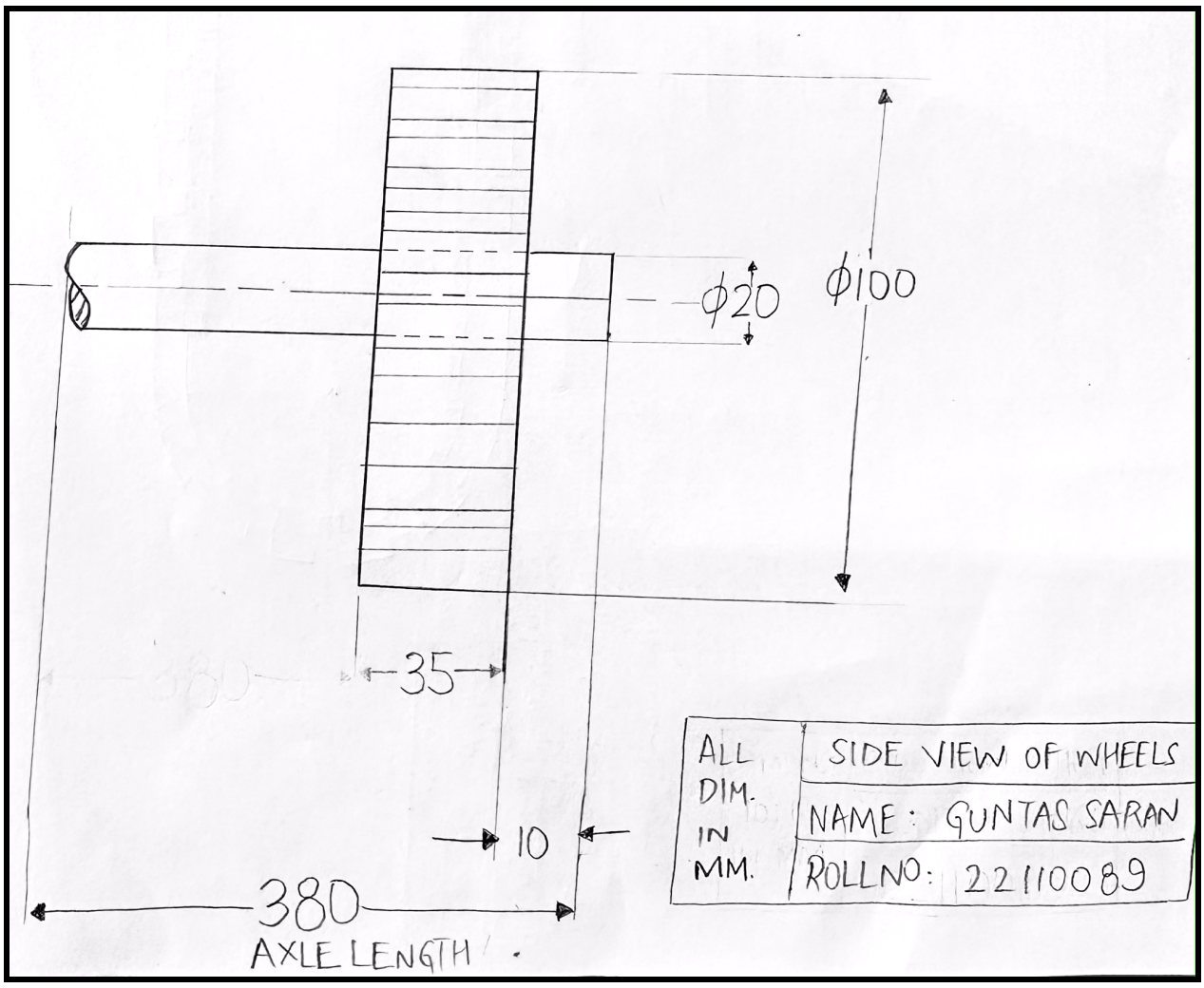
Considering these factors, carbon fiber-reinforced polymer (CFRP) is a strong contender for constructing the scorpion-inspired cleaner robot's body. It provides the necessary strength, lightweight properties, design flexibility, and durability to achieve the desired functionality, aesthetics, and performance.

