Module – ME1050

Smart dustbin

Project done by Group -05

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Abstract

The rate of increasing population in our country has increased rapidly and also garbage disposal is increasing environmental issues. Nowadays people are using more products including food items, industrial products, medicines and plastic materials. After the expiry of these items, they have put them into a dustbin for disposal. A dustbin is a container that collects garbage or stores items which recyclable or non-recyclable, decompose, and non-decompose. People are using different types of dustbins such as pedal dustbins, swing dustbins, wheeled dustbins, etc. Dustbins are getting overflow due to an increase in waste every day. Without proper maintenance of dustbins, these expiry items can create epidemic diseases among people and pollution to the ambiance. In the current state of the corona epidemic, there is also a risk for people to have to tie the knot of the trash bag by hand. So, the dustbins in cities, homes, industries, and hospitals have to be smarter and maintained properly to ensure cleanliness.

This project presents an Arduino-based garbage monitoring system to prevent the trash spilling out from the dustbin and maintain the environment smart and clean. It also includes an automatic zip-tying system to tie the knot of the trash bag, an automatic sealing system, and an automatic lid opening and closing system. We hope to provide a better product by presenting all these features as a solution to the existing problems in waste management.

Acknowledgment

We are overwhelmed in all humbleness and gratefulness to acknowledge my depth to all those who have helped us to put these ideas well above the level of simplicity and into something concrete .We would like to express our special thanks of gratitude to Mr. Madawa Herath and our instructor Ms Janani Kahahena who gave us the golden opportunity to do this wonderful project which also helped us in doing a lot of research and we came to know about so many new things .we are really thankful to them.

The success of this assignment required a lot of guidance and assistance from many people and we are extremely fortunate to have got this all along the completion of our assignment work. Whatever we have done is in only due to such guidance and assistance and we would not forget to thank them. we are really gratefully because we managed to complete this assignment within the time given by Ms Janani. this assignment cannot be complete without the effort and co-operation from our group members group members Vilan , Vinal, Kasuni , Dulanthi ,Thiniuri .

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List of Abbreviations

MT – Mega Ton

kg – kilogram

g – gram

kgf – kilogram-force

Hz – hertz

kHz – kilo hertz

MHz – Mega hertz

ms – milli seconds

µs – microseconds

m – meter

cm – centimeter

mm – millimeter

V – volt

A – ampere

mA – milli ampere

µA – micro ampere

°C – Celsius

LED – Light Emitting Diode

LCD – Liquid Crystal Display

AC – Alternating Current

DC – Direct Current

SMPS – Switched Mode Power Supply

IR – Infrared

PWM – Pulse Width Modulation

GPIO – Generate Purpose Input-Output

SWM – Solid Waste Management

SWOT – Strength, Weaknesses, Opportunities, Threats

3D – Three Dimensional

LKR – Sri Lankan Rupees

Introduction

Currently, waste management is a measure problem in our country. The growth of the population, increasing urbanization, rising standards of living, and rapid developments in technology have all contributed to an increase in both the amount and the variety of wastes generated by industrial, domestic, and other activities. The traditional methods of waste collection are found very inefficient to handle the waste. This has led to the development of smart waste management systems which will help us solve these problems or at least reduce them to a certain extent. In many cities, we find garbage bins overflown at various public places in cities due to an increase in waste. It creates unhygienic surroundings and lousy odor, which leads to the spread of deadly diseases and human illness. Also, this situation is severely affecting the current epidemic in the country.

To evade this situation, we propose to design a Smart Waste Management System for trash bins. We are introducing an automated sealing system to minimize the bad odor of trash. In this proposed system, there is a LED button system, which helps in detecting the level of garbage in the trash bin. As soon as the garbage inside the dustbin reaches the approximate level of 90%, there is a buzzer to know that and it will turn on for few seconds to tell the user not to use this. Till the dustbin is empty again, the lid will not open so that no one can put the garbage into it and create a mess. This project also includes three LED bulbs to indicate the battery level of the trash bin. The system also proposes an automated lid, when any individual reaches near to it, the lid of it will open automatically so there's no got to open that messy cover with your hands. Under the current corona epidemic, tying the knot of the trash bags by hand can pose a risk to the health of the cleaning staff. As a solution to this major problem, we have added an automatic zip-tying mechanism to this system which ties the knot of the trash bag automatically. Including all the above features, a new system for the trash bin is developed with the incorporation of new technologies such as programming languages.

Problem Statement

In the present day's garbage has become a significant problem due to the increase of population. Many countries in the world face to this problem. Many people throw away garbage without any responsibility, carelessly or without any hesitation. Nowadays, people have become selfish and unwilling to throw away trash appropriately. It is common to see people discard trash out of everywhere. Carelessness has also made people just throw rubbish in anywhere without even thinking about it. And we can find garbage bins overflowing at various public places. So that breeding various animals near the trash bins and it creates unhygienic surroundings, lousy odor which leads to the spread of deadly diseases and human illness. Smart dustbins help to create a cleaner, safer, more hygienic environment and enhanced operational efficiency while reducing management cost, resources, and roadsides emissions. The smart bin is ideal for busy locations such as campuses, airports etc. And nowadays dustbins are usually used in hospitals.

Presently there are some kinds of available solutions like swing dustbin, dustbin with a lid (which is manually operated) and dustbins operated with the help of the leg. But they are not good enough because some people with neurological and skeletal disorders get trouble when they open it by using their leg. According to our one of the group members experiences, also factor to make a smart automated dustbin concept. His grandfather who was suffering with arthritis for a long period. When he was admitted to the hospital and he tough to balance to open the lid of the dustbin using the paddle because of the arthritis pain.

So, we need to develop a trash bin that can tie trash bag with a zip tie. This will reduce manpower and save the time. The sensor placed inside the bin will measure the level of trash. So, this system is our solution for monitoring the status of waste bin fill level. Sealing the dustbin with a rubber seal is relatively easy to make sure that everywhere looks clean and smell good. It can minimize bad smell and potential spread of germs from the food waste in garbage bins. This automatic sensor dustbin trash can touch free. Lid of the trash will automatically open the lid will be automatically closed after the garbage is throw, and whole process of throwing garbage no need to use our hand and feet. And also, you can avoid the bacteria in the trash bin. Current available automated solutions average prices range in between $50 to $500. So, we are planning to develop a smart dustbin addressing the above identified weaknesses within the budget of 10,000lkr

Problem Definition

In the current state of the corona epidemic, there is a threat for cleaners to touch the overflowing trash bags. They have to use their hands to tie the knot in garbage bags and it makes it possible to infect the corona virus in this situation. Besides that, when the dustbin is full the user still throws the garbage at the dustbin. Polythene bags are always wasted when the cleaner needs to clean up the dustbin although the dustbin is not full. The cleaner cannot monitor the current level of garbage in the dustbin so the time to check all the dustbin is wasted. The garbage collecting authority in the traditional waste management system doesn't know about the level of garbage in the dustbin, if the dust bins get full of garbage, then it gets overflowed as well as spelled out from the dustbin leading to unhygienic conditions in cities. Sometimes due to unclean garbage bins, bad smell arises also toxic and unhygienic gases are produced which is way to support to the air pollution and to some harmful diseases which are easily spreadable. The use of such traditional systems for trash bins results in time-wasting and money spending.

Literature Review

Solid Waste Management (SWM) is a major problem in developing economies and should be prioritized to address this problem due to rapid population growth as well as increasing waste in developing countries. Although the amount and quality of solid waste generated by urban areas in developing countries are low, compared to the significant Western developed and industrialized countries in the West, SWM is still inadequate. (Llic & Nikolic, 2016)

As a developing country, Sri Lanka generates 7000MT of solid waste per day with the Western Province accounting for nearly 60% of waste generation. Each person generates an average of 1-0.4 kg of waste per day. According to the Waste Management Authority and Central Environmental Authority, only half of the waste generated is collected.

Improper waste management is causing various social and economic losses as well as diseases, unbearable odors, air and water pollution, and esthetic troubles. Many have pointed out that developing countries do not have the appropriate technology, and the lack of proper management and leadership becomes one of the major shortcomings of SW management in these countries. In the current epidemic, health and safety are major concerns and today's society demands more safety than before. Society hopes to focus on sustainable waste management processes, including feedback loops, embody adaptability, and eliminate waste disposal.

Swing dustbins, Automatic lid dustbins, Pedal dustbins, Wheeled dustbins are considered as the existing solutions for waste management. The transition from these traditional unsustainable systems to sustainable waste management systems requires the identification and application of these existing features. On the way to come up with new a solution, the automatic lid can be taken as a good feature of existing solutions. But the fact that trash bags in these bins have to be tied up by hand can be considered as a shortcoming and under the current corona conditions, it is a risk for people engaged in cleaning activities. Therefore, a system is needed to control public health and environmental considerations to control the generation, storage, collection, processing, and disposal of solid waste.

Needs

Identified Needs

Eco friendly

Overflowing trash bins can cause animals to drag garbage everywhere and excessive odor of the garbage cause air pollution.

Reduce Infection

When opening the trash bin and tying the trash bag, there's a risk of getting infected.

High efficiency

Time is wasted when operating the lid of the trash bin manually.

Reduce manpower

When putting a knot in the trash bag and opening the lid of the trash bin manpower is lost.

Easy implementation

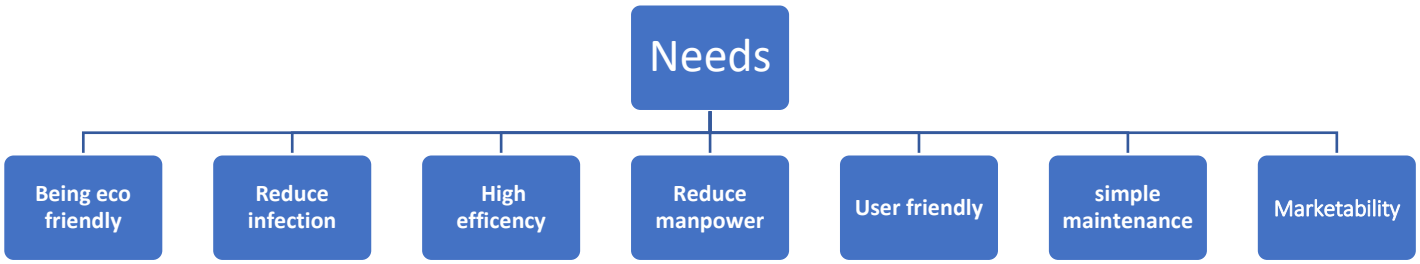
Difficulty doing manual work, such as paddling the trash bin by foot or open it by hand, tying a knot in the bag by hand and cleaning the bin.

Simple maintenance

Overflowing garbage is difficult to clean and maintain.

Marketability

Needs Hierarchy



Reduction of pollution	**Medi waste**	**Time saving**	**Effortless (zip tie)**	**Easy to use**	**Trouble-free**	**Vendible**
Improve waste management	**Hygienic condition**	**Automation**		**Easy to assemble /replace**	**Easy service/ dispose**	**Portable**
Reduction of bad odor						
Trash spilling out						

Methods of identification of problems and needs

Table 1 method of identification of problem and needs

Tools	Description
Research articles	**https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Waste+spill+around+the+grabge+bin&btnG=#d=gs_qabs&u=%23p%3DJUXS93UuX58J**
Television documentaries	We identified several problems that occur when tying a trash bag and it takes a quite long time. When using hands to tie a trash bag it will occur risk of infection **https://www.youtube.com/watch?v=P2RhkgwMHm8**
Magazine articles	There were several magazine articles published with regards to problems in current garbage management
Government publications	Rules and regulations in our country have been tighten in urban areas due to littering in surrounding. **Democratic Socialist Republic of Sri Lanka - Achieving sustainable waste management that is compatible with local characteristics - Passing On a Rich Natural Environment to Future Generations by Reducing Environmental Impact | Publications | JICA**
Brainstorming	Personal experience of our group member helped us to identify problems in garbage disposal.
Survey from minor staff (hospitals)	After conducting an insight survey with the hospital minor staff, we identified the problems in the hospital clinical waste management.
Feedbacks	After conducting a public survey, we have identified several problems in garbage management.

Limitations

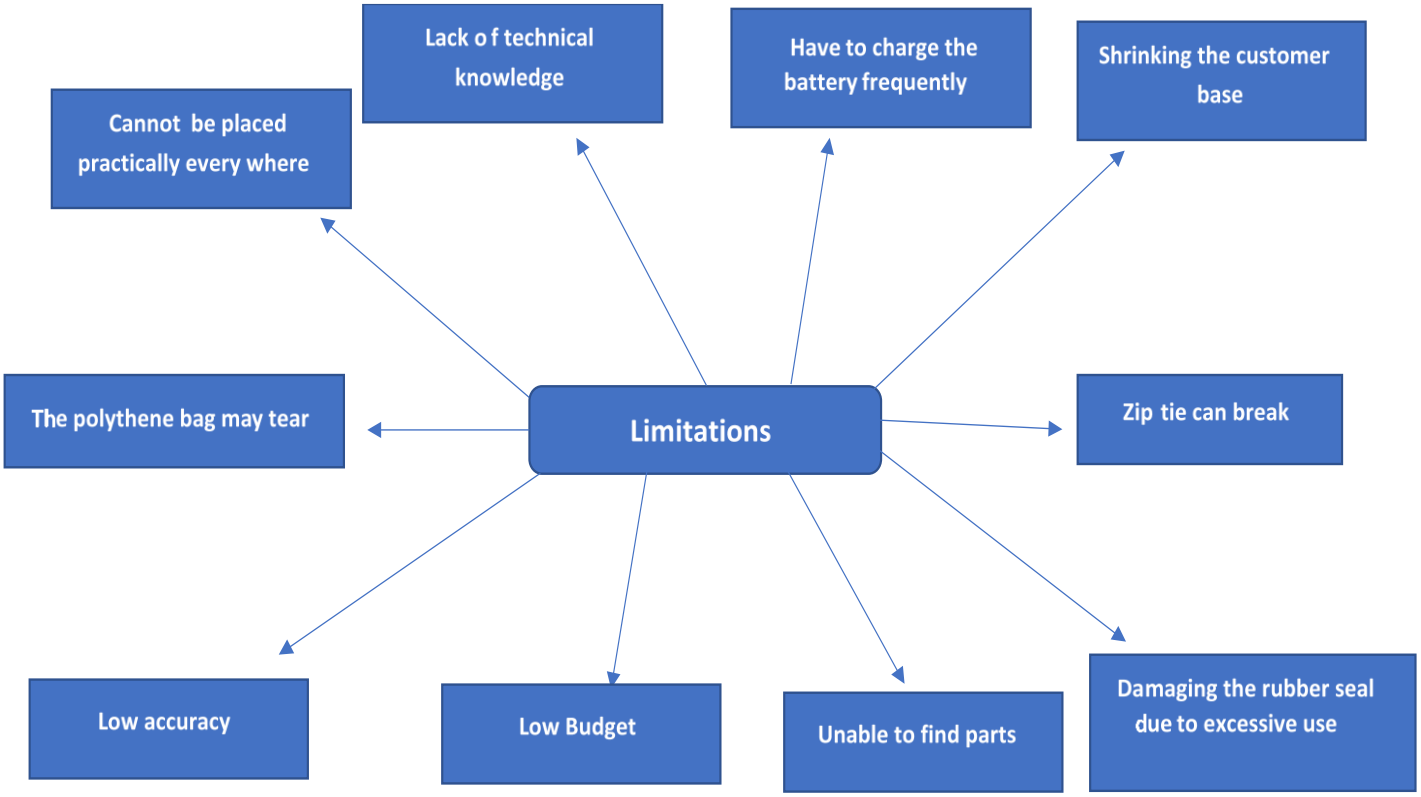


Figure 1 limitations

Constraints

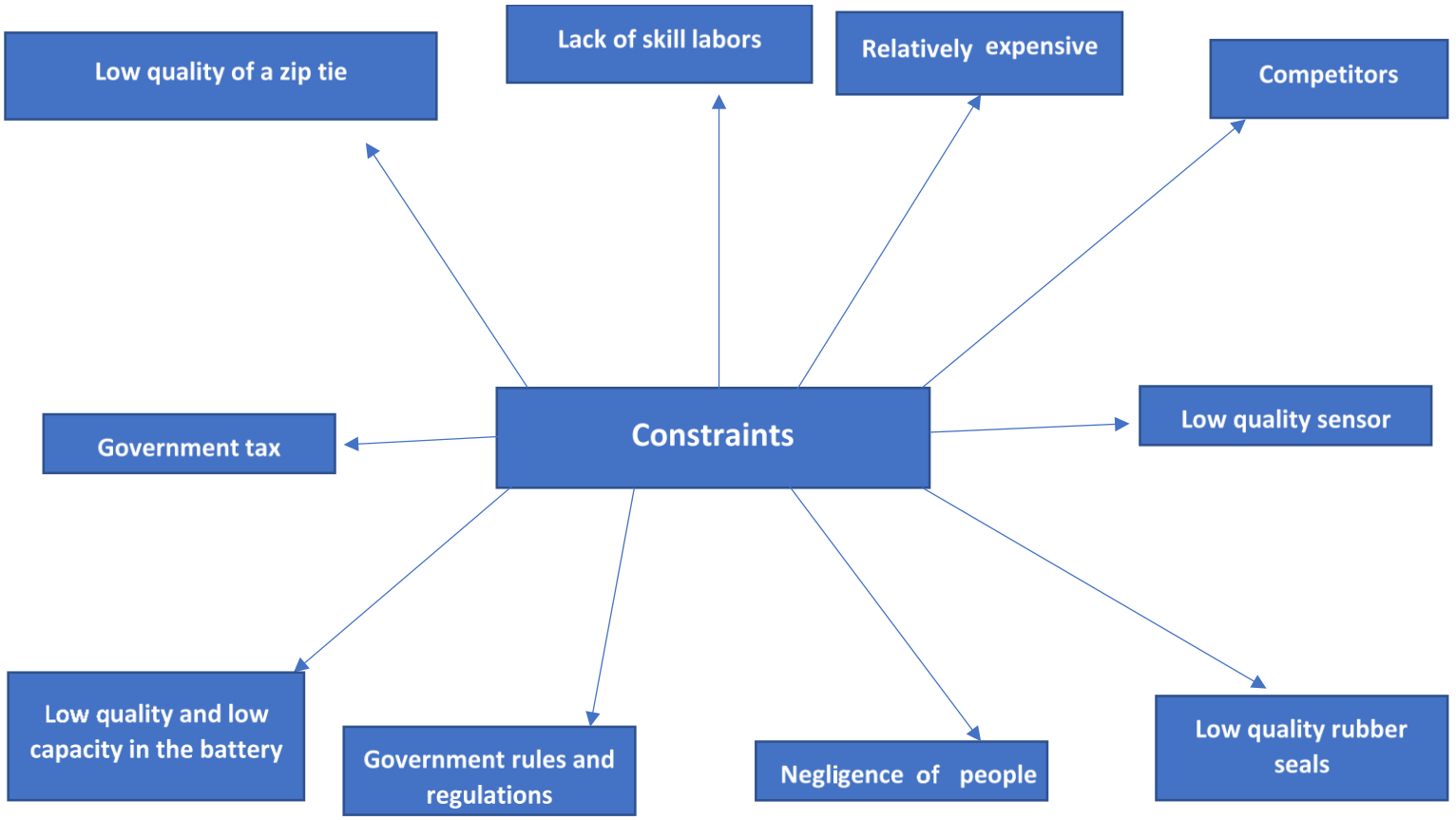


Figure 2 constraints

Objectives

Defined Objectives

• **Time saving**

We currently have trash bins that can be manually operated by hand or foot. Also, when the bin is full, the trash bag must be tied by hand. We must spend extra time to do these things and it is difficult to do them manually.

Therefore, we are introducing an automated lid as a method of facilizing work. As a result, the lid of the trash bin will automatically open and close. So do not have to waste time there.

• **Automation**

As we are living in a busy world, open the trash bin lids, remove the trash bag after it is full, clean the trash bin if it is overflowed and maintain the trash bin, are very difficult to do daily.

So, we came up with the idea that it would be very easy if we could do all those tasks automatically. That is why we introduce this dust bin with automated lid and facility of tying a knot automatically.

• **Properly managing waste**

We have seen litter bins on the road and the rubbish bins, which keeps outdoors are scattered everywhere. Also, the garbage bags are left untied on the road for taken to the municipal council by the waste disposal trucks. If the trucks do not arrive on time, the garbage will still be on the road. On rainy days, all the rubbish can be wet and scattered, or animals could have been dragged away. Those things can create an unpleasant and polluted environment.

We presented our ideas as a solution to this. We can use our method to dispose garbage properly. It may help to keep environment clean. It makes easier to the labors who is going to collect those garbage bags.

• **Reduction of bad odor**

We can feel a strange smell coming from the garbage dumps. Anyway, the stench from the dirt keeps on rising day by day. If we can prevent odors from coming out of the trash bin, can avoid this problem.

By considering this matter, we are willing to add a rubber seal around the bin to sealed with the lid when closed.

- **Trash not spilling out**

We have seen leftovers from trash can /bins scattered everywhere. Reasons for this situation are using dust bins without lids and leaving lid open after using it this occurs due to laziness of people.