Part Name - Wheels and Belt

Guntas Singh Saran (22110089)

Wheels





Reasons for the Selected Dimensions

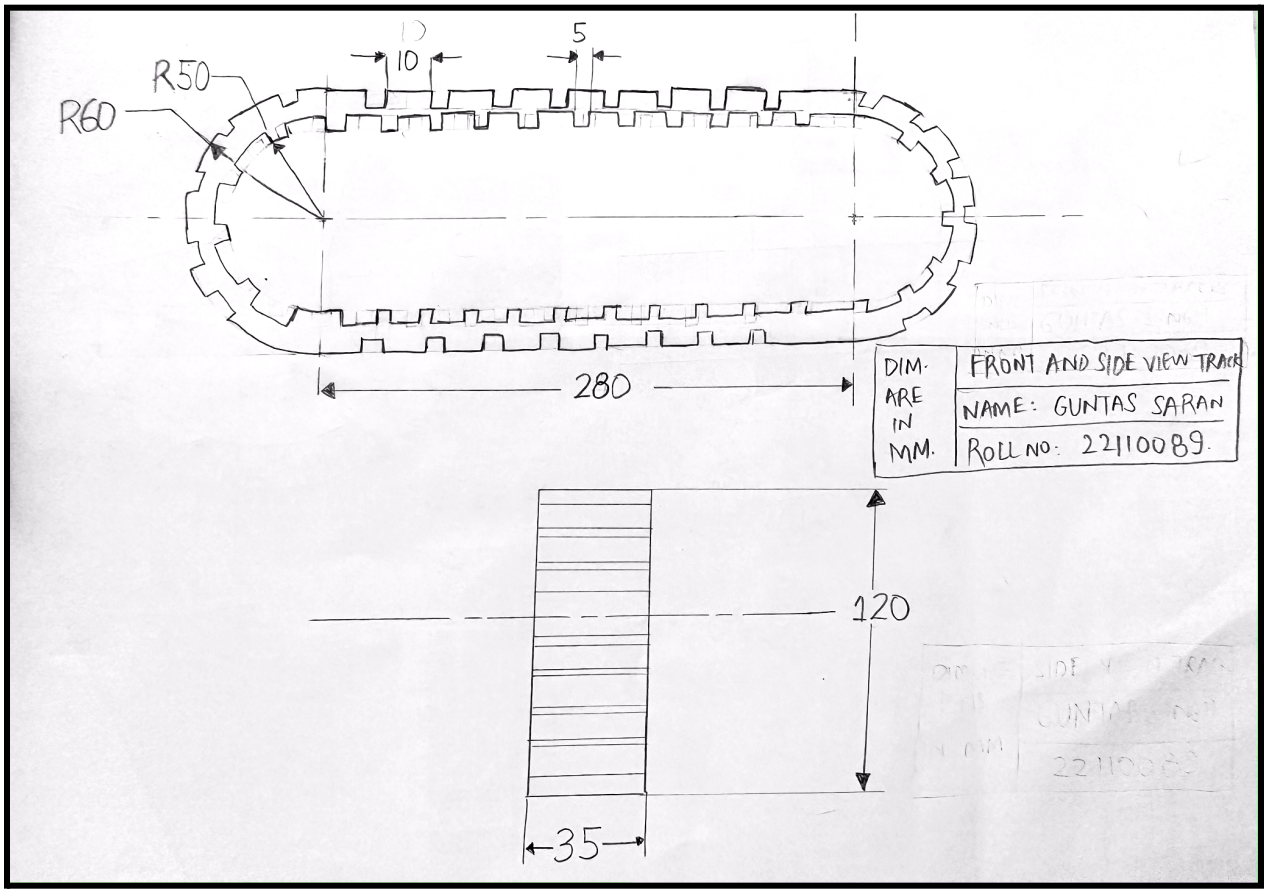
The radius of the wheels has been chosen as 100 mm in proportion to the body dimensions of 250 mm x 400 mm. The axle has to be placed just underneath the body base. The center of the axle acts as a reference point for all the further dimensioning of the wheels. The cut-out has a radius of 1 mm, ensuring that when the sketch is repeated by circular pattern, it completes the 360° by not missing any spot. The axle diameter of 10 mm ensures the adequate height level of the wheel in coherence with the body dimensions. The length of the axle is such that it allows for the whole base length (250 mm) to be covered in addition to the 55 mm extrusions of the body base plus the 10 mm extra segments on either side of the wheels.

Materials to be Employed

The wheel rim and axle of the SPARC-BOT may be fabricated from the following materials:

1. **Steel**: Steel is a widely used material for tank track wheels due to its strength, durability, and ability to withstand heavy loads. It offers excellent wear resistance and can handle rough terrains effectively.
2. **Aluminum**: Aluminium alloys are lightweight and offer good strength-to-weight ratios. They are often used to construct road wheels to reduce the vehicle's overall weight and improve fuel efficiency.

Belt



Reasons for the Selected Dimensions

The belt radius has to be 50 mm (the wheel's radius) + the thickness of the belt itself. Since the belt thickness has been chosen to be 10 mm, the radii at the ends of the horizontal segments turn out to be 60 mm, and the 10 mm and 5 mm peaks are placed such that they fit precisely within the wheel cuts. The 280 mm distance between the wheel or axle center ensures that the whole body of the SPARC-BOT (400 mm) is covered: 60 + 280 + 60 = 400 mm. The wheel thickness has been chosen as 35 mm since the body base extrudes sidewards by 50 mm, so to allow for the spacing of 15 mm between the wheels and the cover of the wheels, the wheel thickness has been chosen accordingly.

Materials to be employed

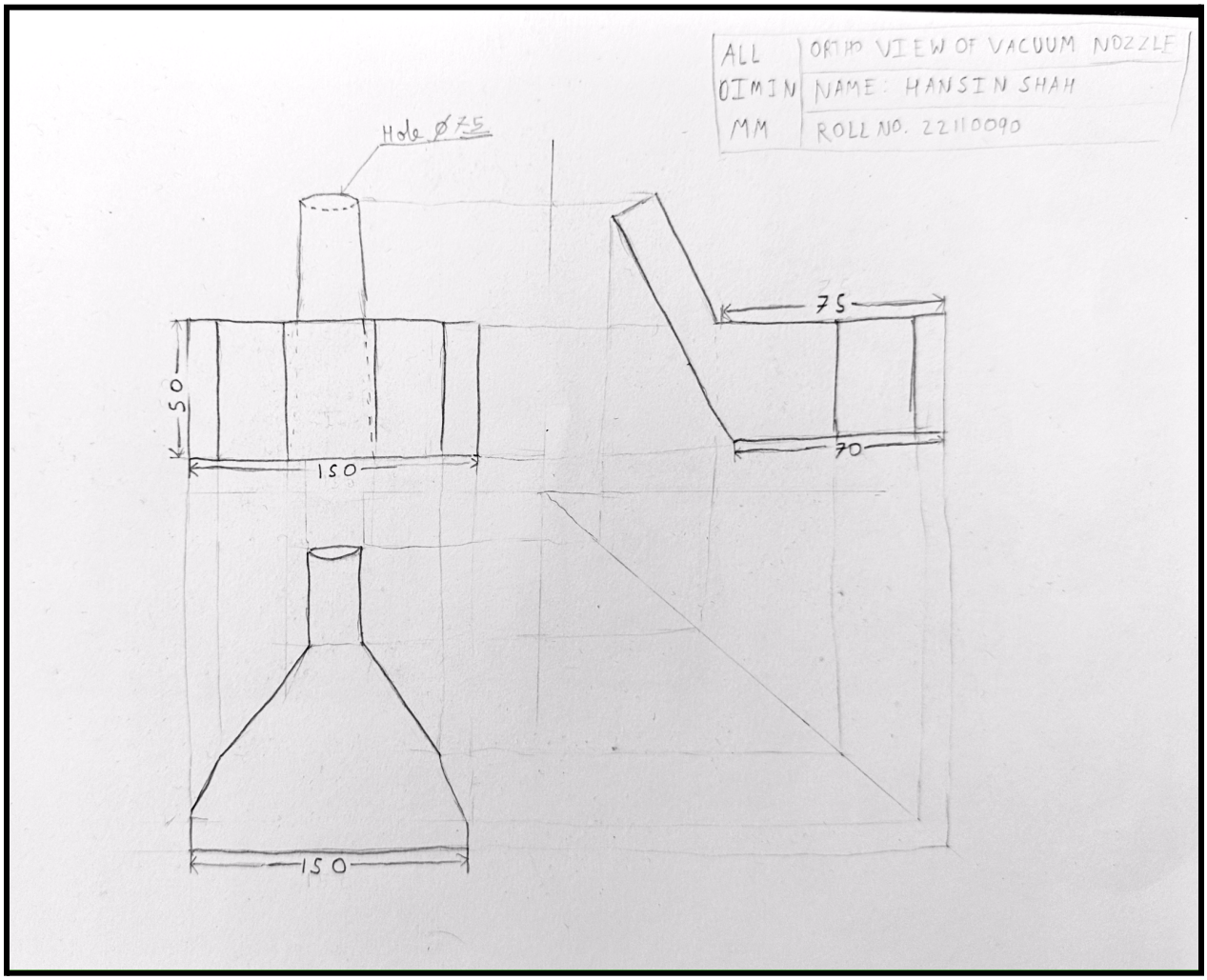
Industry-oriented manufacturing of tank wheel belts involves:

1. **Rubber**: Rubber is utilized for the outer layer of tank track wheels to provide traction and reduce noise. It offers a good grip on various surfaces and helps to absorb shocks and vibrations.
2. **Polyurethane**: Polyurethane is a synthetic material that combines the properties of rubber and plastic. It is resistant to abrasion, provides good traction, and can withstand heavy loads. Polyurethane is commonly used in track wheels for indoor or urban environments.
3. **Composite Materials**: Various composite materials, such as carbon fiber reinforced polymers (CFRP), are increasingly used to construct tank track wheels. These materials offer high strength, low weight, and improved performance characteristics.

Part Name - Vacuum Nozzle and Battery

Hansin Rakesh Shah (22110090)

Vacuum Nozzle



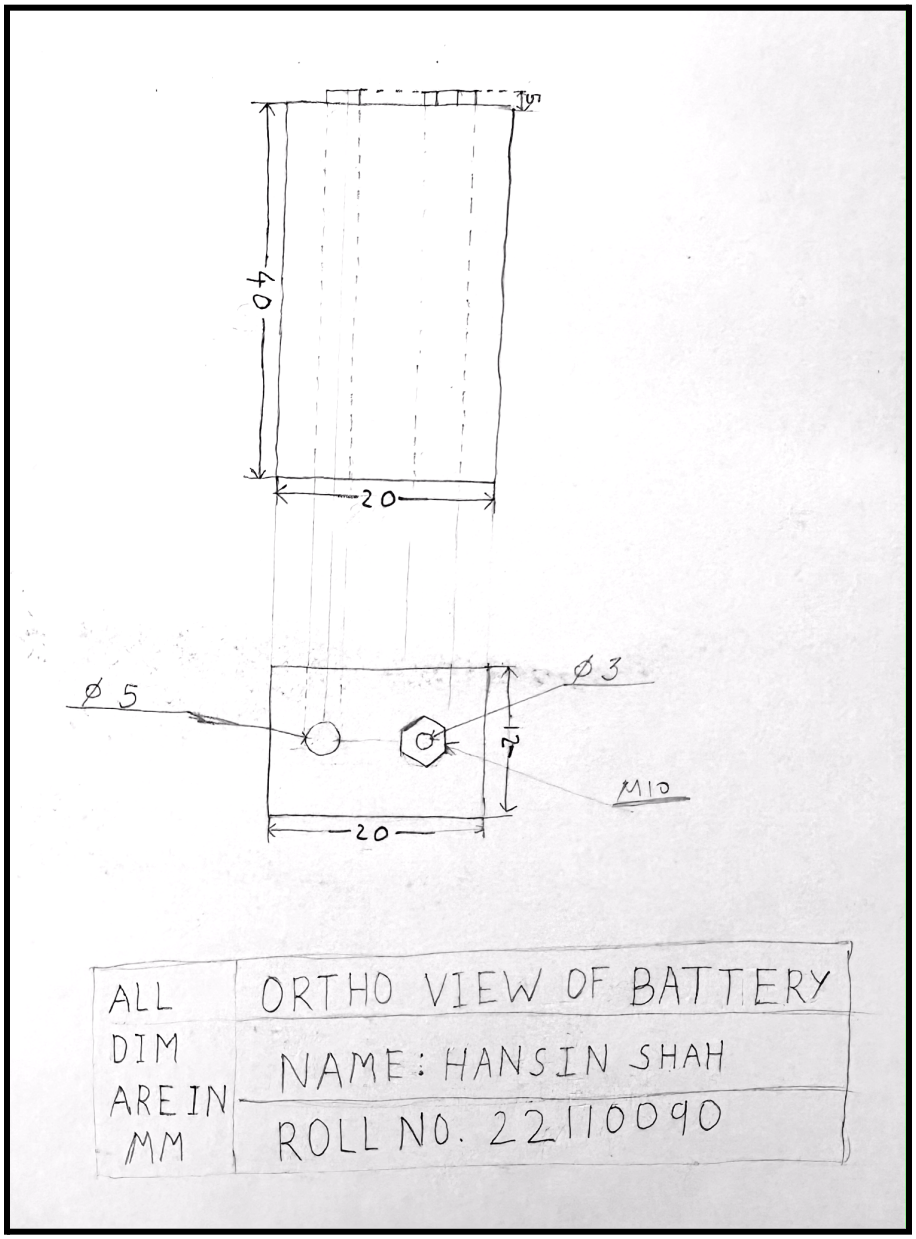
Reasons for the Selected Dimensions

The vacuum nozzle is a relatively large part in comparison with the body. Keeping the function of the vacuum nozzle and its relative size with respect to the body in consideration, I have chosen the dimensions to be 150 mm in length and 50 mm in height for the opening, the end part diameter to be 75 mm, and the length of the nozzle to be 75 mm at the top and 70 mm at the bottom.

Materials to be Employed

1. **Plastic**: it is lightweight, cost-effective, and versatile. Different plastics may be used for different nozzle components, such as ABS for the main body, polypropylene for the brushes' bristles, and PVC for flexible parts.
2. **Nylon or other synthetic materials**: Can be used to make brushes' bristles which aid in carpet cleaning by agitating and lifting the dirt and debris from the carpet.

Battery



Reasons for the Selected Dimensions

The most accepted ratio of height, length, and breadth of a battery is 3 : 5 : 10. Considering this ratio and making sure that the battery fits in the SPARC–BOT without any complications, I choose the dimensions of height, length, and breadth to be 40 mm, 20 mm, and 12 mm respectively.