In our smart dustbin we have introduced the automated lid and zip tie which automatically tightens.

- **Easy to service**

With people being busy, a lot of has problems arise when cleaning bins. because trash bins take a considerable time to clean. Even though we use trash bag in the bin

By using our new smart dust bin which automatically control this situation (use of a zip tie), as it has an automatic system to close the lid and seal the trash bag.

- **Easy to use (readily available parts)**

We have to do all the chores manually such as cleaning the garbage bin disposing trash bag once they are full. It wastes manpower and also time.

As a solution we are designing a lid to open and close garbage automatically. Also, we suggest an automatic knot tying methord.by using our this, we can remove the problem which happen removing the trash out of the bin.

- **Marketability**

Our aim is to present a competitive design to the market by using zip tie, rubber seal , automatic lid as new accessories that are superior to the existing solution for the dust bin

Objective tree

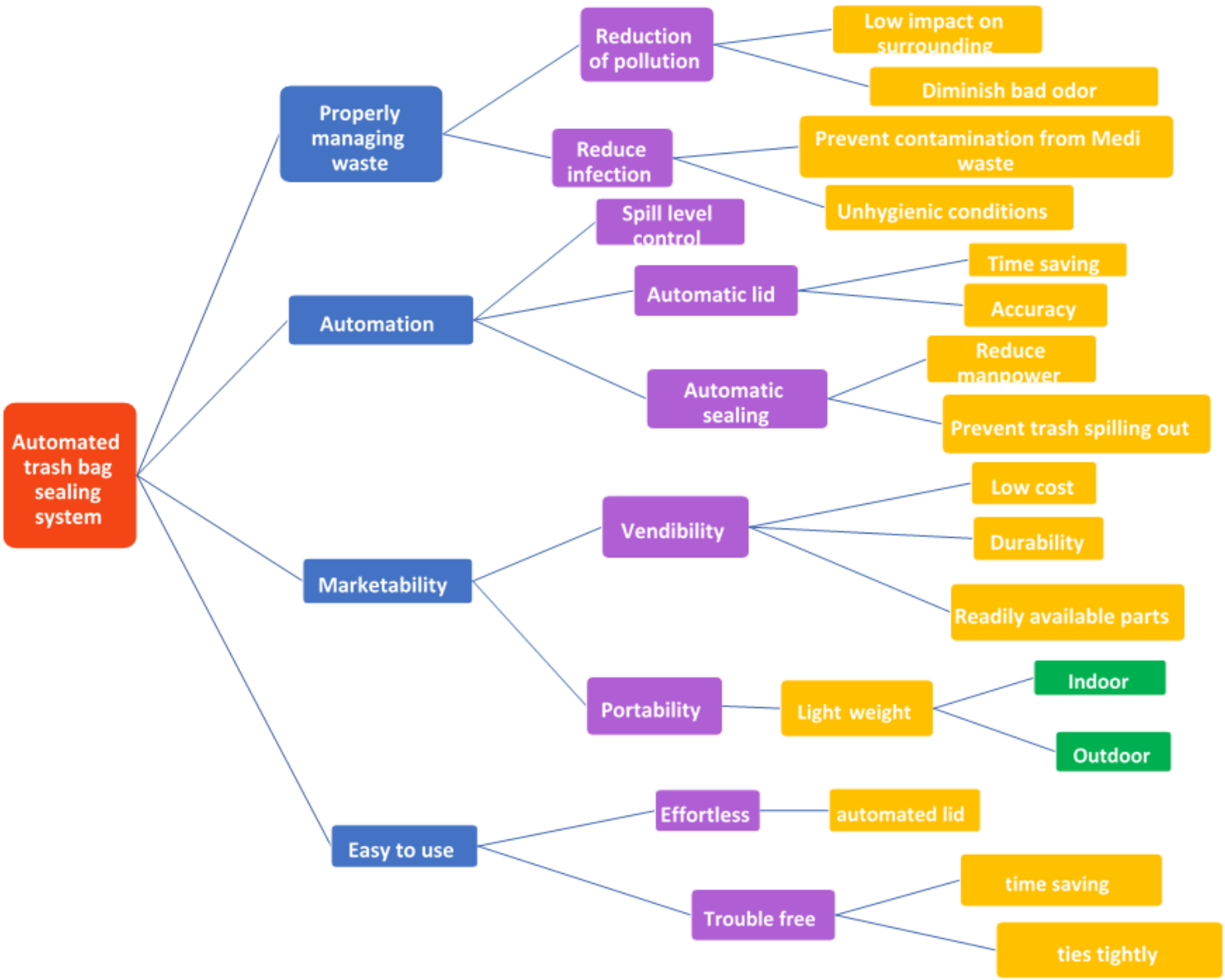


Figure 3 objective tree

Objective, Constraints, Limitations Analysis

Table 2 objective, constraints analysis

Objective	Constraints	Limitations
Time saving (automated lid)	• Low quality sensor	• Low accuracy
Automation (automated lid, automatic level measure, automatic zip tying)	• Government rules and regulations	Low budget Unable to find parts
Properly managing waste (automated lid, rubber seal, automatic level measure)	• Government tax	• Unable to find parts
Reduction of bad odor (Rubber seal, automated lid)	• Low quality rubber seals	• rubber seal damaging in a period due to excessive use
Spill level controlling (automatic level measure, automatic zip tying)	• Negligence of people	• Cannot be placed practically everywhere
Easy to service	• Lack of skill labors	• Lack of technical knowledge
Easy to use (readily available parts)	Low quality and low capacity in the battery Low quality of a zip tie	Have to charge the battery frequently Zip tie can break The polythene bag may tear
Easy to assemble/ replace	• Relatively expensive	• Unable to find parts
Marketability	• Competitors	• Shrinking the customer base

Intended objective

1.Waste should manage properly

- Should reduce pollution
  - Low impact on surrounding
    - Increase garbage capacity of a dustbin
  - Diminish bad odor

- Should reduce getting infected
  - Prevent contamination from Medi waste
    - Infectious waste
  - Provide hygienic conditions

2.Should be automated

- Spill level should be measured

- Lid should work automatically
  - Time saving
  - Accuracy
    - Specific angle and distance to detect a person by a sensor

  - Trash bag should seal automatically
    - Prevent trash spilling out

3.Should be marketable

- Should be portable
  - Should be light weight
    - Useful for indoors
    - Useful for outdoors

4.Should be easy to use

Low impact on surrounding

Overflowing waste bins are ideal breeding ground for breeding for bacteria, insects, besides and other animals that thrive from garbage in and around the dustbin include rats, stray cats, and dogs. And sometimes stray dogs and cats drag the litter and dump them in everywhere. Nowadays we can see open lid trash bins in many public places, and they are overflowing when the trash bins are full. It adversely affects the environment. As a solution to this problem, we choose 1200 litters sized dustbin. But the limitation we have is not produce that size and constraint is, not available that size in the market. By concerning this fact, we are going to increase the garbage capacity of the dustbin. It solves the problem cause by garbage overflow, and it reduces the amount of unwanted waste in the environment.

Diminish bad odor

Overflowing waste cause air pollution resulting various respiratory diseases and other adverse health effects as contaminants are absorbed from lungs into other parts of the body. To solve this, we are planning to seal the dustbin with a rubber seal. But due to our low budget we must use a low-quality rubber seal, resulting a reduce our initially predicted durability from three years (3) to one (1) year.

Prevent contamination from Medi waste

Improper disposal of Medi waste can lead to infections. These infections can be transmitted even by even touching Medi waste. There 3 main types of Medi waste. Such as

- Infectious waste – waste suspected to contain pathogens and other viruses poses a risk of disease transmission.
- Chemical waste – waste containing chemical substances ex: - lab reagents disinfectants that are expired or no longer needed pose a threat.
- Sharp's waste – used or unused sharps ex: - knives, syringes, blades and broken glasses can transmit diseases.

But due to several laws and regulations and our limited knowledge of dealing with above mentioned chemical waste and sharp's waste, we decided to focus on infectious waste.

Provide hygienic conditions

Odor is almost synonymous with government hospitals. Waste materials strewn all around crowded wards and waiting rooms are grim reminder of unhygienic condition of our health instructions.

Spill level should be measured

Overflowing garbage when its full is a major problem to the waste management. We can find a solution to this problem by knowing the maximum capacity of the trash bin and stop filling garbage after coming to that level. So, what we are going to do as a solution for this problem is, to detect the amount of garbage reaches the maximum level by using a sensor. But negligence of people is a limitation and unable to place the dustbin everywhere is a constraint. So, we hope to solve this by raising the public awareness as much as we can.

Time saving

We currently have trash bins that can be manually operated by hand or foot. We must spend extra time to do these things and it is difficult to do them manually. Therefore, we must use several sensors for time saving. But we have a constraint that budget is limited. According to our low budget we must buy low quality sensors and in that case accuracy of the sensor signals may be low.

Accuracy

Sensor with high accuracy precision help the dustbin work at any given time and with any situation. Accuracy is the most important specification while using indoor and outdoor and working to people with different heights without any errors. High accurate sensor can detect 2 cm -400 cm and has a coverage angle of 15 degrees. But due to our low budget using a high accurate sensor is not possible. Using a low-quality sensor will reduce accurately detecting distance and covering angle. As we suggested 180-degree coverage earlier it is not possible. Therefore, we decided to use a single sensor which can work a person is detected from one direction. In the metrics the mentioned accuracy of 90% will reduce accordingly due to the sensor selection.

Prevent trash spilling out

When the leakage from container is a major problem faced near trash bin. The main case is poorly tied trash bag and weakly tied knot. Also poorly tied trash bag will cause trash spill in the truck. This can be solved by using a zip tie that can seal the trash bag automatically. When researching about this solution we have identified that the zip ties imported to Sri Lanka are from China and lacks the quality and resulting zip tie to break when tightening. And this can be solved by using extra heavy duty cable ties with 15 inches and that can handle 250 LB

Portability

Portability and light weight are major factors when choosing a smart dustbin presently. And according to the changes in the market, competitors also make their smart dustbins lighter and user friendly resulting a relative shrink in our customer base due to our dustbins being heavy relatively.

In the metrics, the mentioned proposed weight should be reduced to adopt to the present market decreasing a final weight of dustbin from 3kg to 1kg.

Justifications

Easy to service and easy to assemble

Although our objective is to design a dustbin that is easy for people to service, by considering the declining technical knowledge and skill labor of the people, we decide to remove that objective (easy to service). As well as we removed the objective easy to assemble / replace because it is difficult for people to find the parts needed for the maintenance and they are relatively expensive.

We think the product we offer may cause more inconvenience to people in the future.

Intended objective tree

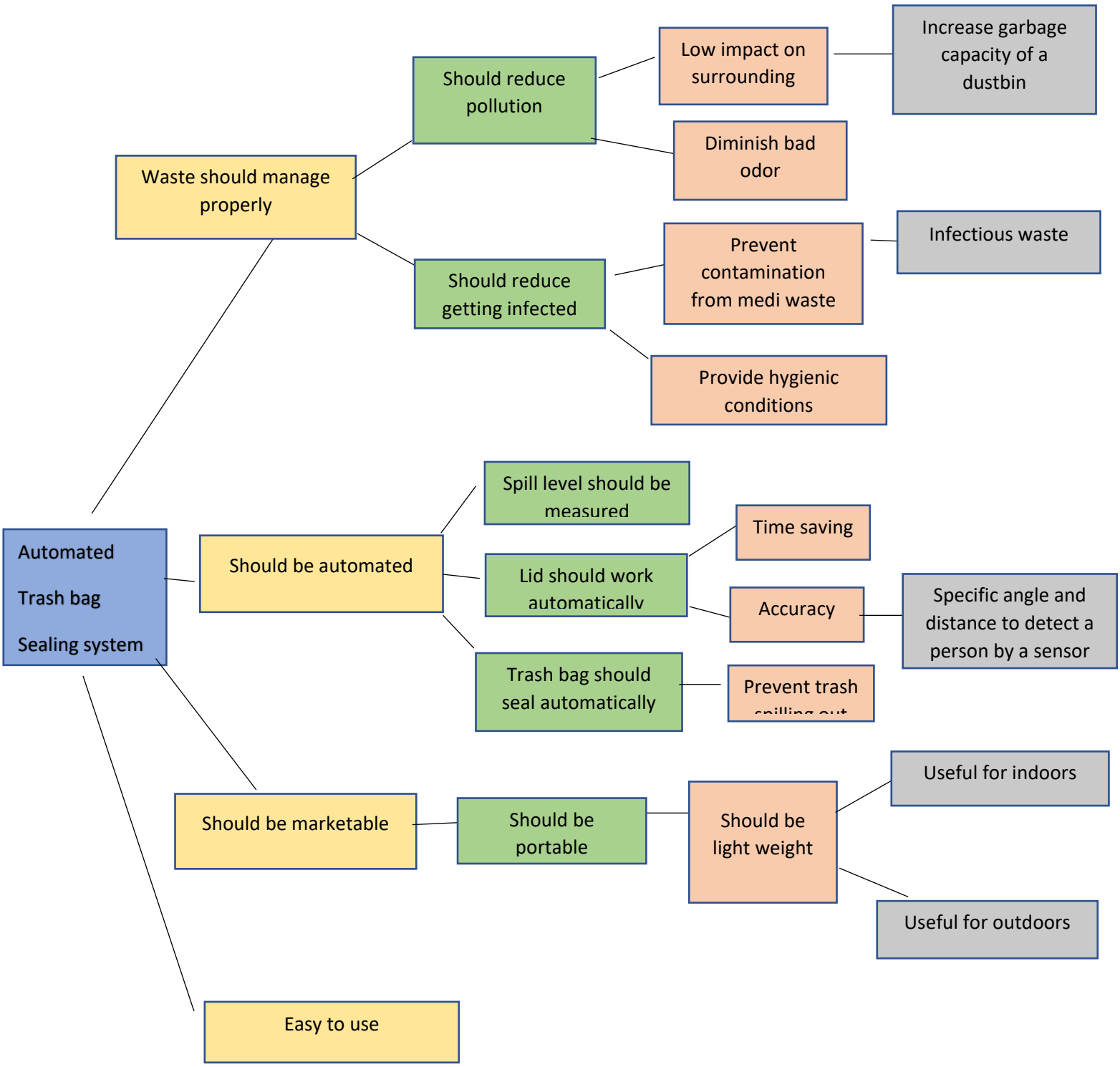


Figure 4 intended objective tree

Redefined Problem Statement

In the present days garbage has become a significant problem due to the increase of population. Many countries in the world face to this problem. Many people throw away garbage without any responsibility, carelessly or without any hesitation. Nowadays, people have become selfish and unwilling to throw away trash appropriately. It is common to see people discard trash out of everywhere. Carelessness has also made people just throw rubbish in anywhere without even thinking about it. And we can find garbage bins overflowing at various public places. So that breeding various animals near the trash bins and it creates unhygienic surroundings, lousy odor which leads to the spread of deadly diseases and human illness. Smart dustbins help to create a cleaner, safer, more hygienic environment and enhanced operational efficiency while reducing management cost, resources, and roadsides emissions. The smart bin is ideal for busy locations such as campuses, airports etc. And nowadays dustbins are usually used in hospitals.

According to statistical data, “Sri Lanka generates 7000 MT of solid waste per day with the western province accounting for nearly 60% of waste generation. Each person generates an average of 1-0.4 kg of waste per day. According to the Waste Management Authority and the Central Environmental Authority, only half of the waste generated is collected.”

Presently there are several available solutions for dustbins such as swing dustbins, manually operated dustbins (in which lid must be opened by hand), dustbins which opens with the help of leg also smart dustbins. All of them have their own draw backs. Currently manually operated dustbins are not a suitable choice for the elderly who are suffering from skeletal and neurological disorders. This was also experienced by a grandparent of our group member who suffered from arthritis and found it difficult to operate dustbins manually. Smart dustbin is another solution available these days. But the prices and lack of several features and being highly technical, reason people not to choose those. Another problem we have identify is the fact that trash bags must be tied down manually which result in spreading diseases to the cleaning staff. And also if the tie knot is not secure it can lead to trash spilling out. Also currently trash bin has a lid that does not seal completely resulting a bad odor spreading near the trash bin leading to unhygienic conditions. Traditional trash bins also have a higher capability of overflowing if unattended for a longer period by the cleaning staff. This can be seen in almost every public trash bins these days. When considering above identified problems in the current existing dustbins we propose our own dustbins addresses each identified problem.

By considering all these facts we need develop a trash bin for solving these problems. Firstly, we should manage waste properly. Therefore, we can reduce the impact on surrounding and diminish the bad odor. Nowadays we can see open lid trash bins in many public places, and they are overflowing when the trash bins are full. This is a major problem to the environmental impurity, and it causes for breeding various animals like insects, rats etc. And sometimes stray dogs and cats drag the litter and dump them in everywhere. It adversely affects the environment. By concerning this fact, we are going to increase the garbage capacity of the dustbin. Not only that we are introducing an automatic sealing system to diminish bad odor. From that, we can minimize the risk of human health because bad odor of the garbage causes various respiratory diseases and other adverse health effects. Medi waste can also be considered as another way in which people can be infected. There are three main types of Medi waste. They are infectious waste, chemical waste and sharp’s waste. But under the undergraduate level constraints and limitations we can provide a solution only to the infectious waste. Disposal of chemical waste and sharp’s waste are dangerous processes. There is constraint that we do not currently have the knowledge of how to dispose the chemical waste. And also, we have to use a different process for the disposal of sharp waste due to the sharpness of the equipment’s. But even though the skill labors are available from outside for this, there

is a constraint that we can't do it under the limited budget. So we removed create solutions for those chemical waste and sharp's waste.

Garbage bins spilling out is a major cause of many problems. If we can know the amount of garbage in the bin before it overflows, it will make our day easier. Therefore, we thought to add a sensor to measure the garbage level when it filled to the limit. But due to the carelessness and laziness of people, even though the garbage bins are filled to the maximum level, people still dump trash without any hesitation. As the designing team we could not get any action for this matter.

In this project we are looking forward to making a dustbin which has a lid with an automatic opening and closing. The bin will automatically open when you approach with trash. We will include a sensor to identify a man who is coming closer near the bin and then it will open, after the man moves away the lid will automatically close. If we could use an ultrasonic sensor, we could make this approach more successful. If this project becomes a success people could save some sort of time while opening and closing bins. Because of the budget limitation we must use a low-quality ultrasonic sensor to this product.

There are smart dustbins, there are already light weight dustbins in the market. So this competitors are the constraints we have and the weight of the dustbin is about 3kg, so we have to create less than 3 kg weight to conflict with the current market, and the limitation is shrinking the customer base. So, we have to create best output according to the customer need.

When the leakage from container is a major problem faced near trash bin. The main case is poorly tied trash bag and weakly tied knot. Also, poorly tied trash bag will cause trash spill in the truck. This can be solved by using a zip tie that can seal the trash bag automatically. When researching about this solution we have identified that the zip ties imported to Sri Lanka are from China and lacks the quality and resulting zip tie to break when tightening. And this can be solved by using extra heavy-duty cable ties with 15 inches and that can handle 250 LB.

Current available automated solutions average prices range in between $50 to $500. So, we are planning to develop a smart dustbin addressing the above identified weaknesses within the budget 15,000 LKR. So, the smart bin designing by us is an innovative solution to the waste management problem that our nation faces and we believe this smart communal bin to be answer of some of the questions posed by our garbage collection system.

Requirements

Identified requirements

1. Market Requirement
2. Functional Requirement
3. Technical requirement
4. Performance Requirement
5. Quality Requirement
6. Software Requirement
7. Hardware Requirement

Categorized requirements

1. Market Requirement
    - Easy control
    - Attractive appearance
    - User friendly
    - Affordability

2. Functional Requirement
    - Taking sensor reading from the sensor circuit

3. Technical requirement
    - Maintenance of the trash bin
    - Usability
    - Sustainability

4. Performance Requirement
    - Coverage angle of 30 degrees by using ultrasonic sensor
    - IR sensor has an angle of coverage 5 degrees
    - Battery level of the trash bin is displayed by 3 led bulbs placed in the control panel

5. Quality Requirement
    - Quality of the trash bin
    - Quality of the sensors
    - Quality of the stepper and servo motors

6. Software Requirement
    - Arduino board

7. Hardware Requirement
    - Ultrasonic sensor HY- SRF05

- 12V 3000ma Battery
- Infrared sensor
- Servo motor SG90
- Stepper motor

Objective metric

Table 3 metrics

Objective	**Metrics**	**Targets**
Time saving	Time (Time duration for tying a zip tie)	Less than 10 seconds
Diminish bad odor (Sealing the bin with a rubber seal)	Durability of the rubber (time span)	3 years
Automation	Cost (For parts)	10,000LKR
portability	Weight of dustbin	Less than 3 kg
Accuracy (Automatic lid)	Customer feedback	Success rate above 90%

Specification

Specification list

1. Infrared obstacle avoidance sensor module adjustable (YL – 63)

    • Working voltage: DC 3.3V-5V
    • Working current: ≥ 20mA
    • Operating temperature: -10°C to +50°C
    • detection distance :2-40cm
    • IO Interface: 4-wire interfaces (- / + / S / EN)
    • Output signal: TTL level (low level there is an obstacle, no obstacle high)
    • Adjustment: adjust multi-turn resistance
    • Effective angle: 35 °
    •Size: 28mm × 23mm
    • Weight Size: 9g

2. Servo motor SG90

    •Weight: 9 g
    • Dimension: 22.2 x 11.8 x 31 mm approx.
    • Stall torque: 1.8 kgf·cm
    • Operating speed: 0.1 s/60 degree
    • Operating voltage: 4.8 V (~5V)
    • Dead band width: 10 µs
    • Temperature range: 0 ºC – 55 ºC

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is all the way to the left. ms pulse) is all the way to the right, ""-90" (~1ms pulse) is all the way to the left.

3. Ultrasonic sensor HY -SRF05

    •Trigger Pin Format:10 us digital pulse
    •Sound Frequency:40 kHz
    •Echo Pin Output:0-Vcc
    •Echo Pin Format: output is DIGITAL and directly proportional with range. See our conversion formula above
    .
    •Measurement Range:2cm to ~4.5m
    •Measurement Resolution:0.3cm
    •Measurement Angle: up to 15 degree
    •Measurement Rate:40 Hz
    •Supply Voltage:4.5V to 5.5V
    •Supply Current:10 to 40mA

- Connector: standard 5-pin male connector which can plug directly into breadboards.
- Static current: less than 2mA
- Detection distance:2cm-450cm

4. NEMA 17 17HS4023 stepper motor

- Shaft diameter 5mm
- Shaft Length 21mm
- 4 wires / 2 Phase
- Voltage: 12 V
- Current: 0.7 A / Phase
- Resistance: 4.0 ± 10% Ω / Phase
- Inductance: 3.2 ± 20% mH / Phase
- Holding Torque: 14 N. Cm
- Insulation Class: B
- Step Angle: 1.8 ± 5% / Step
- Item Size: 42 * 42 * 23mm

5. Easy Driver A3967 V44 stepper motor

- Design - SIMATIC ET 200®S plastic housing
- Dimensions (W x H x D) - 30 x 81 x 50 mm
- Weight - 80 g
- Mounting position - Optional
- Mounting - Plug-in in SIMATIC ET 200®S terminal modules

6. 12V 3000mA Battery

- Output voltage – 12V
- Capacity -- 3000mAh
- weight - 158g
- length. - 80mm
- width. - 65mm
- Thickness. - 12mm

7. Passive buzzer Electromagnetic 3V 16Ohm 2KHZ

- Resistance: 16ohm
- Voltage: 3V 5V 9V 12V AC 2KHz

8. Arduino Uno R3 AT mega 328p
   - Operating voltage: 2.7V to 5.5V for ATmega328P

- ●Temperature range: Automotive temperature range: –40°C to +125°C
- ●Speed grade:
  - ○ 0 to 8MHz at 2.7 to 5.5V (automotive temperature range: –40°C to +125°C)
  - ○ 0 to 16MHz at 4.5 to 5.5V (automotive temperature range: –40°C to +125°C)
- ●Low power consumption:
  - ○Active mode: 1.5mA at 3V - 4MHz
  - ○Power-down mode: 1μA at 3V

Subcategories of specifications

Performance specification

1. Detecting a person
   - Infrared obstacle avoidance sensor module adjustable (YL – 63)
     - ■ can detects the object between 2 – 30 cm
     - ■ Detection angle 35 °

2. Measuring the trash level
   - Ultrasonic sensor HY -SRF05
     - ■ most widely used range is 40 to 70 kHz.

(Sensor sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.)

3. Lid motor mechanism
   - Servo motor SG90
     - ■ servo motor that can rotate approximately 180°

4. Motor mechanism of sealing the trash bag
   - NEMA 17 17HS4023 stepper motor
     - ■ Step Angle(degrees): 1.8

5. Operating of microcontroller
   - Arduino Uno R3 AT mega 328p
     - ■ Operating voltage: 2.7V to 5.5V for ATmega328P

Tests to confirm achievements of objectives/metrics

Durability of rubber

- rubber is tested in many ways by applying different tensions, compressions and adhesion test and if the rubber seal achieves sufficient strength, it will be used as to seal the trash bin to prevent unwanted odors releasing to the environment

Arduino circuits and easy drive circuits

– Simulation is carried out using the proteus software before attaching it to the dustbin, to test the circuit accuracy

Sensors

– Sensors like the ultrasonic sensor and the IR sensor which has been used are tested in different environmental conditions, indoors and outdoors as the dustbin should work at direct locations

Stepper motor and the servo motor

– both of these Dc motors are tested to make sure the DC motors rotor can turn with no impediments.

Power consumption

– Testing is carried out by considering the power consumption of each component in their highest and their lowest voltage requirements.

Zip tie

– the zip ties used to seal the trash bag should be strong indoor to keep the trash bag sealed this is tested by applying a specific force to determine their breaking point

Mind map

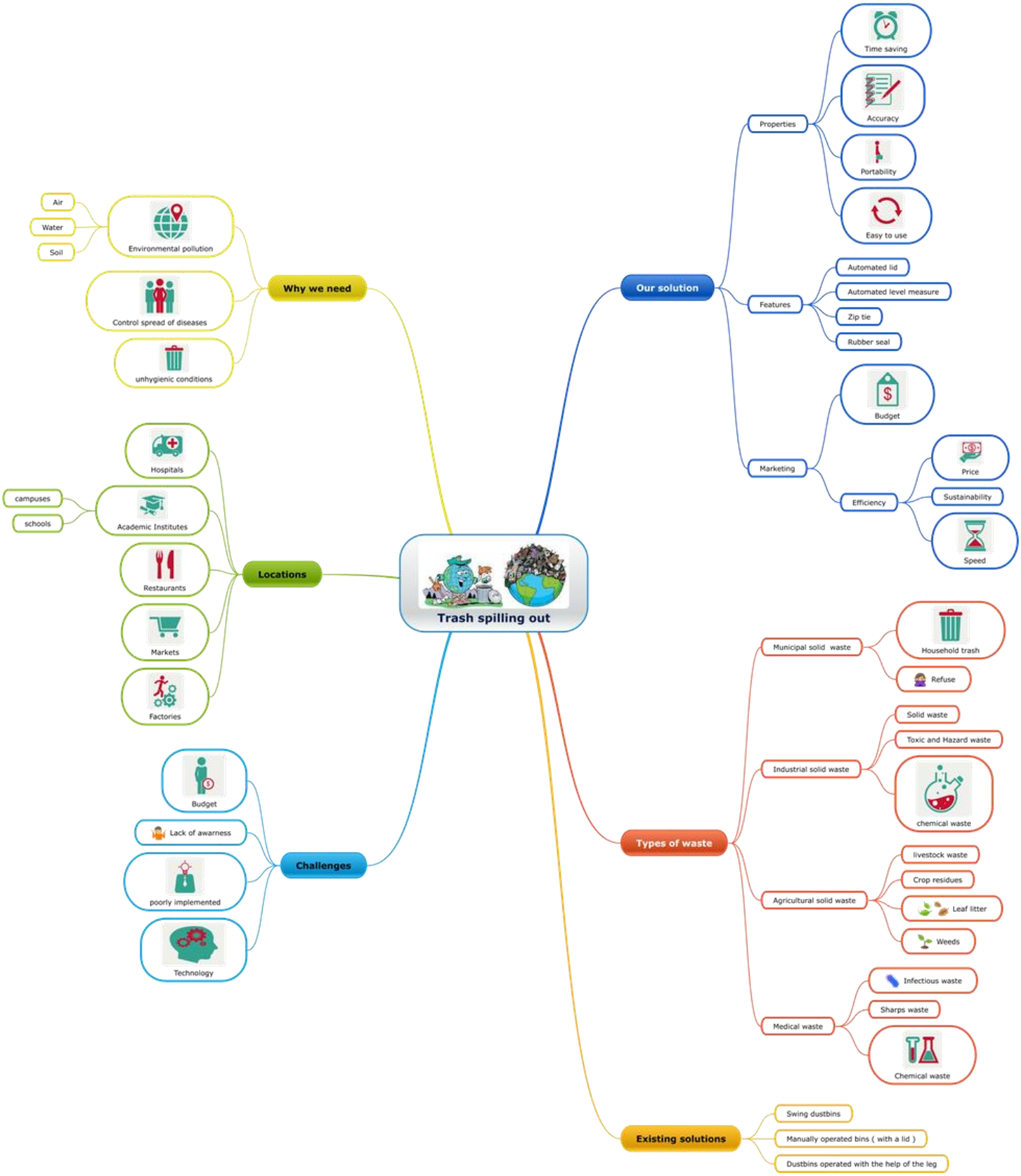


Figure 5 mind map

Ishikawa Diagrams

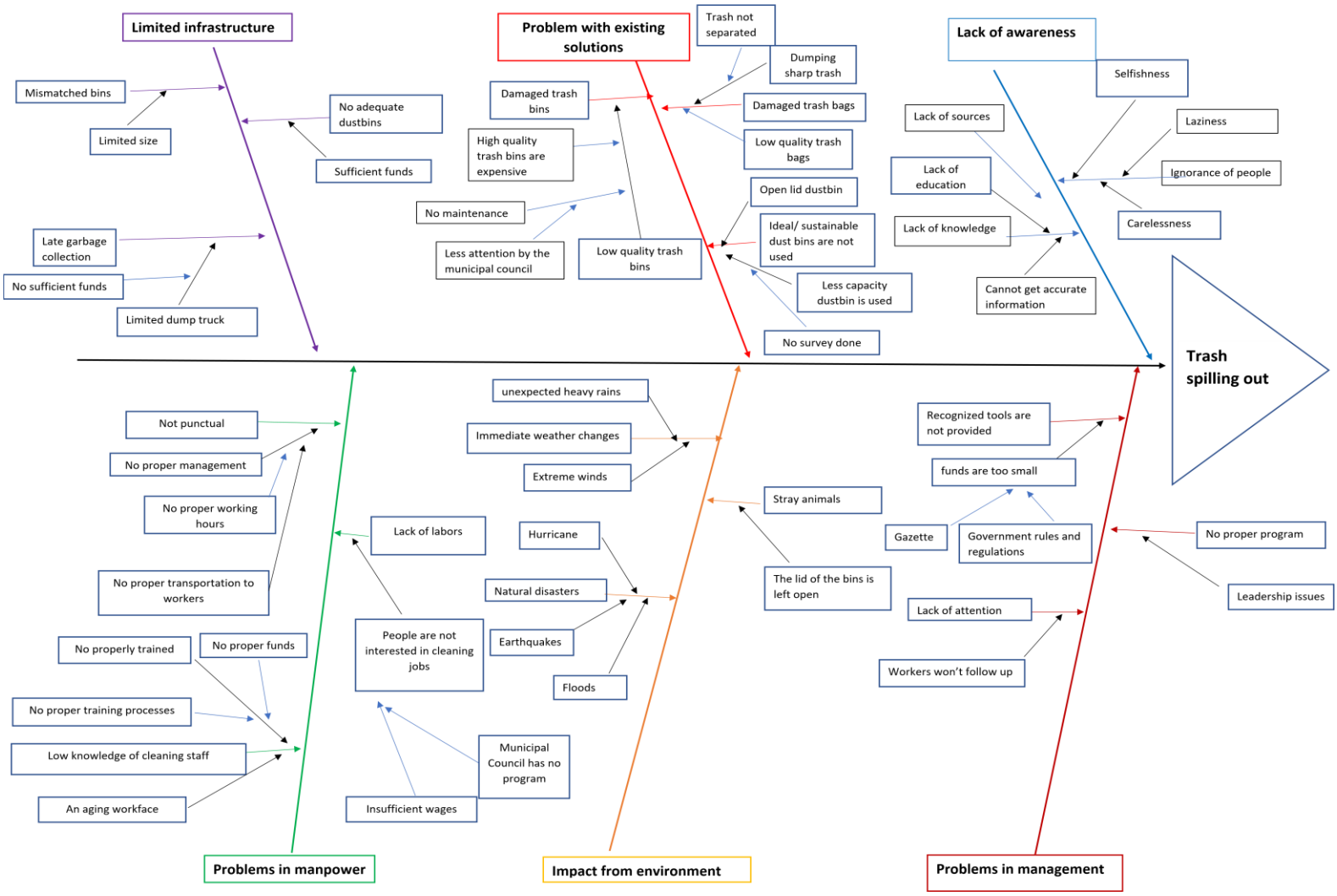


Figure 6 Ishikawa diagram

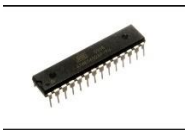
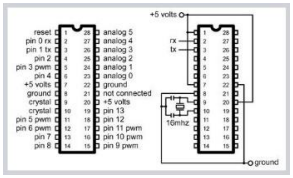
Objective alternatives with physical principle, working principle and abstract embodiment

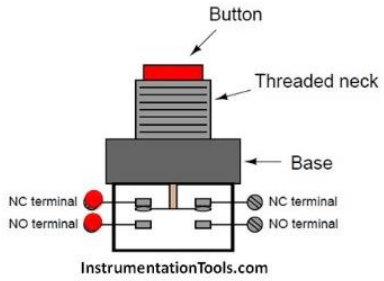
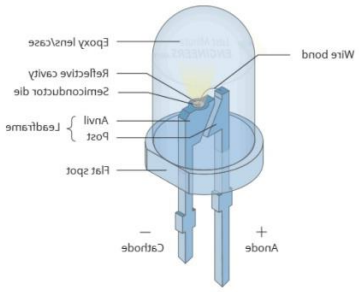
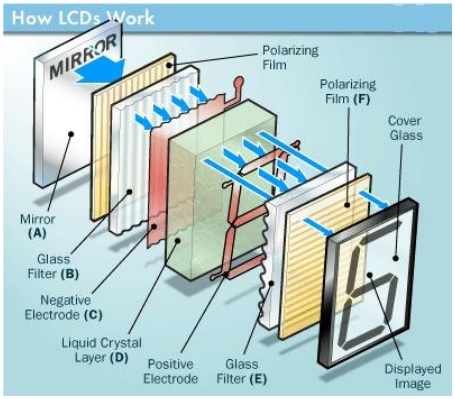
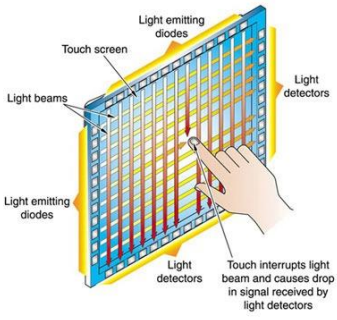
Table 4 physical principle

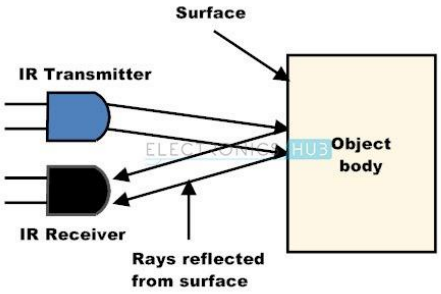
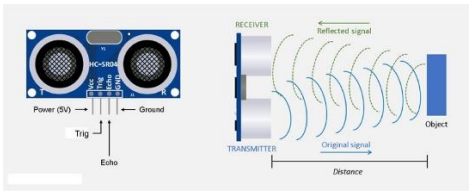
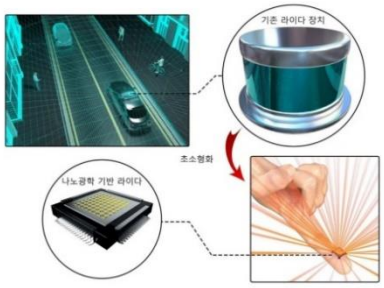
Sub function	**Alternative**	**Physical principle**
Operating of microcontroller	Arduino UNO board	Digital signal conversion with C+ programming
	Arduino mega	
	Arduino Leonardo	
Displaying data and controlling device	LED – Button system	Electro-luminance
	LCD Display	An electrical current is applying to the liquid crystal molecules, the molecule tends to untwist
	Touch screen	The body electrical induction
Detecting a person	Infrared sensor	Reflected light waves
	Ultra-sonic sensor	Emission and reflection high frequency ultrasonic waves
	LiDAR sensor	Emission and reflection of light waves from a laser

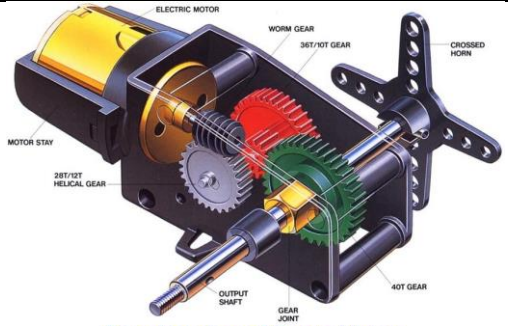
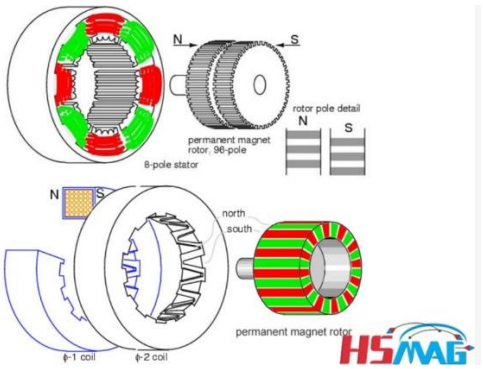
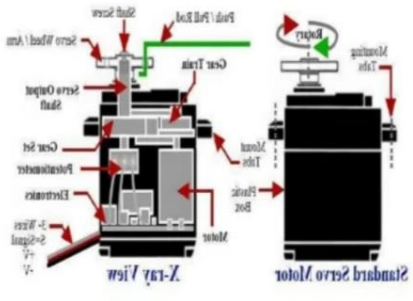
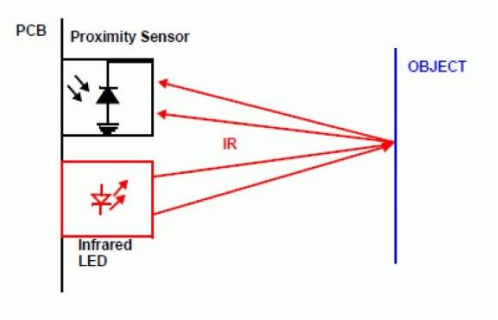
Lid motor mechanism	Servo motor	PWM principle (Pulse Width Modulation) (Its angle of rotation is controlled by the duration of pulse applied to its control PIN.)
	Stepper motor	By energizing one or more of the stator phases, a magnetic field is generated by the current flowing in the coil and the rotor aligns with this field
	AC standard servo motor	PWM principle (Pulse Width Modulation)
Measuring the trash level	Ultra-sonic sensor	Emission and reflection high frequency ultrasonic waves
	Infrared sensor	Reflected light waves
	Position sensor	Light is transmitted from an emitter and sent over to a receiver at the other end of the sensor
Motor mechanism of sealing the trash bag	Stepper motor	By energizing one or more of the stator phases, a magnetic field is generated by the current flowing in the coil and the rotor aligns with this field
	Hydraulic system	Pascal law
	Servo motor	PWM principle

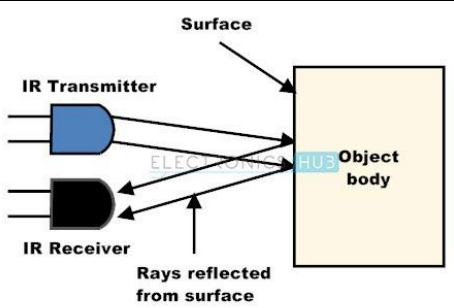
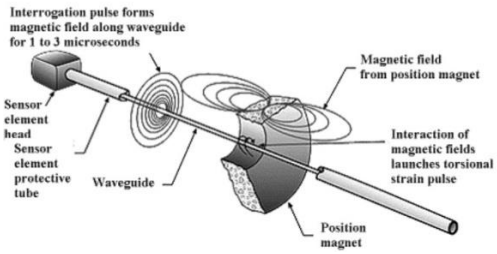
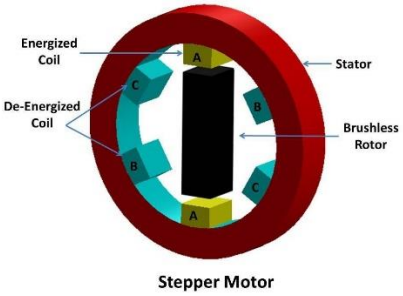
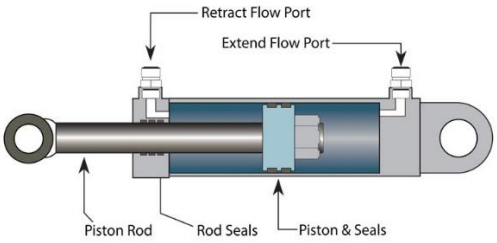
Table 5 working principle and abstract embodiment