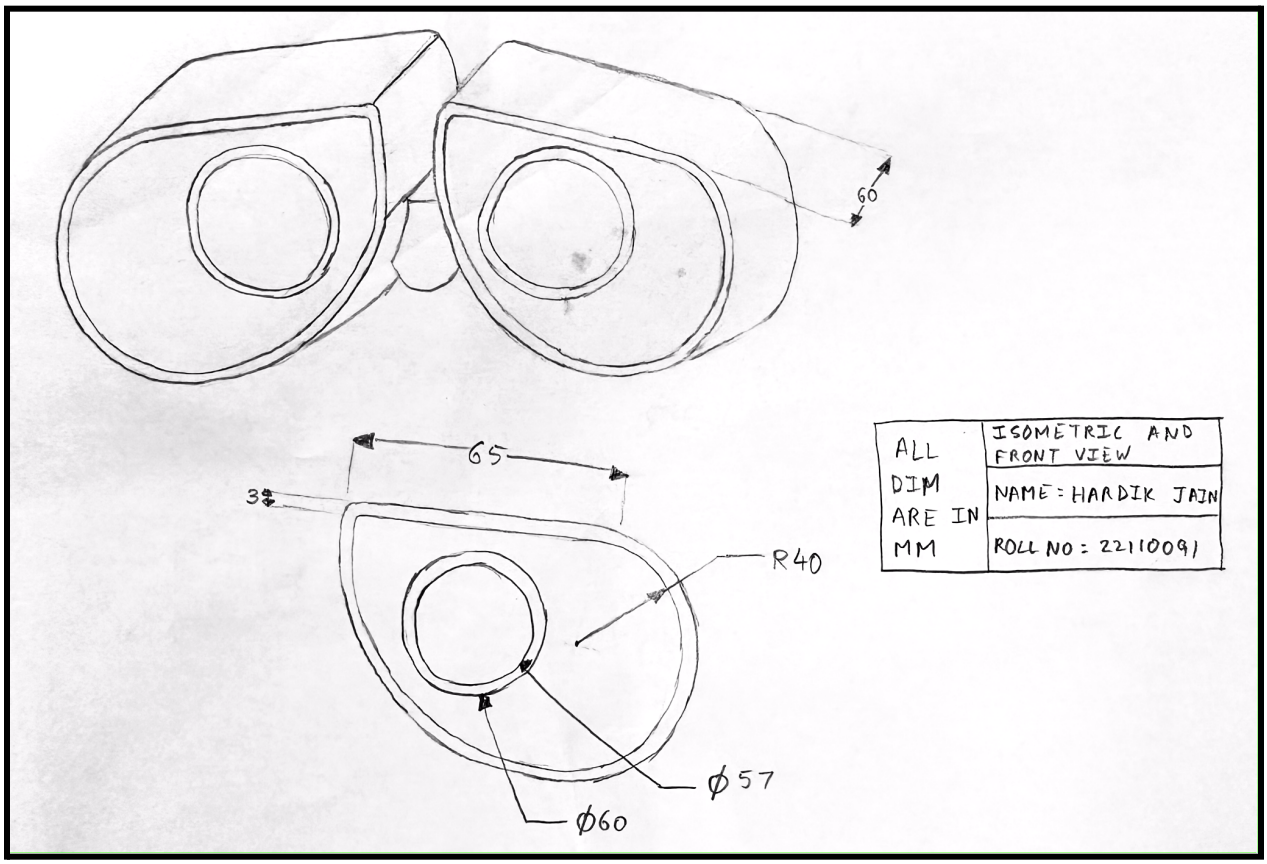
Materials to be Employed

1. **Plastic**: The battery's outer shell is usually durable, such as polypropylene or ABS.
2. **Zinc and Manganese Dioxide**: The battery's anode comprises powdered zinc and manganese dioxide.
3. **Manganese Dioxide and Carbon Graphite**: The cathode consists of a mixture of manganese dioxide and carbon graphite.
4. **Metal**: The battery has two metal terminal connectors, one positive and one negative, usually made of nickel-plated steel or conductive material.

Part Name - Camera in Eyes and Wheel Motors

Hardik Jain (22110091)

Eyes



Reasons for the Selected Dimensions

The eyes play a crucial role in determining the overall appearance of the robot. Hence, it is essential to carefully decide the dimensions of the eyes to make the robot look good and to account for other factors mentioned.

I have drawn the isometric view and the front view of the eyes, as they are enough to understand the complete structure of it and the dimensions of the various sub-parts. The eyes of the robot will be placed at the top of the robot and supported on the neck made by my teammate Samyak Gosalia.