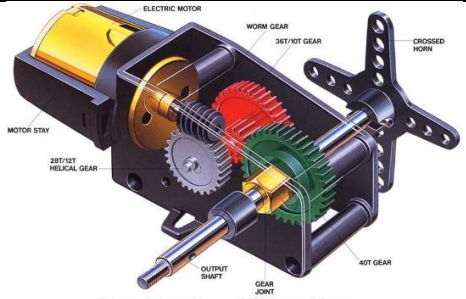
Sub function	Alternatives	Working principles	Abstract embodiment
Operating of microcontroller	Arduino UNO board	Microcontroller runs the commands stored in flash memory, interacting with GPIO, or calculating something. Microcontrollers may be programmed to emulate the functions of digital logic gates in addition to wide variety of combinational and multivibrator functions.	ATmega328  
	Arduino Mega		ATmega2560 
	Arduino Leonardo		ATmega32u4 
Displaying data and controlling device	LED button system	An emitting diode (LED) is a semiconductor light source that emits light as current flows through it. The electrons in the semiconductor reconnect with the electron holes and release energy in the form of photons.	3 LEDs with 2 buttons

			 
	LCD display	The liquid crystal display screen works on the principle of blocking light rather than emitting light. LCDs require a backlight as they do not emit light them.	Liquid crystal 
	Touch screen	When an object, such as a fingertip or a stylus tip, presses down on to the outer surface, the two layers touch to become connected at the point. The panel then behaves as a pair of voltage dividers, one axis at a time. By rapidly switching between each layer, the position of pressure on the screen can be detected.	Infrared touch screen 

Detecting a person	Infrared sensor	Active infrared sensors both emit and detect infrared radiation. Active IR sensors have two parts: a light emitting diode (LED) and a receiver. When an object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver.	IR sensor 
	Ultrasonic sensor	Ultrasonic sensors emit short, high frequency sound pulses at regular intervals. If the strike an object, then they are reflected as eco signals to the sensor, which itself computes the distance to the target based on the time span between emitting the signal and receiving the eco.	Ultrasonic sensor 
	LiDAR sensor	A typical LiDAR sensor emits pulsed light waves into the surrounding environment. These pulses bounce off surrounding objects and return to the sensor. The sensor uses the time it took for each pulse to return to the sensor to calculate the distance it traveled.	LiDAR sensor 
Lid motor mechanism	Servo motor	Servo motor works on the PWM principle, which means its angle of rotation is controlled by the duration of pulse applied to its control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor and some gears.	SG90, MG995, MG90

			 Construction of Servo Motor
	Stepper motor	Stepper motors have a stationary part (the stator) and a moving part (the rotor). On the stator, there are teeth on which coils are wired, while the rotor is either a permanent magnet or a variable reluctance iron core. We will dive deeper into the different rotor structure later	Permanent magnet stepper 
	AC standard servo motor	Servo motor angle of rotation is controlled by the duration of pulse applied to its control PIN. Basically, servo motor is made up of DC motor which is control by a variable resistor (potentiometer) and some gears.	Positional rotation AC servo motor 
Measuring the trash level	Ultrasonic sensor	Ultrasonic sensors emit short, high frequency sound pulses at regular intervals. If the strike an object, then they are reflected as eco signals to the sensor, which itself computes the distance to the target based on the time span between emitting the signal and receiving the eco.	Ultrasonic proximity sensor 
	Infrared sensor	Active infrared sensors both emit and detect infrared radiation. Active IR sensors have two parts: a light emitting diode (LED) and a receiver. When an object comes close to the sensor, the infrared light	Active infrared sensor

		from the LED reflects off of the object and is detected by the receiver.	
	Position sensor	Potentiometric position sensor is operated based on the principle of resistive effect. A resistive track acts as a sensing element, and a wiper is attached to the body or part of the body whose displacement is to be measured. The movement of wiper changes the resistance of wiper changes the resistance between one end of the resistance between one end of the track and wiper.	Linear position sensor 
Motor mechanism of sealing the trash bag	Stepper motor	Stepper motors have a stationary part (the stator) and a moving part (the rotor). On the stator, there are teeth on which coils are wired, while the rotor is either a permanent magnet or a variable reluctance iron core. We will dive deeper into the different rotor structure later	Permanent magnet stepper 
	Hydraulic system	Hydraulic systems use the pump to push hydraulic through the system to create fluid power. The fluid passes through the valves and flows to the cylinder where the hydraulic energy converts back into mechanical energy. The valves help to direct the flow of the liquid and relieve pressure when needed.	Hydraulic cylinder 
	Servo motor	Servo motor works on the PWM principle, which means its angle of rotation is controlled by the duration of pulse applied to its control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor and some gears.	Dc servo motor

			 Construction of Servo Motor

User Interaction List

Table 6 user interaction list

User	Function	Process
Cleaning staff	Setup	Unbox package Read the user manual Assemble components Charge batteries Testing
	Daily use	Remove filled trash bag Charging Batteries Changing zip ties Changing trash bags
	Maintenance	Replace malfunctioning components Clean the trash bin Oiling the Tires
	Disposal	Disassemble the trash bin Separate into trash categories Dispose of according to rules and regulations
Patients / Hospital staff	Daily use	Getting closer to the trash bin Dumping trash

Functional decomposition diagram

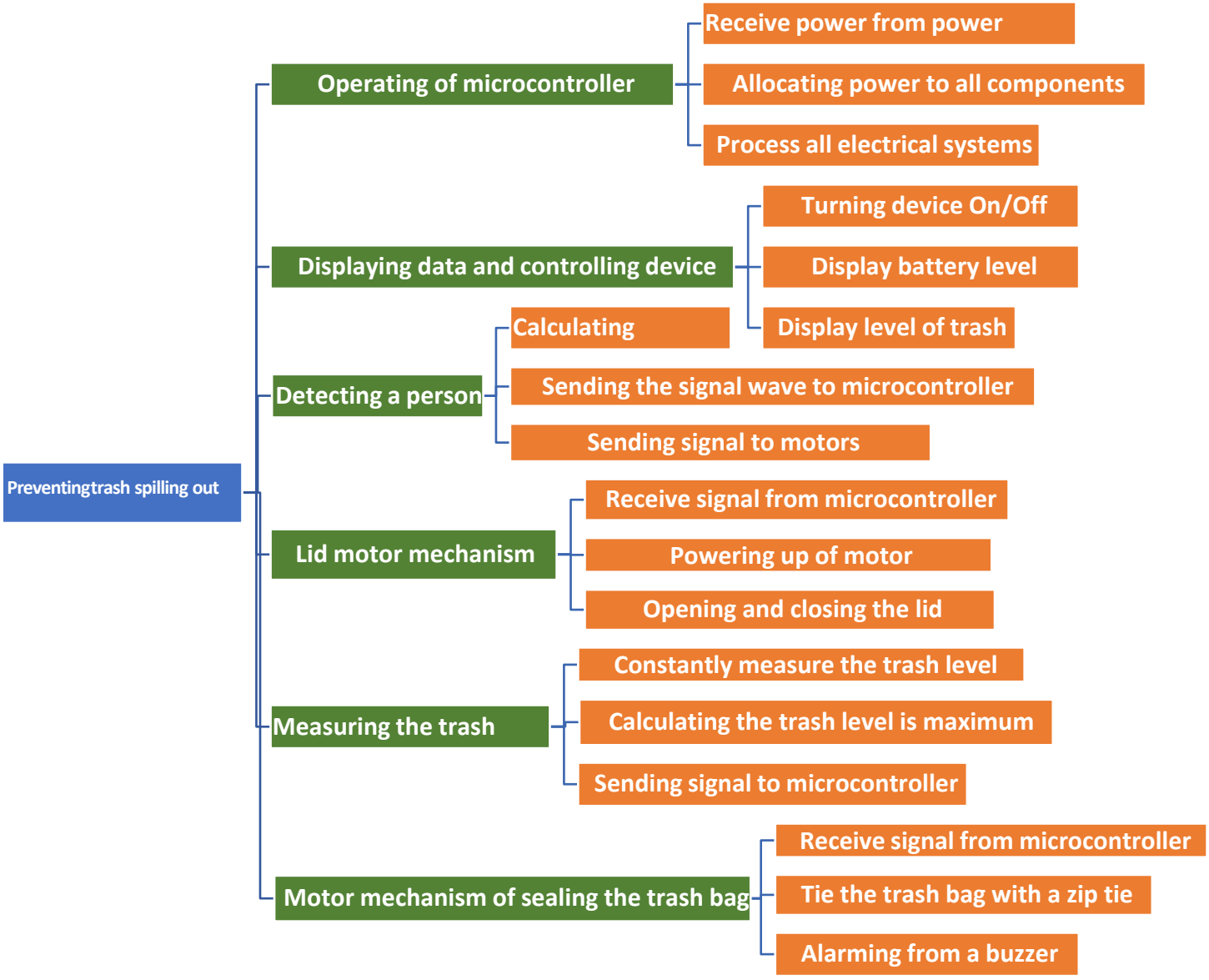


Figure 7 functional decomposition diagram

Sub-functions and Relevant Alternatives

Operating of microcontroller

This unit receives power from power supply unit. It allocates power to all components and process all electrical systems.

Displaying data and controlling device

The device can turn on and off when needed. The Power supply unit delivers the necessary power to the components when it is required. The battery level is shown by 3 LEDs rather than a display. This saves battery. There is a button to use the zip tie and seal the trash bag if needed to the cleaning staff.

Detecting a person

We use a sensor to detect a person who moves near the trash bin. After detecting this sends the signals to the microcontroller. It sends signals to the motors.

Lid motor mechanism

After receiving signals from microcontroller, it sends power to the motors to open and close the automatic lid. The motors will stop working when the lid touches the switch which is placed on top of the trash bin. This prevents the motors overspinning and ensures a tight fit between the trash bin and the lid.

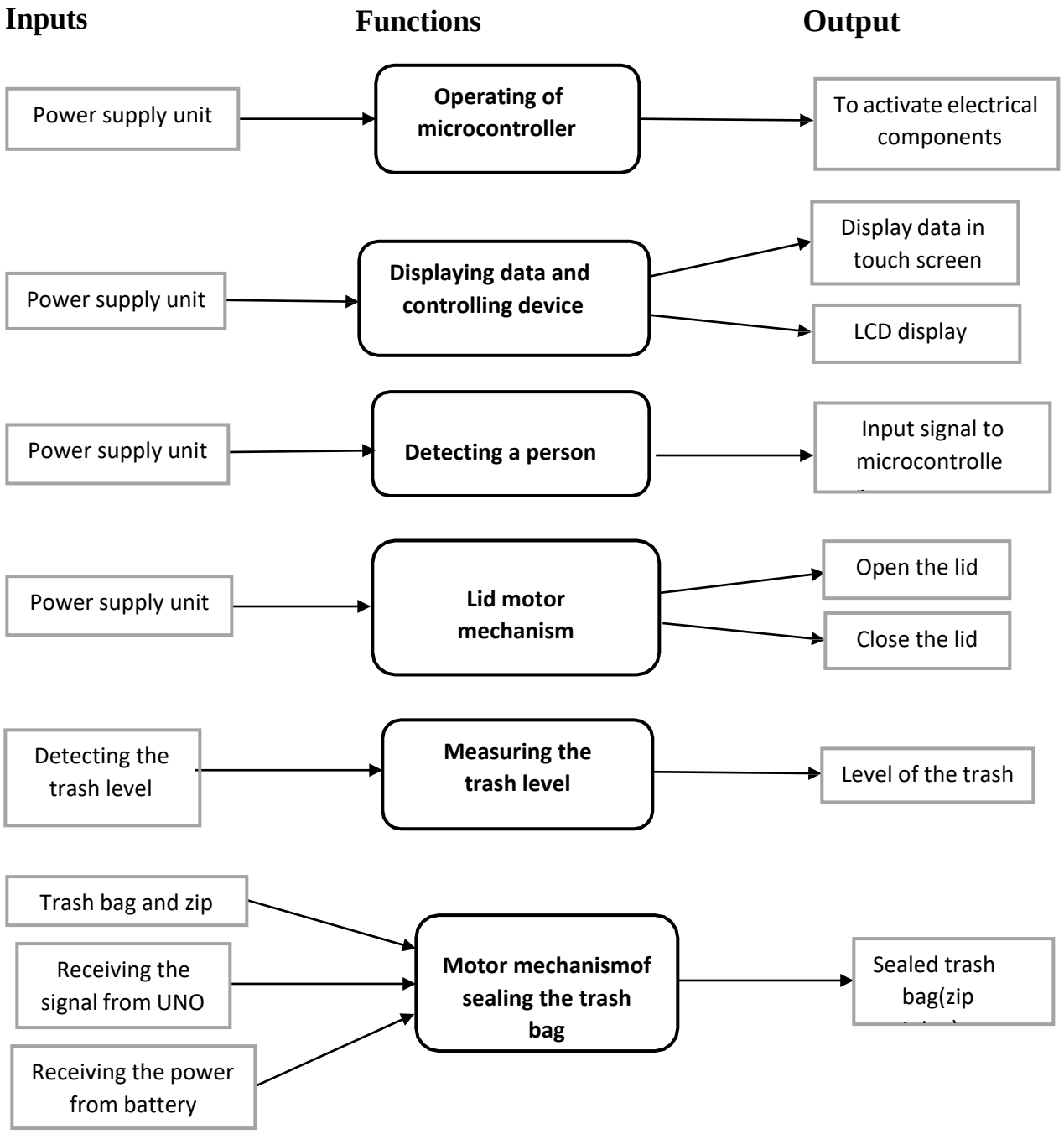
Measuring the trash level

Constantly measure the level by a sensor to detect inside the bin. This sensor Calculates the trash level, and when it is maximum this sends a signal to microcontroller when filled.

Motor mechanism sealing the trash bag

After receiving the signals from Uno the motor receives power from the power source. When the motor turns the zip tie runs through the gear rods. This system works when the cleaning staff place a zip tie prior in between the two gear rods which is connected to a motor. When the process is done automatically the buzzer will alarm.

Input/Function/Output relationship of each sub function



Alternatives for each sub function

Table 7 alternatives

Sub functions	Alternatives		
	1	2	3
Operating of microcontroller	Arduino UNO board	Arduino Mega	Arduino Leonardo
Displaying data and controlling device	LED – Button system	LCD Display	Touch screen
Detecting a person	IR sensor	Ultrasonic sensor	LiDAR sensor
Lid motor mechanism	Servo motor	Stepper motor	AC standard servomotor

Measuring the trashlevel	Ultrasonic sensor	Infrared sensor	Position sensor
Motor mechanism ofsealing the trash bag	Stepper motor	Hydraulic system	Servo motor

Weighted Rating Evaluation Method for Sub Functions

Table 8 rating table

Rating	Value
Unsatisfactory	0
Just tolerable	1
Adequate	2
Good	3
Very good	4

1. Operating of Microcontroller

Table 9 rating for micro controller

	Concept alternatives		
	Arduino Uno	Arduino Mega	Arduino Leonardo

Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Low cost	25	4	1.00	0	0	2	0.5
Low Power rating	20	4	0.8	1	0.2	3	0.6
High reliability	10	4	0.4	4	0.4	4	0.4
High efficiency	30	2	0.4	4	1.20	3	0.9
No of ports	15	2	0.3	4	0.9	3	0.45
	100	N/A	3	N/A	2.7	N/A	2.85

2.Displaying data and controlling device

Table 10 rating for controlling devices

		Concept alternatives					
		LED – BUTTON system		LCD Display		Touch screen	
Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Low cost	40	4	1.6	1	0.4	0	0
Low power rating	30	4	1.2	2	0.6	1	0.3
Reliability	20	4	0.8	3	0.6	2	0.2
Quality	10	4	0.4	3	0.3	3	0.3
	100	N/A	4	N/A	2.5	N/A	0.8

3. Detecting a person

Table 11 ratings for sensors

		Concept alternatives					
		Ultrasonic sensor		Infrared Radiation sensor		LiDAR sensor	
Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Accuracy	35	2	0.7	4	1.4	3	1.05
Range	25	1	0.25	4	1.0	2	0.5
Low cost	15	4	0.9	3	0.75	1	0.15
Efficiency	15	2	0.3	4	0.9	3	0.45
Low Power rating	10	2	0.2	4	0.4	1	0.1
	100	N/A	2.35	N/A	4.45	N/A	2.25

4.Lid motor mechanism

Table 12 ratings for motors

		Concept alternatives					
		Servo motor		Stepper motor		AC standard servo motor	
Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Low cost	40	4	1.6	2	0.8	1	0.4
Efficiency	20	3	0.6	0	0	4	0.8
Low Power rating	30	4	1.2	3	0.9	2	0.6
Reliability	20	4	0.8	4	0.8	4	0.8
	100	N/A	4,2	N/A	2.5	N/A	2.6

5. Measuring trash level

Table 13 rating for trash level measuring sensors

		Concept alternatives					
		Ultrasonic sensor		Infrared sensor		Position sensor	
Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Low cost	20	3	0.6	2	0.4	1	0.2
Accuracy	40	4	1.6	3	1.20	2	0.8
Power rating	15	3	0.45	2	0.3	1	0.15
High efficiency	25	3	0.75	3	0.75	3	0.75
	100	N/A	3.4	N/A	2.66	N/A	1.9

6.Motor mechanism of sealing the trash bag

Table 14 motor mechanism for sealing trash bag

		Concept alternatives					
		Stepper motor		Hydraulic system		Servo motor	
Criteria	Importance weight (%)	Ratings	Weighted rating	Rating	Weighted rating	Rating	Weighted rating
Accuracy	40	4	1.6	3	1.2	2	0.8
Low cost	30	3	0.9	0	0	4	1.2
Efficiency	15	3	0.45	0	0	4	0.6
Low Power rating	10	3	0.3	4	0.4	4	0.4
Reliability	5	3	0.15	4	0.2	1	0.05
	100	N/A	3.4	N/A	1,8	N/A	3.05

Systematic Combination & Selection of a Suitable Combination

Table 15 combinations

1.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR
2.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM
3.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR
4.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR
5.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM
6.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR
7.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR
8.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM
9.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	SERVO MOTOR	POSITION SENSOR	SERVO MOTOR
10.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR
11.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM
12.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	SERVO MOTOR
13.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	STEPPER MOTOR
14.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM
15.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	SERVO MOTOR
16.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	STEPPER MOTOR
17.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM
18.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	SERVO MOTOR
19.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR
20.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM
21.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR
22.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR
23.	ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM

24. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR	
25. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR	
26. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
27. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	SERVO MOTOR	
28. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
29. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
30. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	

31. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR
32. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM
33. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR
34. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR
35. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM
36. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	SERVO MOTOR
37. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR
38. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM
39. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	SERVO MOTOR
40. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	STEPPER MOTOR
41. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM
42. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	SERVO MOTOR
43. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	STEPPER MOTOR
44. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM
45. ARDUINO UNO BOARD	LED – BUTTON SYSTEM	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	SERVO MOTOR

46. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
47. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
48. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
49. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor
50. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system
51. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor
52. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor
53. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system
54. Arduino UNO board	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor
55. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor
56. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
57. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor
58. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor
59. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system
60. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Servo motor

61. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Stepper motor
62. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Hydraulic system
63. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Servo motor
64. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor
65. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system
66. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor
67. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor
68. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system
69. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor
70. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Stepper motor
71. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system
72. Arduino UNO board	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Servo motor
73. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
74. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
75. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
76. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor
77. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
78. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor

79. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor
80. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system
81. Arduino UNO board	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor
82. Arduino UNO board	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor
83. Arduino UNO board	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
84. Arduino UNO board	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Servo motor
85. Arduino UNO board	LCD Display	IR sensor	Servo motor	Infrared sensor	Stepper motor
86. Arduino UNO board	LCD Display	IR sensor	Servo motor	Infrared sensor	Hydraulic system
87. Arduino UNO board	LCD Display	IR sensor	Servo motor	Infrared sensor	Servo motor
88. Arduino UNO board	LCD Display	IR sensor	Servo motor	Position sensor	Stepper motor
89. Arduino UNO board	LCD Display	IR sensor	Servo motor	Position sensor	Hydraulic system
90. Arduino UNO board	LCD Display	IR sensor	Servo motor	Position sensor	Servo motor

91. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
92. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
93. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
94. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	STEPPER MOTOR	
95. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	
96. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	INFRARED SENSOR	SERVO MOTOR	
97. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	STEPPER MOTOR	
98. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
99. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	STEPPER MOTOR	POSITION SENSOR	SERVO MOTOR	
100. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
101. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
102. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
103. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR	
104. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	
105. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR	
106. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR	
107. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
108. ARDUINO UNO BOARD	LCD DISPLAY	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	SERVO MOTOR	
109. ARDUINO UNO BOARD	LCD DISPLAY	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
110. ARDUINO UNO BOARD	LCD DISPLAY	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
111. ARDUINO UNO BOARD	LCD DISPLAY	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
112. ARDUINO UNO BOARD	LCD DISPLAY	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR	
113. ARDUINO UNO BOARD	LCD DISPLAY	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	

114. Arduino UNO board	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor	Servo motor	
115. Arduino UNO board	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Stepper motor	
116. Arduino UNO board	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Hydraulic system	
117. Arduino UNO board	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Servo motor	
118. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
119. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
120. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Servo motor	

121. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Stepper motor	
122. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Hydraulic system	
123. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Servo motor	
124. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Stepper motor	
125. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Hydraulic system	
126. Arduino UNO board	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Servo motor	
127. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor	
128. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system	
129. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Servo motor	
130. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor	
131. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system	
132. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor	
133. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor	
134. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system	
135. Arduino UNO board	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor	
136. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor	
137. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system	
138. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor	
139. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor	
140. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system	
141. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Servo motor	
142. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Position sensor	Stepper motor	
143. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Position sensor	Hydraulic system	

144. Arduino UNO board	LCD Display	LiDAR sensor	Servo motor	Position sensor	Servo motor	
145. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
146. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
147. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
148. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor	
149. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system	
150. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor	

151. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Stepper motor
152. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system
153. Arduino UNO board	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Servo motor
154. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
155. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
156. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
157. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor
158. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
159. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor
160. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor
161. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system
162. Arduino UNO board	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor
163. Arduino UNO board	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor
164. Arduino UNO board	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
165. Arduino UNO board	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Servo motor
166. Arduino UNO board	Touch screen	IR sensor	Servo motor	Infrared sensor	Stepper motor
167. Arduino UNO board	Touch screen	IR sensor	Servo motor	Infrared sensor	Hydraulic system
168. Arduino UNO board	Touch screen	IR sensor	Servo motor	Infrared sensor	Servo motor
169. Arduino UNO board	Touch screen	IR sensor	Servo motor	Position sensor	Stepper motor
170. Arduino UNO board	Touch screen	IR sensor	Servo motor	Position sensor	Hydraulic system

171. Arduino UNO board	Touch screen	IR sensor	Servo motor	Position sensor	Servo motor	
172. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
173. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
174. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
175. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Infrared sensor	Stepper motor	
176. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Infrared sensor	Hydraulic system	
177. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Infrared sensor	Servo motor	
178. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Position sensor	Stepper motor	
179. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Position sensor	Hydraulic system	
180. Arduino UNO board	Touch screen	IR sensor	Stepper motor	Position sensor	Servo motor	

181. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
182. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
183. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
184. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR	
185. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	
186. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR	
187. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR	
188. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
189. ARDUINO UNO BOARD	TOUCH SCREEN	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	SERVO MOTOR	
190. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
191. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
192. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
193. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR	
194. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	
195. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR	
196. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR	
197. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
198. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	SERVO MOTOR	POSITION SENSOR	SERVO MOTOR	
199. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
200. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
201. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	
202. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	STEPPER MOTOR	
203. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM	

204. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	INFRARED SENSOR	SERVO MOTOR	
205. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	STEPPER MOTOR	
206. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM	
207. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	STEPPER MOTOR	POSITION SENSOR	SERVO MOTOR	
208. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR	
209. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM	
210. ARDUINO UNO BOARD	TOUCH SCREEN	ULTRASONIC SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR	

211. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor
212. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system
213. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor
214. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor
215. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system
216. Arduino UNO board	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor
217. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor
218. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
219. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor
220. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor
221. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system
222. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Servo motor
223. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Position sensor	Stepper motor
224. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Position sensor	Hydraulic system
225. Arduino UNO board	Touch screen	LiDAR sensor	Servo motor	Position sensor	Servo motor
226. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor
227. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system
228. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor
229. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor

230. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system
231. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor
232. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Stepper motor
233. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system
234. Arduino UNO board	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Servo motor
235. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
236. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
237. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
238. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor
239. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
240. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor

241. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor	
242. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system	
243. Arduino UNO board	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor	
244. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor	
245. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system	
246. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Servo motor	
247. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Stepper motor	
248. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Hydraulic system	
249. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Servo motor	
250. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Stepper motor	
251. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Hydraulic system	
252. Arduino Mega	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Servo motor	
253. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
254. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
255. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
256. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Infrared sensor	Stepper motor	
257. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Infrared sensor	Hydraulic system	
258. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Infrared sensor	Servo motor	
259. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Position sensor	Stepper motor	
260. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Position sensor	Hydraulic system	
261. Arduino Mega	LED – BUTTON system	IR sensor	Stepper motor	Position sensor	Servo motor	

262. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	STEPPER MOTOR
263. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	HYDRAULIC SYSTEM
264. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	ULTRASONIC SENSOR	SERVO MOTOR
265. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	STEPPER MOTOR
266. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	HYDRAULIC SYSTEM
267. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	INFRARED SENSOR	SERVO MOTOR
268. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	STEPPER MOTOR
269. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	HYDRAULIC SYSTEM
270. ARDUINO MEGA	LED – BUTTON SYSTEM	IR SENSOR	AC STANDARD SERVO MOTOR	POSITION SENSOR	SERVO MOTOR

271. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Stepper motor
272. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Hydraulic system
273. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Servo motor
274. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor	Stepper motor
275. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor	Hydraulic system
276. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor	Servo motor
277. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor	Stepper motor
278. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor	Hydraulic system
279. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor	Servo motor
280. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Stepper motor
281. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Hydraulic system
282. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Servo motor
283. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Infrared sensor	Stepper motor
284. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Infrared sensor	Hydraulic system
285. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Infrared sensor	Servo motor
286. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Position sensor	Stepper motor

287. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Position sensor	Hydraulic system
288. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Position sensor	Servo motor
289. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
290. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
291. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
292. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor
293. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system
294. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor
295. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor
296. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system
297. Arduino Mega	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor
298. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor
299. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
300. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor

301. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor
302. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system
303. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor	Servo motor
304. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Stepper motor
305. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Hydraulic system
306. Arduino Mega	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor	Servo motor
307. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor
308. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system
309. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor
310. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor
311. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system
312. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor
313. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Stepper motor
314. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system
315. Arduino Mega	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor	Servo motor
316. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
317. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
318. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
319. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor

320. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
321. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor
322. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor
323. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system
324. Arduino Mega	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor
325. Arduino Mega	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor
326. Arduino Mega	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
327. Arduino Mega	LCD Display	IR sensor	Servo motor	Ultrasonic sensor	Servo motor
328. Arduino Mega	LCD Display	IR sensor	Servo motor	Infrared sensor	Stepper motor
329. Arduino Mega	LCD Display	IR sensor	Servo motor	Infrared sensor	Hydraulic system
330. Arduino Mega	LCD Display	IR sensor	Servo motor	Infrared sensor	Servo motor

331. Arduino Mega	LCD Display	IR sensor	Servo motor	Position sensor	Stepper motor	
332. Arduino Mega	LCD Display	IR sensor	Servo motor	Position sensor	Hydraulic system	
333. Arduino Mega	LCD Display	IR sensor	Servo motor	Position sensor	Servo motor	
334. Arduino Mega	LCD Display	IR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
335. Arduino Mega	LCD Display	IR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
336. Arduino Mega	LCD Display	IR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
337. Arduino Mega	LCD Display	IR sensor	Stepper motor	Infrared sensor	Stepper motor	
338. Arduino Mega	LCD Display	IR sensor	Stepper motor	Infrared sensor	Hydraulic system	
339. Arduino Mega	LCD Display	IR sensor	Stepper motor	Infrared sensor	Servo motor	
340. Arduino Mega	LCD Display	IR sensor	Stepper motor	Position sensor	Stepper motor	
341. Arduino Mega	LCD Display	IR sensor	Stepper motor	Position sensor	Hydraulic system	
342. Arduino Mega	LCD Display	IR sensor	Stepper motor	Position sensor	Servo motor	
343. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor	
344. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system	
345. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor	
346. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Infrared sensor	Stepper motor	
347. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Infrared sensor	Hydraulic system	
348. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Infrared sensor	Servo motor	
349. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Position sensor	Stepper motor	
350. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Position sensor	Hydraulic system	
351. Arduino Mega	LCD Display	IR sensor	AC standard servo motor	Position sensor	Servo motor	

352. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Stepper motor	
353. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Hydraulic system	
354. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Servo motor	
355. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor	Stepper motor	
356. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor	Hydraulic system	
357. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor	Servo motor	
358. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Stepper motor	
359. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Hydraulic system	
360. Arduino Mega	LCD Display	Ultrasonic sensor	Servo motor	Position sensor	Servo motor	

361. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Stepper motor
362. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Hydraulic system
363. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Servo motor
364. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Stepper motor
365. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Hydraulic system
366. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor	Servo motor
367. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Stepper motor
368. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Hydraulic system
369. Arduino Mega	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor	Servo motor
370. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
371. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
372. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
373. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor
374. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system
375. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor
376. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor
377. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system
378. Arduino Mega	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor
379. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor

380. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system	
381. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor	
382. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor	
383. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system	
384. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Infrared sensor	Servo motor	
385. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Position sensor	Stepper motor	
386. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Position sensor	Hydraulic system	
387. Arduino Mega	LCD Display	LiDAR sensor	Servo motor	Position sensor	Servo motor	
388. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
389. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
390. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor	

391. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor
392. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system
393. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor
394. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Stepper motor
395. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system
396. Arduino Mega	LCD Display	LiDAR sensor	Stepper motor	Position sensor	Servo motor
397. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
398. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
399. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
400. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor
401. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
402. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor
403. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor
404. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system
405. Arduino Mega	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor
406. Arduino Mega	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor
407. Arduino Mega	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
408. Arduino Mega	Touch screen	IR sensor	Servo motor	Ultrasonic sensor	Servo motor
409. Arduino Mega	Touch screen	IR sensor	Servo motor	Infrared sensor	Stepper motor
410. Arduino Mega	Touch screen	IR sensor	Servo motor	Infrared sensor	Hydraulic system
411. Arduino Mega	Touch screen	IR sensor	Servo motor	Infrared sensor	Servo motor

412. Arduino Mega	Touch screen	IR sensor	Servo motor	Position sensor	Stepper motor	
413. Arduino Mega	Touch screen	IR sensor	Servo motor	Position sensor	Hydraulic system	
414. Arduino Mega	Touch screen	IR sensor	Servo motor	Position sensor	Servo motor	
415. Arduino Mega	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
416. Arduino Mega	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
417. Arduino Mega	Touch screen	IR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
418. Arduino Mega	Touch screen	IR sensor	Stepper motor	Infrared sensor	Stepper motor	
419. Arduino Mega	Touch screen	IR sensor	Stepper motor	Infrared sensor	Hydraulic system	
420. Arduino Mega	Touch screen	IR sensor	Stepper motor	Infrared sensor	Servo motor	

421. Arduino Mega	Touch screen	IR sensor	Stepper motor	Position sensor	Stepper motor
422. Arduino Mega	Touch screen	IR sensor	Stepper motor	Position sensor	Hydraulic system
423. Arduino Mega	Touch screen	IR sensor	Stepper motor	Position sensor	Servo motor
424. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
425. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
426. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
427. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Infrared sensor	Stepper motor
428. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Infrared sensor	Hydraulic system
429. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Infrared sensor	Servo motor
430. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Position sensor	Stepper motor
431. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Position sensor	Hydraulic system
432. Arduino Mega	Touch screen	IR sensor	AC standard servo motor	Position sensor	Servo motor
433. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Stepper motor
434. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Hydraulic system
435. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Ultrasonic sensor	Servo motor
436. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor	Stepper motor
437. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor	Hydraulic system
438. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor	Servo motor
439. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Position sensor	Stepper motor
440. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Position sensor	Hydraulic system
441. Arduino Mega	Touch screen	Ultrasonic sensor	Servo motor	Position sensor	Servo motor

442. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
443. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
444. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Ultrasonic sensor	Servo motor	
445. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Infrared sensor	Stepper motor	
446. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Infrared sensor	Hydraulic system	
447. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Infrared sensor	Servo motor	
448. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Position sensor	Stepper motor	
449. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Position sensor	Hydraulic system	
450. Arduino Mega	Touch screen	Ultrasonic sensor	Stepper motor	Position sensor	Servo motor	

451. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor
452. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system
453. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Ultrasonic sensor	Servo motor
454. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Stepper motor
455. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Hydraulic system
456. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Infrared sensor	Servo motor
457. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Stepper motor
458. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Hydraulic system
459. Arduino Mega	Touch screen	Ultrasonic sensor	AC standard servo motor	Position sensor	Servo motor
460. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Stepper motor
461. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Hydraulic system
462. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Ultrasonic sensor	Servo motor
463. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Stepper motor
464. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Hydraulic system
465. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Infrared sensor	Servo motor
466. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Position sensor	Stepper motor
467. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Position sensor	Hydraulic system
468. Arduino Mega	Touch screen	LiDAR sensor	Servo motor	Position sensor	Servo motor
469. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Stepper motor

470. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
471. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
472. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Stepper motor	
473. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Hydraulic system	
474. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Infrared sensor	Servo motor	
475. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Stepper motor	
476. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Hydraulic system	
477. Arduino Mega	Touch screen	LiDAR sensor	Stepper motor	Position sensor	Servo motor	
478. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Stepper motor	
479. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Hydraulic system	
480. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Ultrasonic sensor	Servo motor	

481. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Stepper motor	
482. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Hydraulic system	
483. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor	Servo motor	
484. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Stepper motor	
485. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Hydraulic system	
486. Arduino Mega	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor	Servo motor	
487. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Stepper motor	
488. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Hydraulic system	
489. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Ultrasonic sensor	Servo motor	
490. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Stepper motor	
491. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Hydraulic system	
492. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Infrared sensor	Servo motor	
493. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Stepper motor	
494. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Hydraulic system	
495. Arduino Leonardo	LED – BUTTON system	IR sensor	Servo motor	Position sensor	Servo motor	
496. Arduino Leonardo	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Stepper motor	
497. Arduino Leonardo	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Hydraulic system	
498. Arduino Leonardo	LED – BUTTON system	IR sensor	Stepper motor	Ultrasonic sensor	Servo motor	
499. Arduino Leonardo	LED – BUTTON system	IR sensor	Stepper motor	Infrared sensor	Stepper motor	
500. Arduino Leonardo	LED – BUTTON system	IR sensor	Stepper motor	Infrared sensor	Hydraulic system	
501.						

1. Arduino Leonardo	LED – BUTTON system	Infrared sensor	Stepper motor	Infrared sensor
2. Arduino Leonardo	LED – BUTTON system	Infrared sensor	Stepper motor	Position sensor
3. Arduino Leonardo	LED – BUTTON system	Infrared sensor	Stepper motor	Position sensor
4. Arduino Leonardo	LED – BUTTON system	Infrared sensor	Stepper motor	Position sensor
5. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
6. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
7. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
8. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Infrared sensor
9. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Infrared sensor
10. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Infrared sensor
11. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Position sensor
12. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Position sensor
13. Arduino Leonardo	LED – BUTTON system	Infrared sensor	AC standard servo motor	Position sensor
14. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
15. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
16. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
17. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor
18. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor
19. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Infrared sensor
20. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor
21. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor
22. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Servo motor	Position sensor
23. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
24. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
25. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
26. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Infrared sensor
27. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Infrared sensor
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29. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	Stepper motor	Position sensor
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32. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultra-sonic sensor
33. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultra-sonic sensor
34. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Ultra-sonic sensor
35. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor
36. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor
37. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Infrared sensor
38. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor
39. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor

40. Arduino Leonardo	LED – BUTTON system	Ultrasonic sensor	AC standard servo motor	Position sensor
41. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Ultra-sonic sensor
42. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Ultra-sonic sensor
43. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Ultra-sonic sensor

44. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor
45. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor
46. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Infrared sensor
47. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor
48. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor
49. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Servo motor	Position sensor
50. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultra-sonic sensor
51. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultra-sonic sensor
52. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Ultra-sonic sensor
53. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor
54. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor
55. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Infrared sensor
56. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor
57. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor
58. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	Stepper motor	Position sensor
59. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
60. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
61. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
62. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor
63. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor
64. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Infrared sensor
65. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor
66. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor
67. Arduino Leonardo	LED – BUTTON system	LiDAR sensor	AC standard servo motor	Position sensor
68. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Ultra-sonic senso
69. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Ultra-sonic senso
70. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Ultra-sonic senso
71. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Infrared sensor
72. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Infrared sensor
73. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Infrared sensor
74. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Position sensor
75. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Position sensor
76. Arduino Leonardo	LCD Display	Infrared sensor	Servo motor	Position sensor
77. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Ultra-sonic senso
78. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Ultra-sonic senso

79. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Ultra-sonic senso
80. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Infrared sensor
81. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Infrared sensor
82. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Infrared sensor
83. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Position sensor
84. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Position sensor
85. Arduino Leonardo	LCD Display	Infrared sensor	Stepper motor	Position sensor
86. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
87. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Ultra-sonic sensor

88. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
89. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Infrared sensor
90. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Infrared sensor
91. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Infrared sensor
92. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Position sensor
93. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Position sensor
94. Arduino Leonardo	LCD Display	Infrared sensor	AC standard servo motor	Position sensor
95. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
96. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
97. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
98. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor
99. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor
100. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Infrared sensor
101. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Position sensor
102. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Position sensor
103. Arduino Leonardo	LCD Display	Ultrasonic sensor	Servo motor	Position sensor
104. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
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106. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
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108. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor
109. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Infrared sensor
110. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor
111. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor
112. Arduino Leonardo	LCD Display	Ultrasonic sensor	Stepper motor	Position sensor
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114. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultra-sonic sensor
115. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Ultra-sonic sensor
116. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor
117. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor

118. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Infrared sensor
119. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor
120. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor
121. Arduino Leonardo	LCD Display	Ultrasonic sensor	AC standard servo motor	Position sensor
122. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Ultra-sonic sensor
123. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Ultra-sonic sensor
124. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Ultra-sonic sensor
125. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Infrared sensor
126. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Infrared sensor
127. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Infrared sensor
128. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Position sensor
129. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Position sensor
130. Arduino Leonardo	LCD Display	LiDAR sensor	Servo motor	Position sensor
131. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Ultra-sonic sensor

132. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Ultra-sonic sensor
133. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Ultra-sonic sensor
134. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor
135. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor
136. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Infrared sensor
137. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Position sensor
138. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Position sensor
139. Arduino Leonardo	LCD Display	LiDAR sensor	Stepper motor	Position sensor
140. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
141. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
142. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
143. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor
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145. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Infrared sensor
146. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor
147. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor
148. Arduino Leonardo	LCD Display	LiDAR sensor	AC standard servo motor	Position sensor
149. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Ultra-sonic sensor
150. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Ultra-sonic sensor
151. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Ultra-sonic sensor
152. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Infrared sensor
153. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Infrared sensor
154. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Infrared sensor
155. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Position sensor
156. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Position sensor

157. Arduino Leonardo	Touch screen	Infrared sensor	Servo motor	Position sensor
158. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Ultra-sonic sensor
159. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Ultra-sonic sensor
160. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Ultra-sonic sensor
161. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Infrared sensor
162. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Infrared sensor
163. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Infrared sensor
164. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Position sensor
165. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Position sensor
166. Arduino Leonardo	Touch screen	Infrared sensor	Stepper motor	Position sensor
167. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
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169. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Ultra-sonic sensor
170. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Infrared sensor
171. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Infrared sensor
172. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Infrared sensor
173. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Position sensor
174. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Position sensor
175. Arduino Leonardo	Touch screen	Infrared sensor	AC standard servo motor	Position sensor

176. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
177. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
178. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Ultra-sonic sensor
179. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor
180. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor
181. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Infrared sensor
182. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Position sensor
183. Arduino Leonardo	Touch screen	Ultrasonic sensor	Servo motor	Position sensor
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185. Arduino Leonardo	Touch screen	Ultrasonic sensor	Stepper motor	Ultra-sonic sensor
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223. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Ultra-sonic sensor
224. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor
225. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor
226. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Infrared sensor
227. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor
228. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor
229. Arduino Leonardo	Touch screen	LiDAR sensor	AC standard servo motor	Position sensor

Total combinations =500+229 =729

Selection of Suitable Combinations with Proper Justification

Table 16 selection of suitable combination

Sub Functions	Operating of microcontroller	Displaying data and controlling device	Detecting a person	Lid motor mechanism	Measuring the trash level	Motor mechanism of sealing the trash bag	Weighted rating
Combinations that were chosen before weighted rating analysis							
Concept Alternatives	Arduino UNO (3.0)	LED – BUTTON system (4.0)	Ultrasonic sensor (2.35)	Servo motor (4.2)	Ultrasonic sensor (3.4)	Stepper motor (3.4)	20.35
	Arduino Mega (2.7)	LCD Display (2.5)	Infrared Radiation sensor (4.45)	Stepper motor (2.5)	Infrared sensor (2.66)	Hydraulic system (1.8)	16.61
	Arduino Leonardo (2.85)	Touch Screen (0.8)	LiDAR sensor (2.25)	AC standard servo motor (2.6)	Position sensor (1.9)	Servo motor (3.05)	13.45
Combination with the highest and lowest weighted rating							
Highest weighted rating	Arduino UNO (3.0)	LED – BUTTON system (4.0)	Infrared Radiation sensor (4.45)	Servo motor (4.2)	Ultrasonic sensor (3.4)	Stepper motor (3.4)	22.45
Lowest weighted rating	Arduino Mega (2.7)	Touch Screen (0.8)	LiDAR sensor (2.25)	Stepper motor (2.5)	Position sensor (1.9)	Hydraulic system (1.8)	11.95

The above table represents the combination between highest and lowest weighted rating alternatives of each sub function. We have obtained the highest total weighted rating as 22.45 and the lowest total weighted rating as 11.95. By considering the above table, we have chosen the highest weighted component of each sub function as the best alternative. They are shown in the table below.