I have chosen the following dimensions to keep the eyes proportionated to the rest of the robot. If the eyes are too small or big compared to the body, they will look disproportionate and not

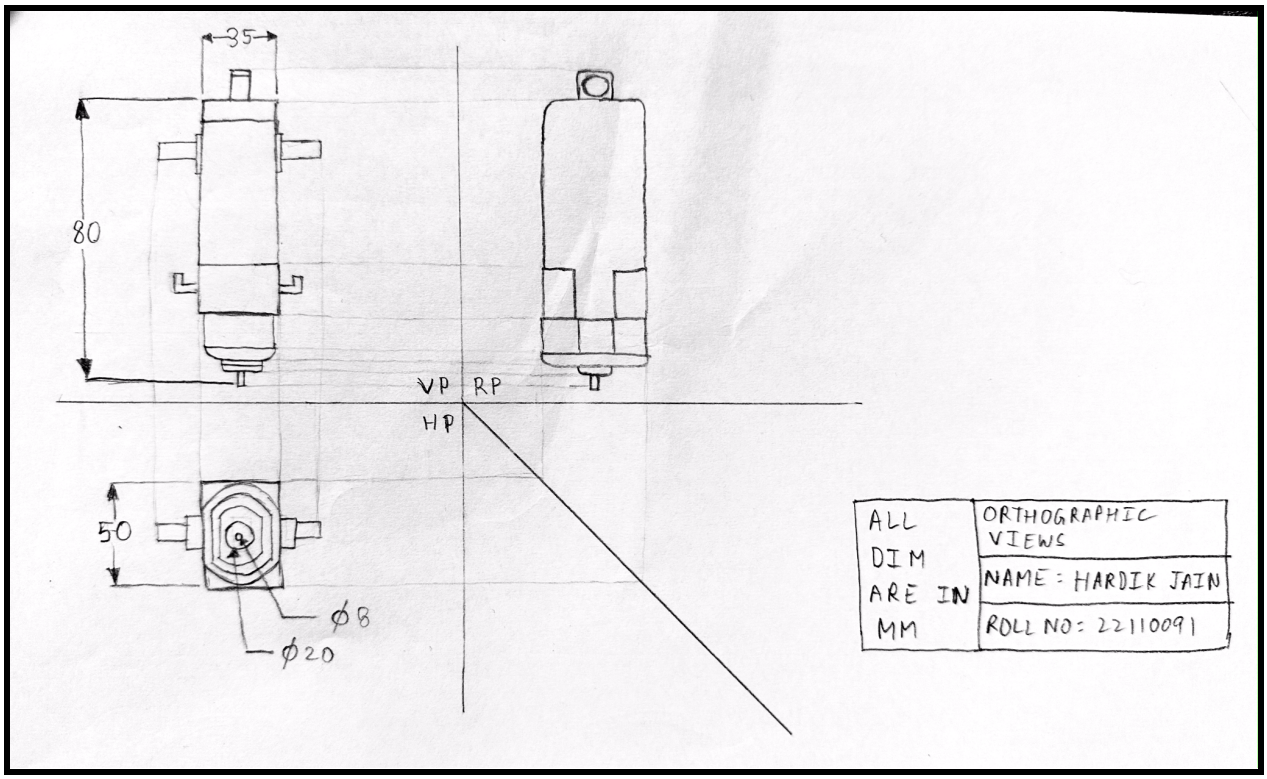
suit the robot. As the robot also resembles a living creature, the dimensions of each body part should be perfect compared to the rest of the body to resemble a living creature.
Since the eyes are directly supported on the neck, the size of the eyes should be appropriate so that a balance is maintained between the two parts. The weight distribution between the eyes and the neck should be carefully managed to avoid any breakage. So, if the eyes are too big, the joint between the eyes and neck might break because of the heavy weight of the eyes.

Materials to be Employed

The materials that can be employed are:

1. **Polycarbonate**: The outer part of the eyes can be made using polycarbonate, a solid and lightweight thermoplastic. It provides good impact resistance, shielding the inner components from external damage.
2. The inner components of the eyes, which consist of cameras, sensors, and other electronic components, can be made using different metals, semiconductors, and plastics, depending on the usage.