Table 17 selected components

Sub function	Selected component
Operating of microcontroller	Arduino UNO
Displaying data and controlling device	LED – BUTTON system

Detecting a person	Infrared Radiation sensor

Lid motor mechanism	Servo motor
Measuring the trash level	Ultrasonic sensor
Motor mechanism of sealing the trash bag	Stepper motor

Including the above selected components, we are designing the shape of the trash bin according to Vilan's conceptual design (Design 1). The volume of the dust bin is cm. Apart from that we are including tires and a handle to trash bin for portability. And we are using a battery pack for allocating power to all components. The main battery placed beneath the trash bin with a charger plugged to the back of the trash bin. Two servo motors are used to the lid of the trash bin when a person get closer. Using two servo motors increase the durability due to reduce of tress instead of a single servo motor. The main control panel of our design is located on the side of the trash bin. Battery level of the trash bin is displayed by three LED bulbs, placed in the control panel. Buzzer is also used to emit the signal when trash level reaches to the constant level 75cm. Rubber seal has been placed on the lid with a space in between allowing another rubber seal fit through it. An ultrasonic sensor has been placed beneath the lid of the trash bin. The ultrasonic sensor has a coverage angle of 30 degrees which increases accurately measure the trash level inside the bin. An IR sensor is used which has an angle coverage of 5 degrees as a maximum range of 80cm. It detects when a person is nearby. Rather than an ultrasonic sensor which has an angle coverage of 30 degrees and maximum range of 21m, IR sensor will have less errors.

In this design, the method to seal the trash bag was done according to the design which works when the cleaning staff initially insert a zip tie in between the gear rods according to Design 1. In the alternatives, we have found that there are many other types of motors that we can use. But as shown above each of them have their own drawbacks, which were identified. By considering them we have decided to use a stepper motor which has a high torque, efficiency, accuracy, low power, power rating and good reliability considering other alternatives. The trash bag will be sealed according to the design and a stepper motor will be also used.

Switch has been placed next to the rubber seal (on top of the trash bin) which is used to stop the servo motor used in the hinges. Use of a switch to stop servo motor over spinning after the lid has been closed will make the motors more durable.

Conceptual Designs

Vilan's Design

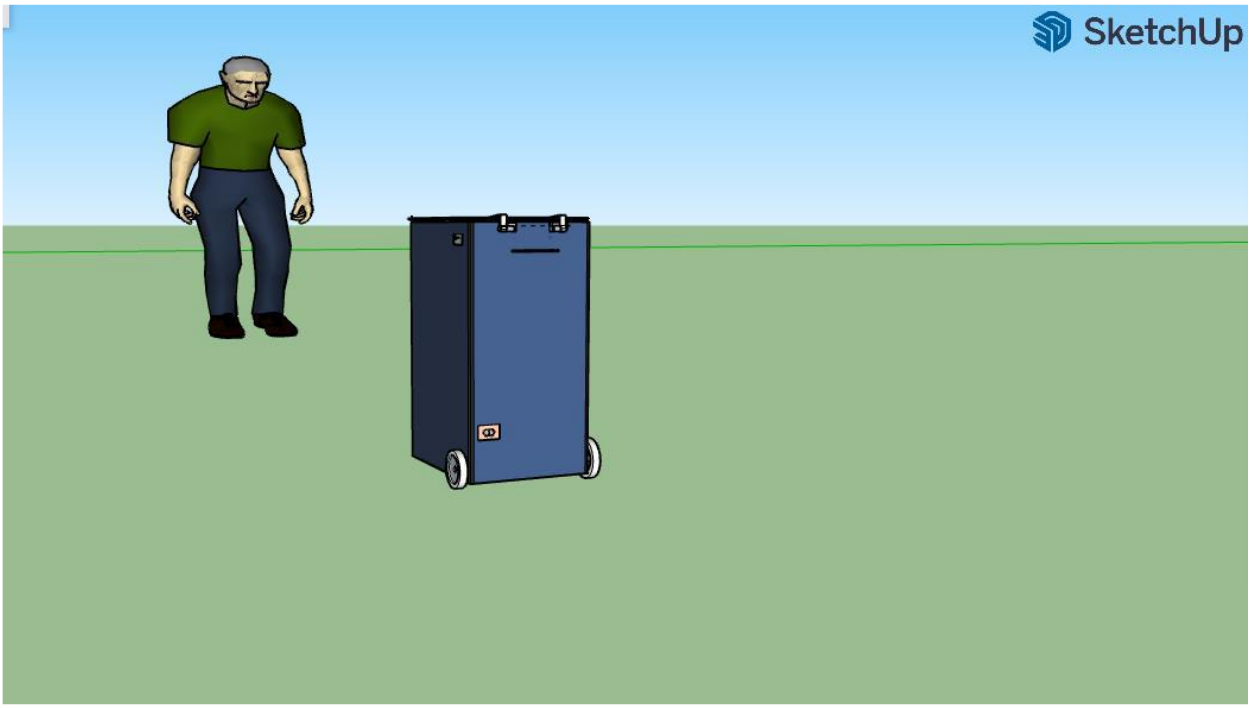


Figure 8 trash bin

In this report my conceptual design has be presented addressing the problems we have identified in the current dustbin design. In this design I have achieved the intended objectives that we presented earlier through the solutions I have provided.

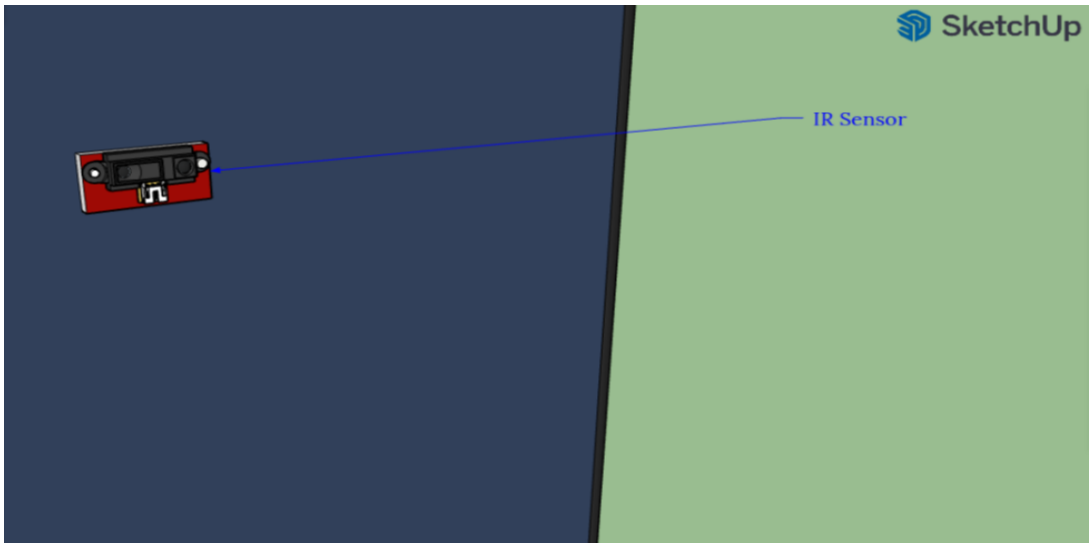


Figure 9 IR sensor

In this picture we can see an IR sensor used to detect if a person is nearby.IR sensor - A IR sensor is used which has an angle of coverage of 5 degrees and a maximum range of 80cm Rather than a ultra-sonic sensor which has a angle of coverage of 30 degrees and max range of 21 meters, IR sensor will have less errors

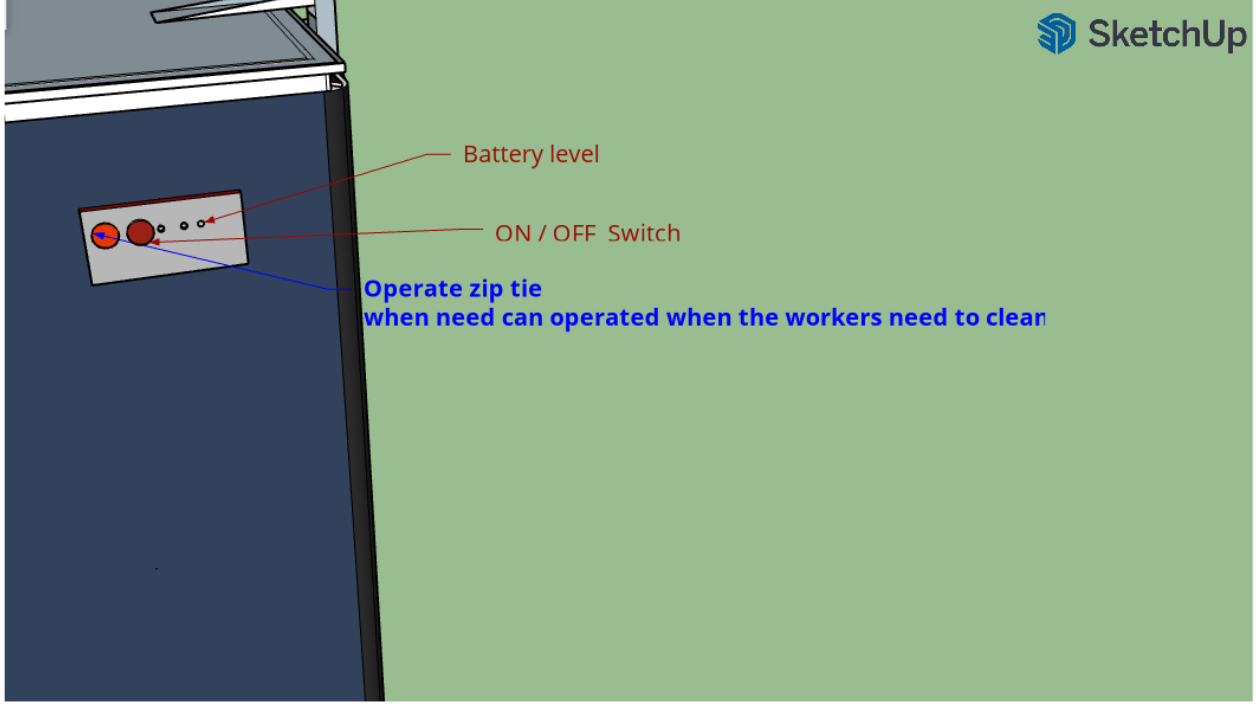


Figure 10 control panel

On the side of the trash bin the main control panel is located

Orange button – If the cleaning staff needs to clean the trash bin even though the trash bag isn't full that mechanism can be done by this button.

Red button – Turing the trash bin on/off can be done using this button.

Battery level – Battery level of the trash bin is displayed by three led bulbs placed in the control panel.

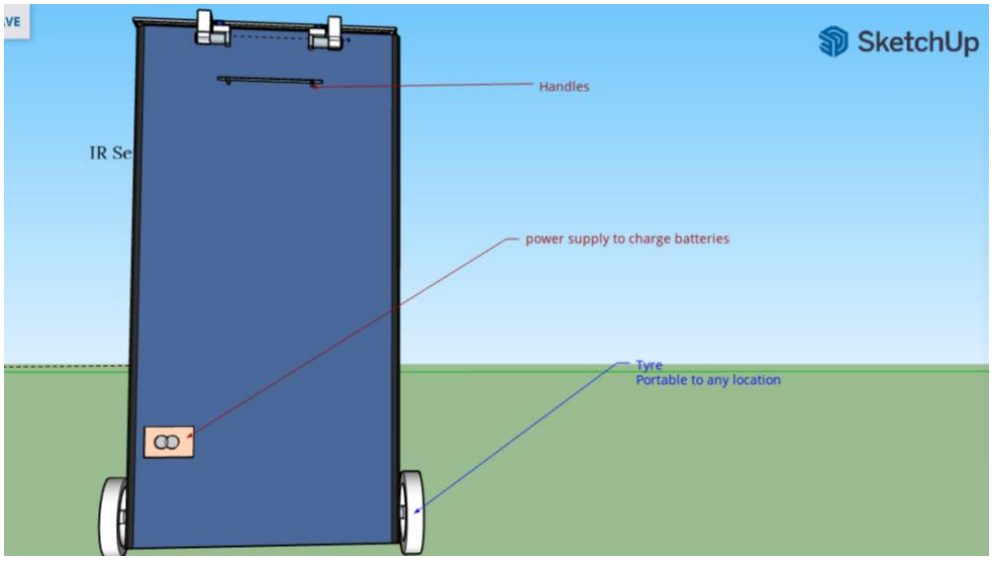


Figure 11 back view

Handles – Using the handles placed in the back of the trash bin it can be transported to any location.

Power supply – The main battery placed beneath the trash bin can be charged using the with a charger plugged to the back of the trash bin.

Tires – These help the Trash bin to be transported to any location indoors or outdoors.

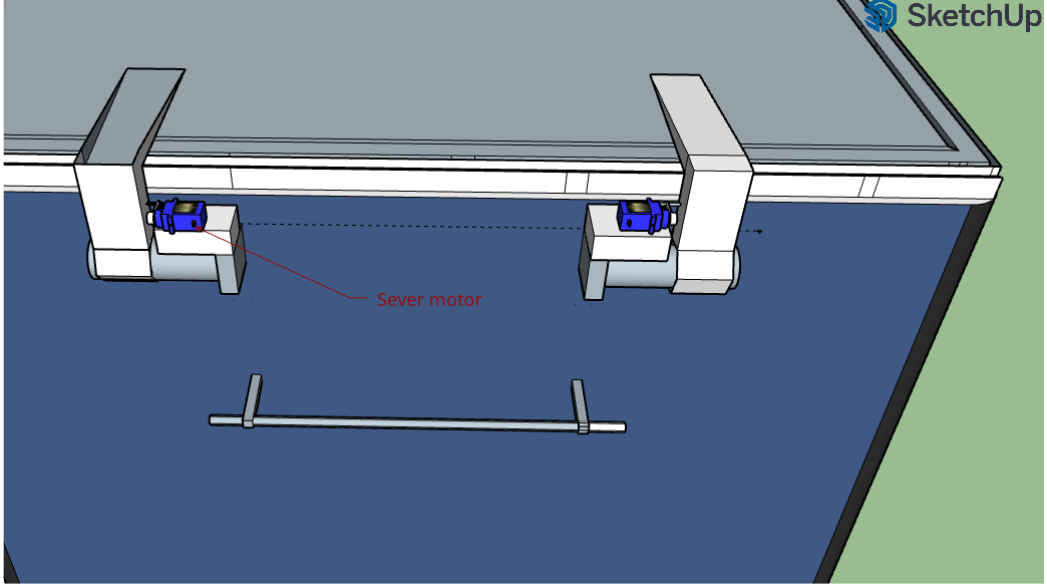


Figure 12 lid

Server motor – Two sever motors have been used to lift the lid of the trash bin when a person gets closer

Using 2 server motors also increases the durability if the trash bin due to reduce of tress instead of a single server motor.

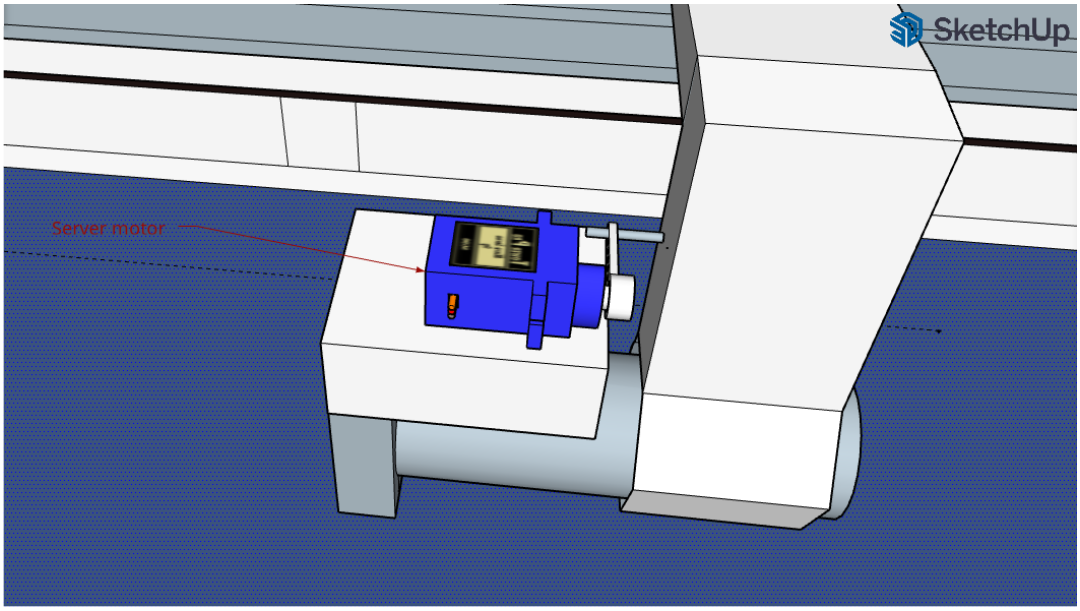


Figure 13 hinge

The server motor has been connected to the hinge of the trash bin using a rod

A single servo motor has a torque of 250 foot pounds which can lift a weight up to 2.5kg and can easily lift the lid.

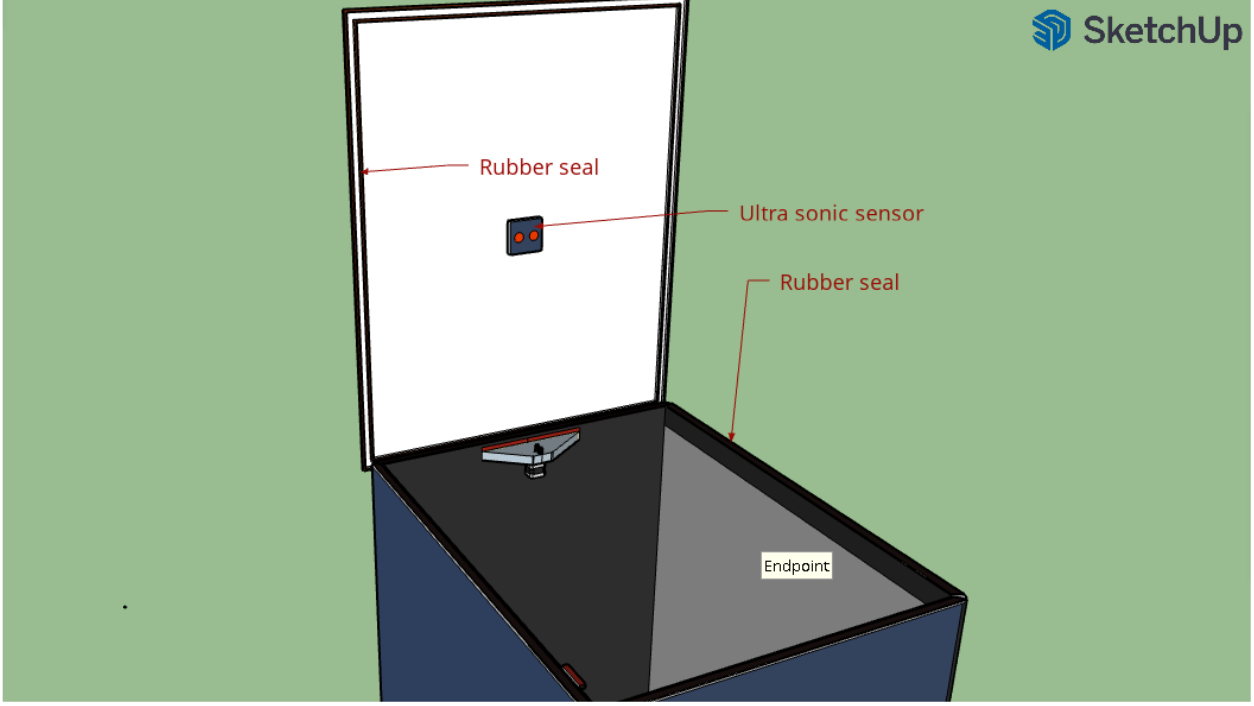


Figure 14 sensor used for detecting trash level

Rubber seal -On the lid and on top of the trash bin – rubber seals has been placed on the lid with a space in between allowing another rubber seal fit through it.

Ultra-sonic sensor – A ultra-sonic sensor has been placed beneath the lid of the trash bin. The ultra-sonic sensor has a coverage angle of 30 degrees which increases accurately measure the trash level inside the bin

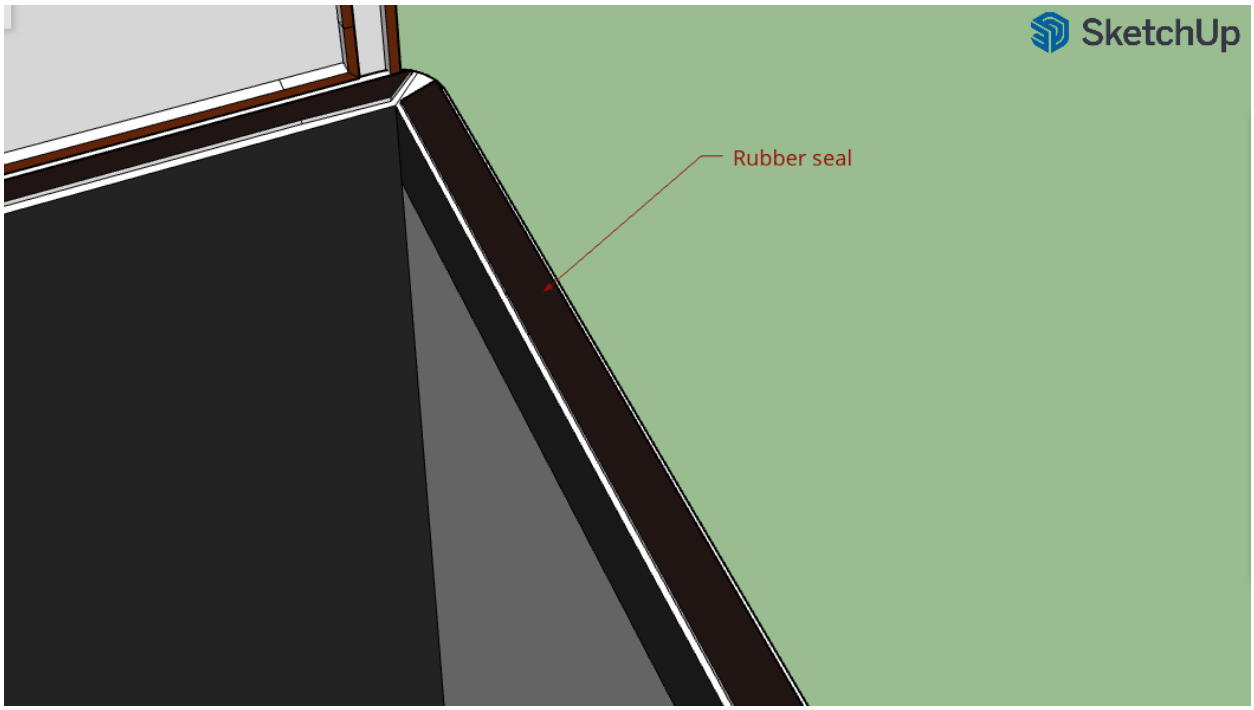


Figure 15 Rubber seal

Rubber seal – The main rubber seal which prevent the odor from spreading. This also stops animals getting inside the bin.

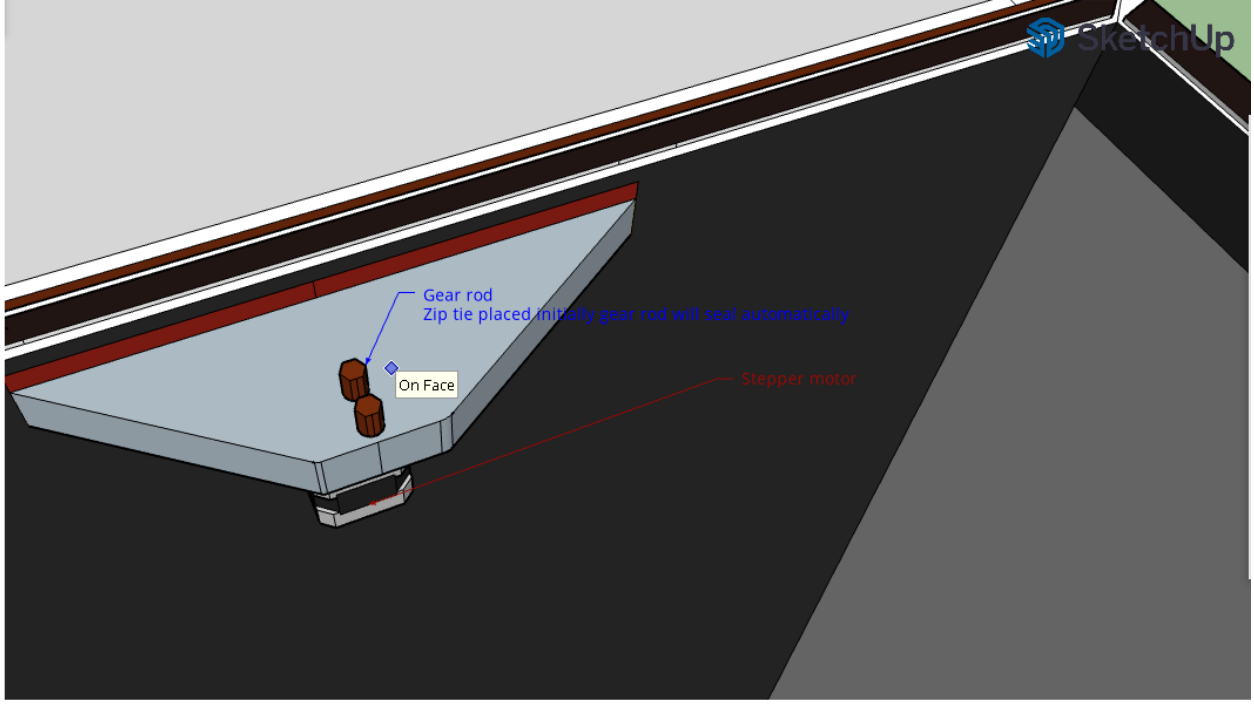


Figure 16 zip tying mechanism

Gear rod – Two gear rods has been placed connecting one to the stepper motor which is placed underneath and another free rotating gear rod which moves freely. This allows zip tie to be placed in between the gear rod which can be used to seal the trash bag pulling the zip tie.

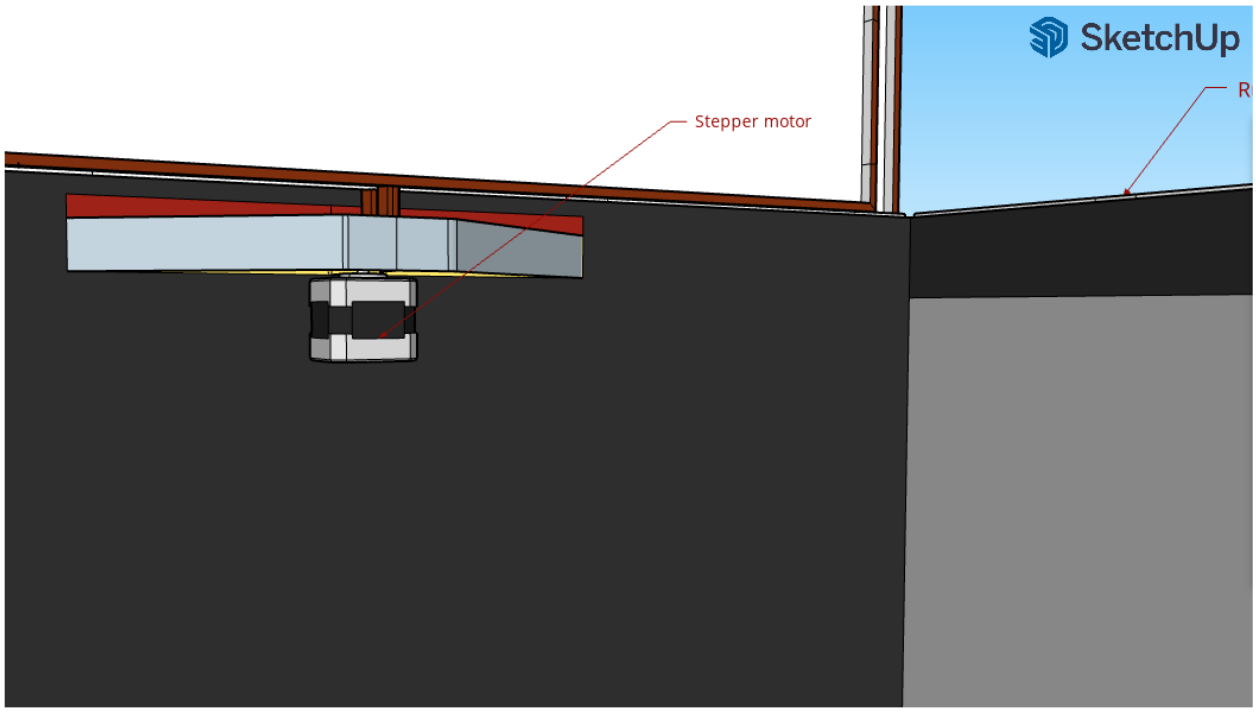


Figure 17 motor mechanism of sealing trash bag

Stepper motor – A stepper motor has been used to turn the gear rod above. The stepper motor which has a 5.9 nm high torque, and a low speed has been used to increase accuracy.

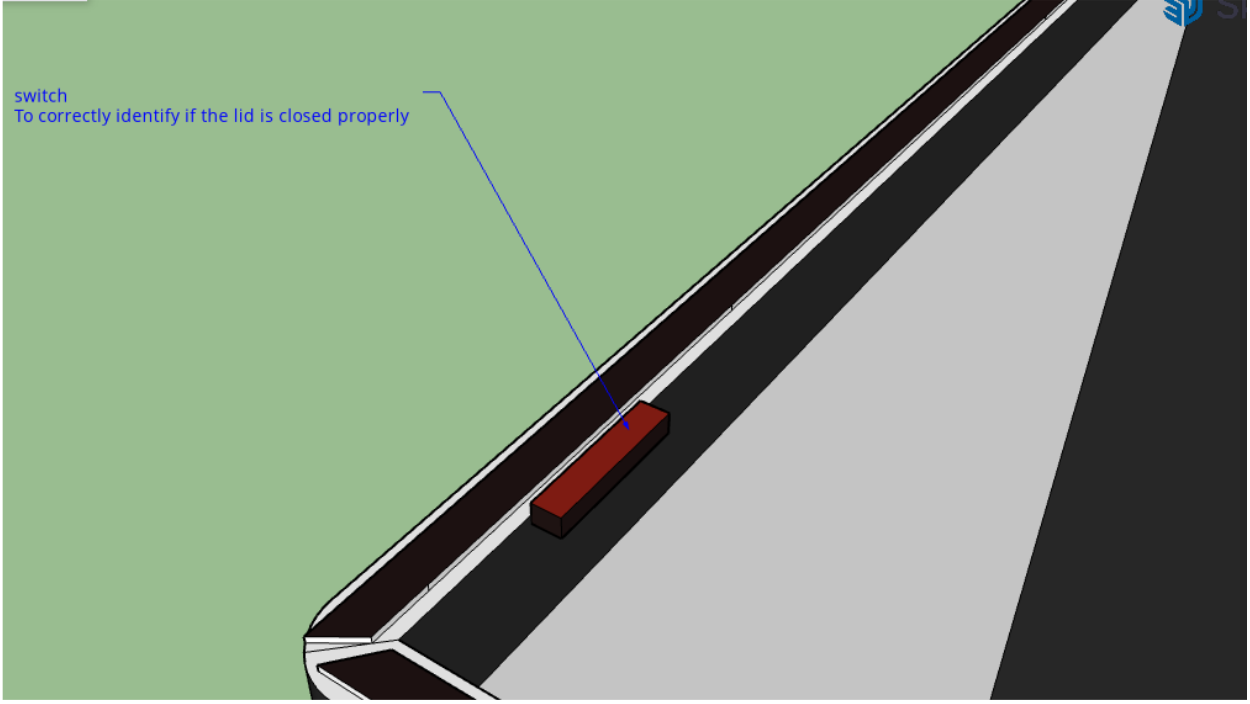


Figure 18 switch

Switch – switch has been placed next to the rubber seal (on top of trash bin) which is used to stop the sever motor used in the hinges. Use of a switch to stop server motor over spinning after t\lid has been closed will make the motors more durable.

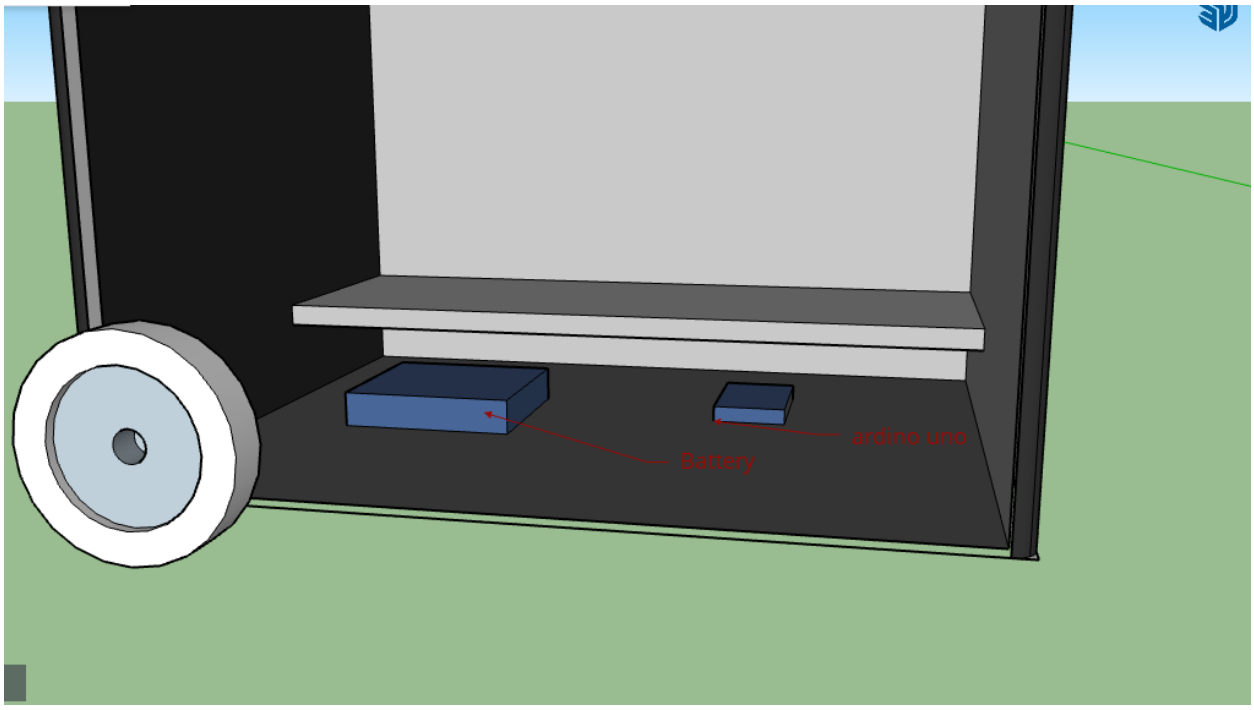


Figure 19 circuits

The battery and the Arduino and the other circuits has been placed underneath the dust bin which makes the dust stable and suitable to unexpectable weather conditions.

Vinal's design

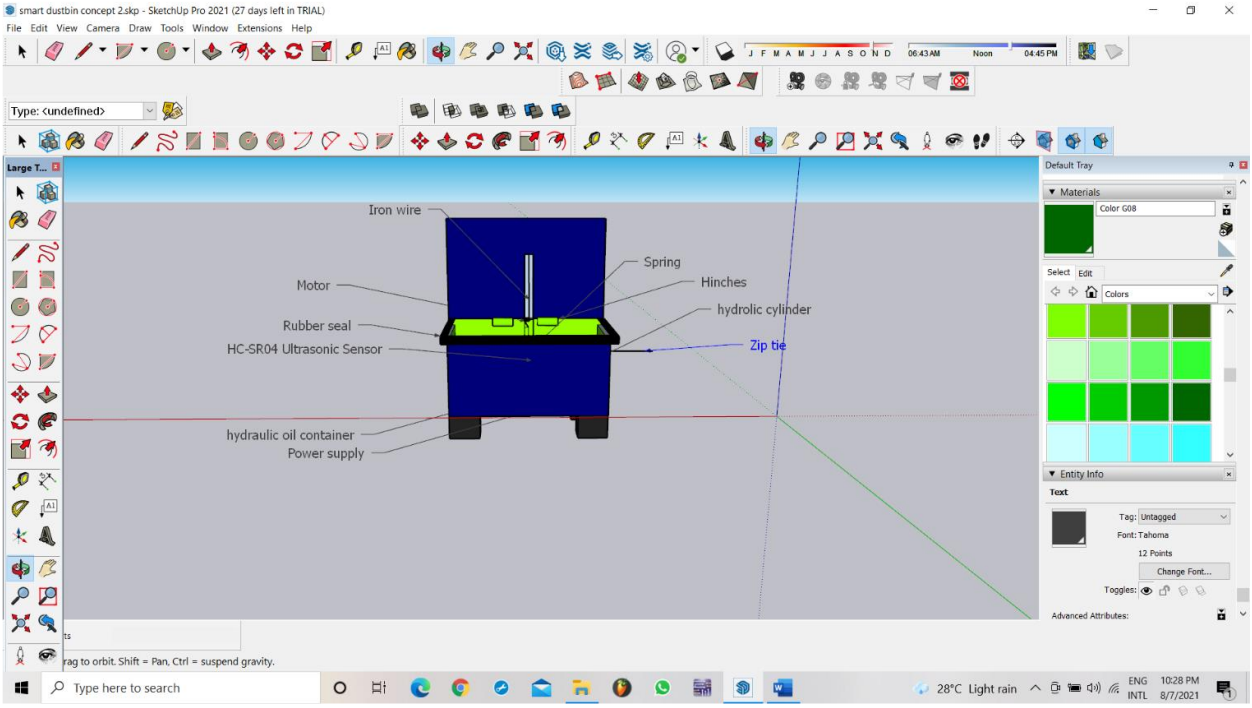


Figure 20 front view

In this view I have included an ultrasonic sensor which cannot be seen because its bit smaller than the dustbin

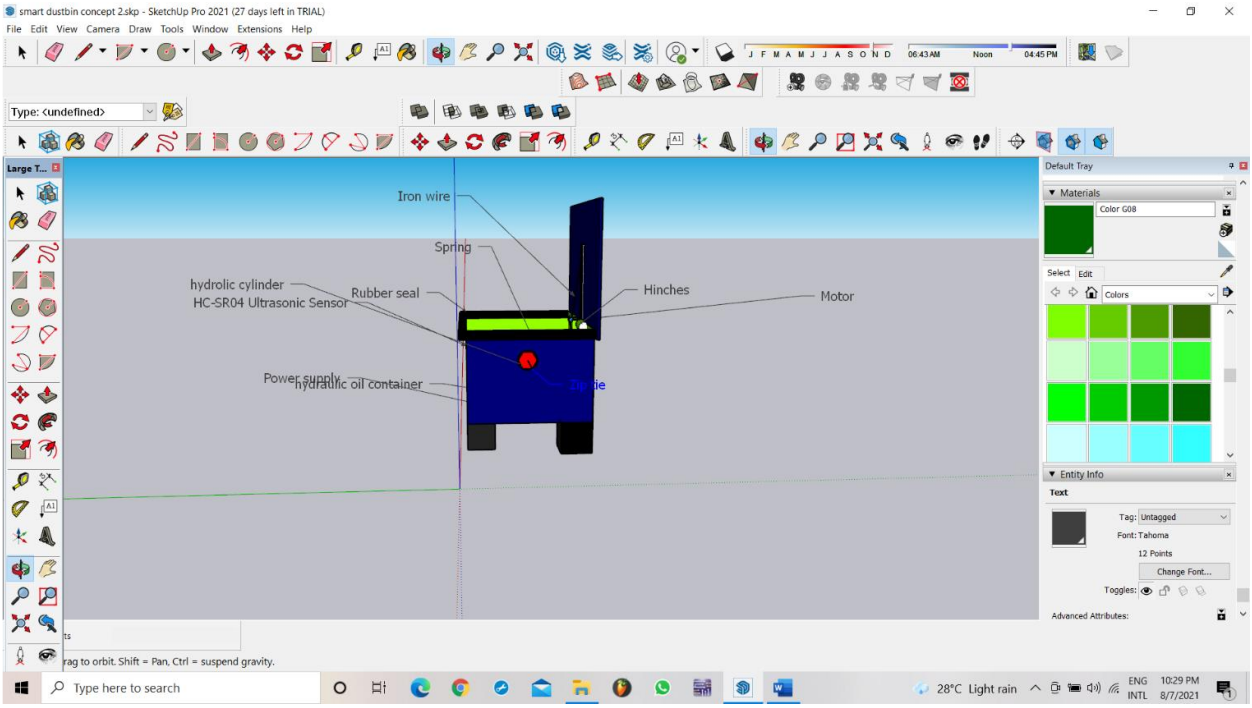


Figure 21 side view

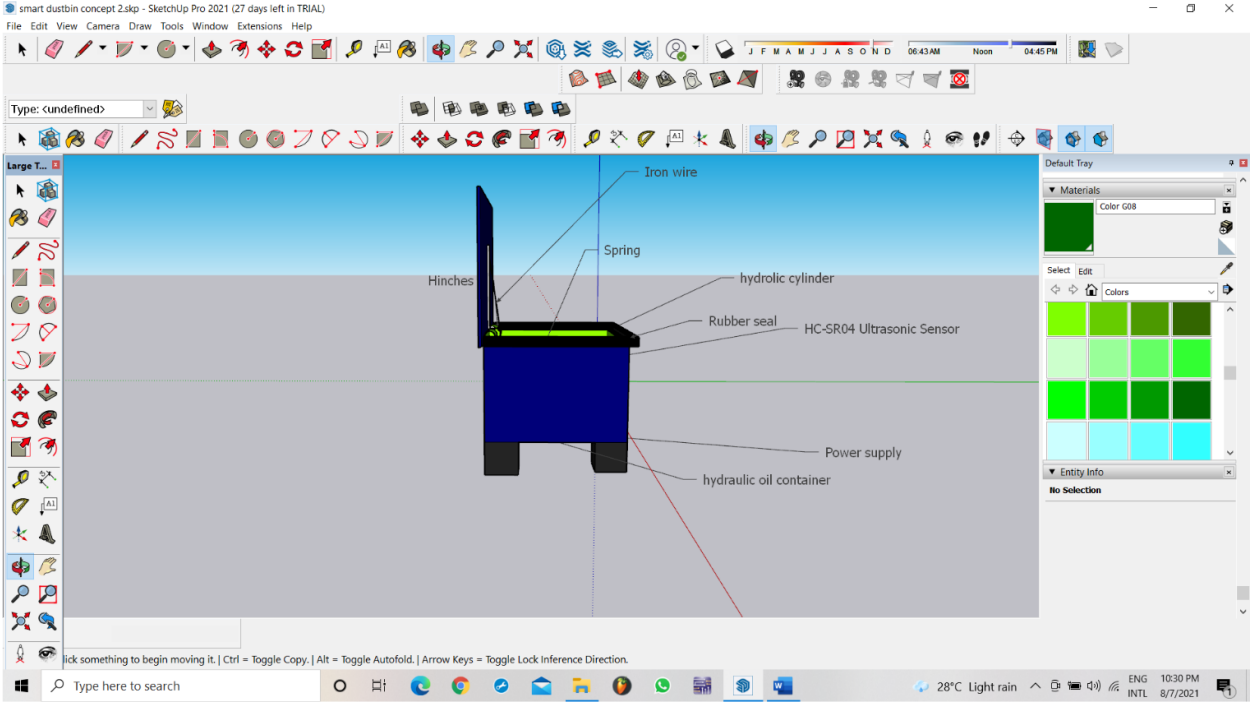


Figure 22 side view

In his view there is the place to insert the zip tie. And could see the rubber seal. There are legs in this design as well to keep the design portable in indoors and outdoors.