Wheel Motors



Reasons for the Selected Dimensions

The wheel motors are also an essential part of the robot. They are directly connected to the wheels and help translate the robot. The dimensions I have chosen for the motors are such that the wheels fit perfectly with the shaft. The length of the wheel motor is 80 mm, the breadth is 35 mm, and the depth is 50 mm. The diameter of the shaft is 10 mm, per the wheel my teammate Guntas Singh Saran has made.

Materials to be Employed

The materials that can be employed are:

1. **Laminated steel**: Laminated steel is a good material for making motor rotors because they reduce the energy losses in the motor due to Eddy currents and improve efficiency.
2. **ABS (Acrylonitrile Butadiene Styrene)**: Thermoplastics such as ABS are used to make the outer casing of the DC motors as they provide good impact resistance, electrical insulation, and lightweight construction.
3. **Carbon**: Brushes in a motor are usually made of carbon or graphite composite materials. Carbon brushes are preferred due to their excellent electrical conductivity, low friction, and ability to withstand high temperatures generated during motor operation.
4. **Copper**: The commutator of the motor is made of copper. Copper is an excellent conductor of electricity, making it ideal for transmitting power between the rotor and the external circuit.
5. **Stainless steel**: Stainless steel is used to make the motor shaft. Stainless steel is a strong and durable material, making it perfect for the shaft as it needs to withstand high torque and vibrations during motor operation.

Meeting Details

Meeting 1:
Date: 17th May 2023
Duration: 90 mins
Absent: None
Topic: General Discussion on Course and Ideation

1. Introduction to the Course and Project
2. Preliminary Discussions and Ideation

Meeting 2:
Date: 20th May 2023
Duration: 120 mins
Absent: 2
Topic: Finalising Idea

1. Further Discussion of the preliminary ideas
2. Selecting the best Idea.
3. Brainstorming on the basic details.

Meeting 3:
Date: 21st May 2023
Duration: 100 mins
Absent: 2
Topic: Parts Distribution and Basic Sketching

1. Distributed Parts to each member.
2. Everyone Researched their parts.
3. Discussed the look and feel of the bot and made a firsthand sketch of the whole bot.

Meeting 4:
Date: 25th May 2023
Duration: 140 mins
Absent: 6
Topic: Finalised the proposal

Meeting 5:
Date: 31st May 2023
Duration: 45 mins
Absent: 3

Topic: Discussing Dimensions of each part

1. Made Changes in the initial ideas and designs
2. Discussed Dimensions of each part

Meeting 6:
Duration: 75 mins
Date: 5th June 2023
Absent: 3
Topic: Finalised Dimensions of each part

Meeting 7:
Date: 6th June 2023
Duration: 60 mins
Absent: 6
Topic: Started Sketching

Meeting 8:
Date: 7th June 2023
Duration: 140 mins
Absent: 2
Topic: Finished Sketching and Worked on the Sketches PDF.

Work Distribution

Proposal:

Template made by: Guntas
The signature page was done by: Guntas, Farhan, and Parth
Introduction and Motivation, written by: Farhan and Gaurav
Sketching of the bot(on the cover page): Parth
Formatting: Guntas, Farhan and Parth
Reviewing: Guntas, Farhan, Parth, Hardik, and Gaurav
Sketches were done by: Each member sketched their own parts
Content of each part done by: Each member wrote the content for the parts allotted to them.
Prints taken by: Farhan and Parth

Sketches:

Template made by: Guntas
General Modifications written by: Gaurav
Sketching done by: Each member did sketching for their parts.
Content in each part written by: Individual members wrote content for their own parts
Help in sketching provided by: Parth and Gaurav
Meeting Details page done by: Farhan
Work Distribution page done by: Farhan
Formatting: Gaurav, Farhan, and Parth
Reviewing: Guntas, Farhan, Hardik, and Parth
Prints taken by: Parth and Farhan