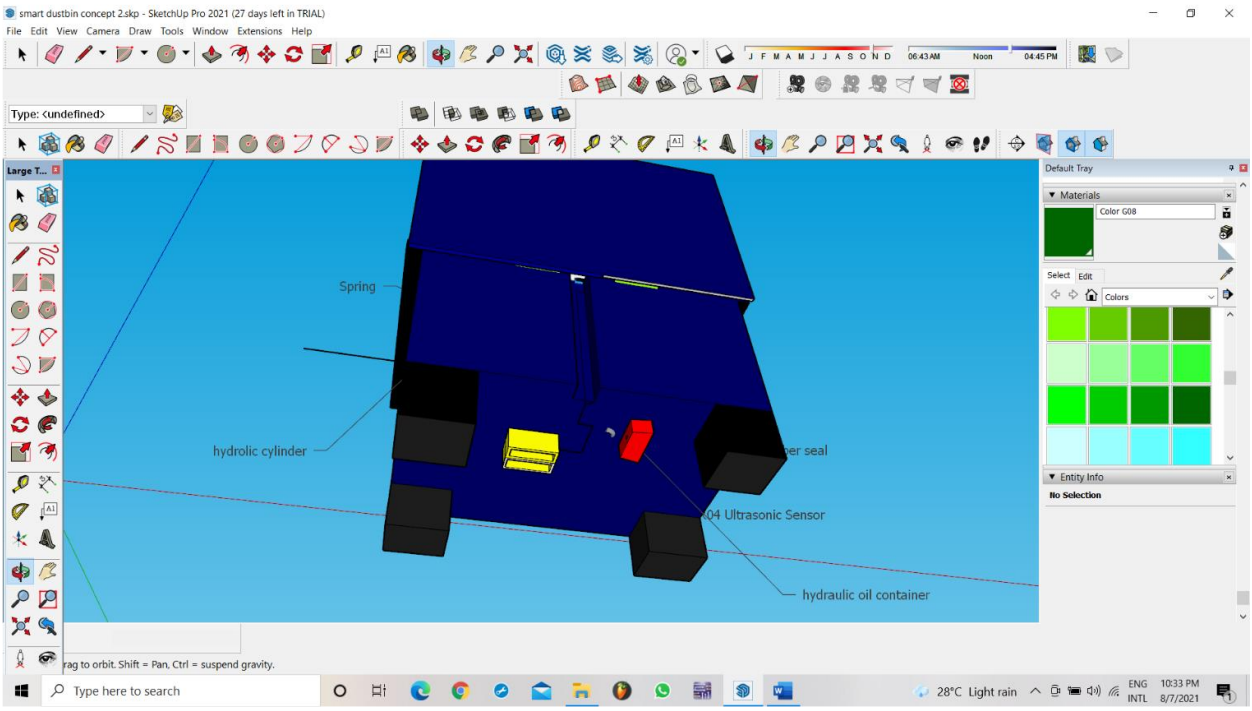


Figure 23 view from underneath

In this view I placed the power supply as well as the hydraulic container. This was kept underneath because if the bin was placed outdoors, in a heavy rainy day, the power supply might be short circuited. The risk to get damage is also reduced to the power supply and the hydraulic container. The legs are being placed because it could give some sort of a safety and give a decent portability to the bin in any surface.

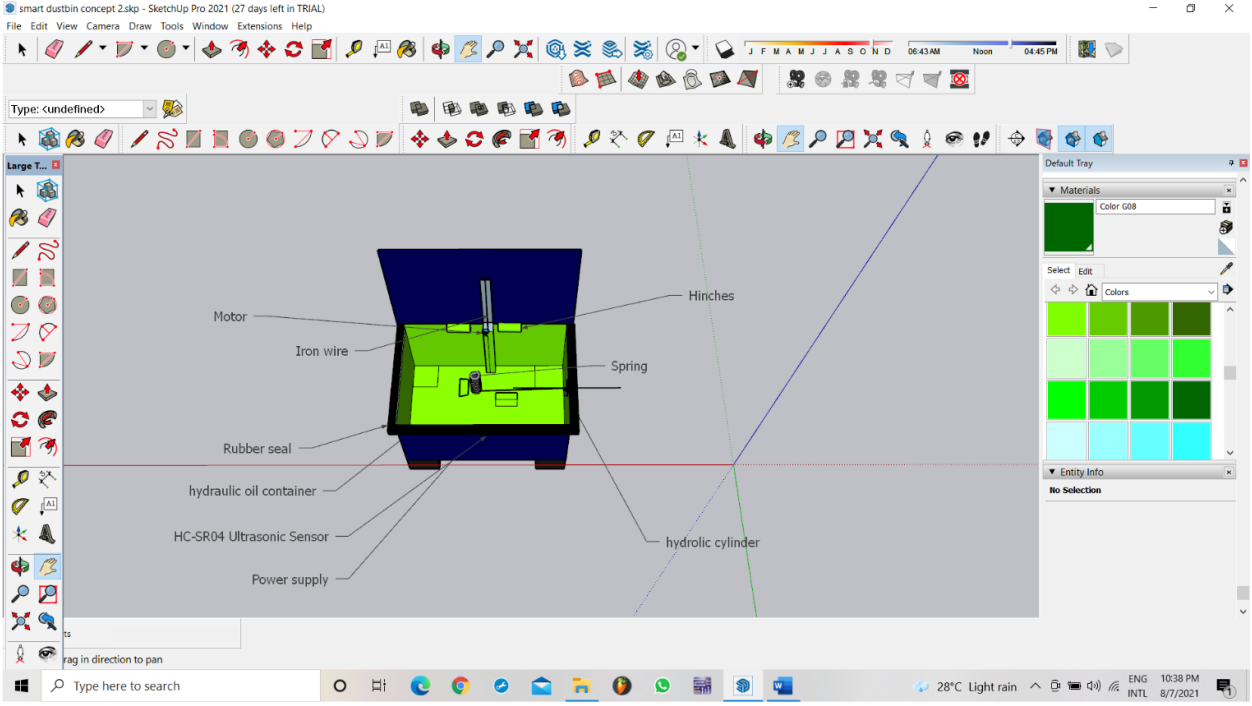


Figure 24 top view

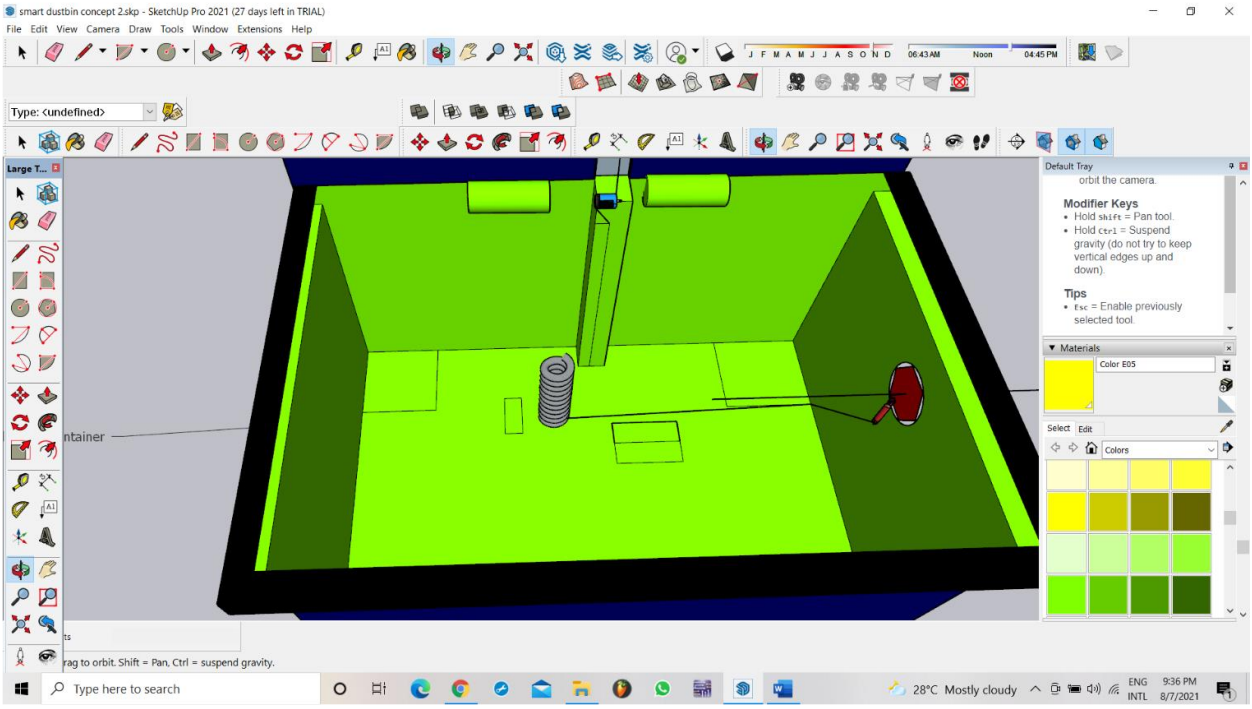


Figure 25 top view

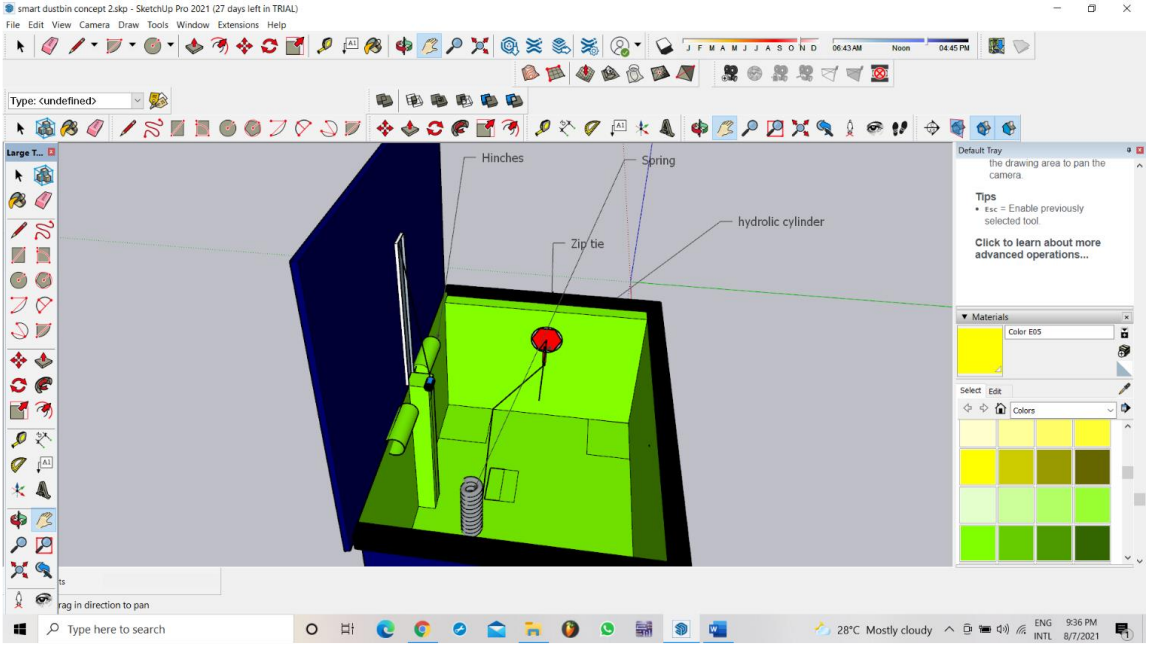


Figure 26 level detecting method

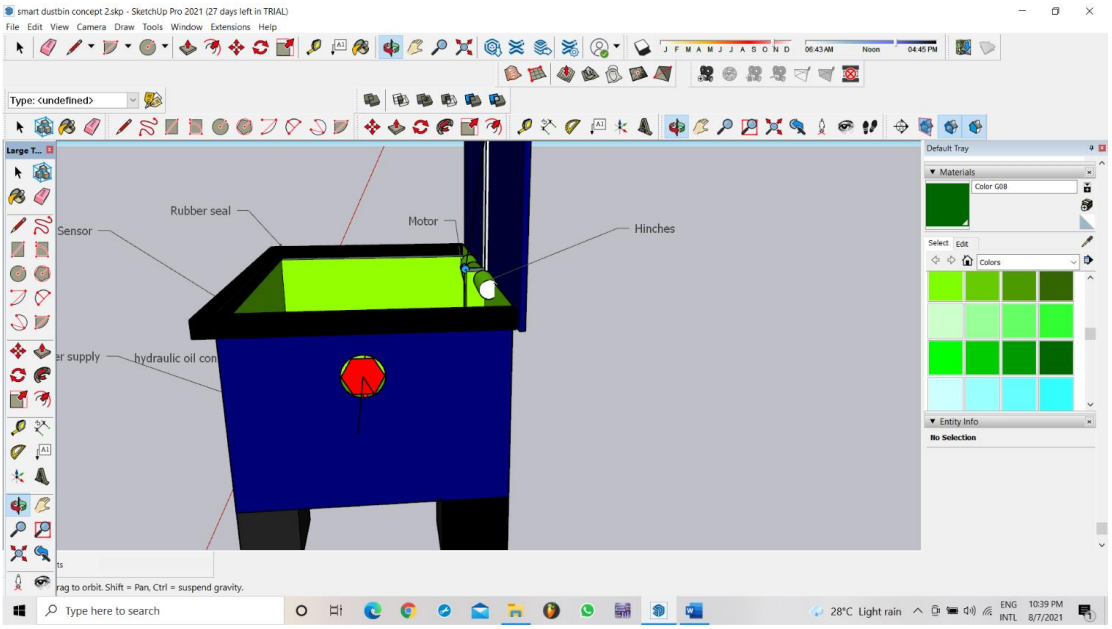


Figure 27 side view

Inside of this bin there is a bit to be explain. The main objects that I have included inside is a spring, a motor an iron wire, zip tie and a one-sided hydraulic cylinder.

5) The mechanism

In this design I have included an ultrasonic sensor to detect a person from 40 -60 cm moving near to the trash bin. Then with the help of the motor the lid will open automatically and after the man passes away from the detected area the lid is closing automatically. The lid when it's been closed, it is sealed with a rubber seal. When the level of the garbage bag has been filled the spring shrinks and that power is transmitted to the hydraulic cylinder and the piston transmits the power to the zip tie. So the zip tie is being pulled from out to inside and tie automatically.

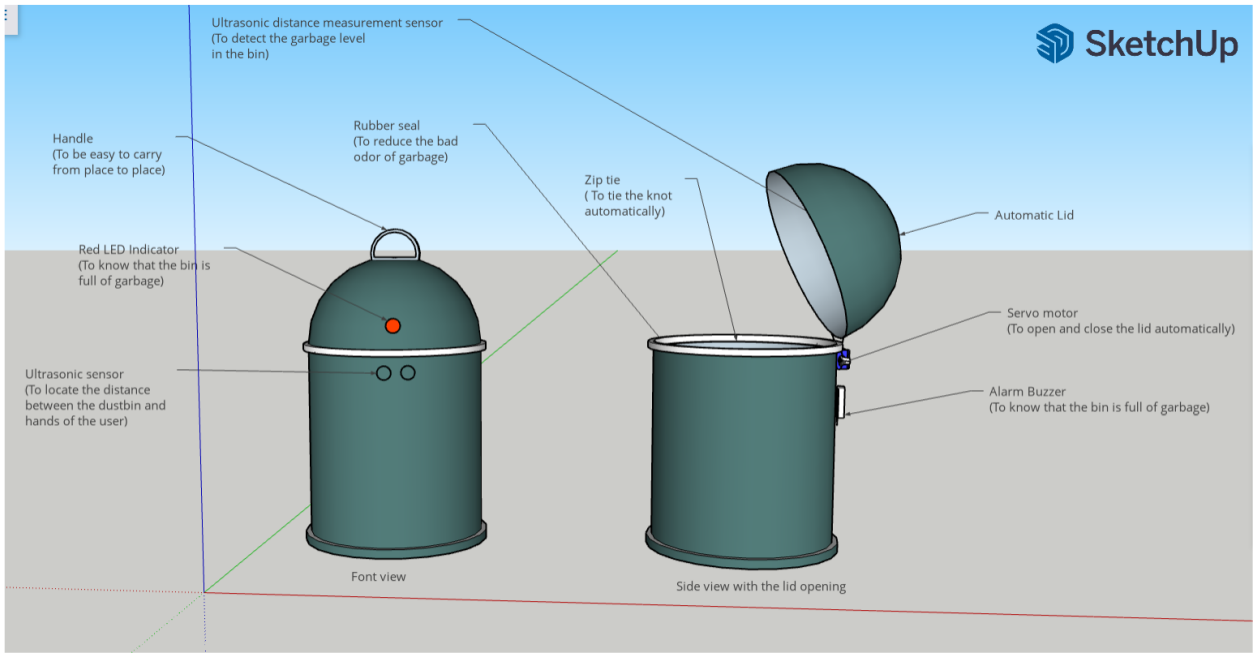


Figure 28 front view

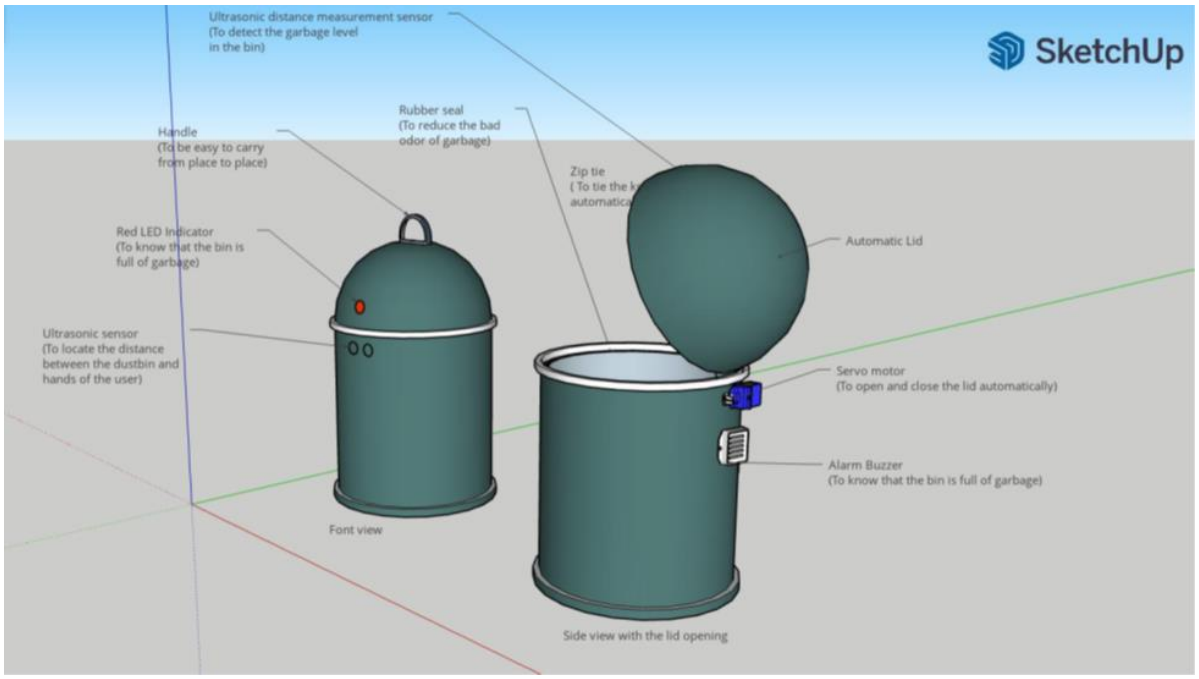


Figure 29 side view

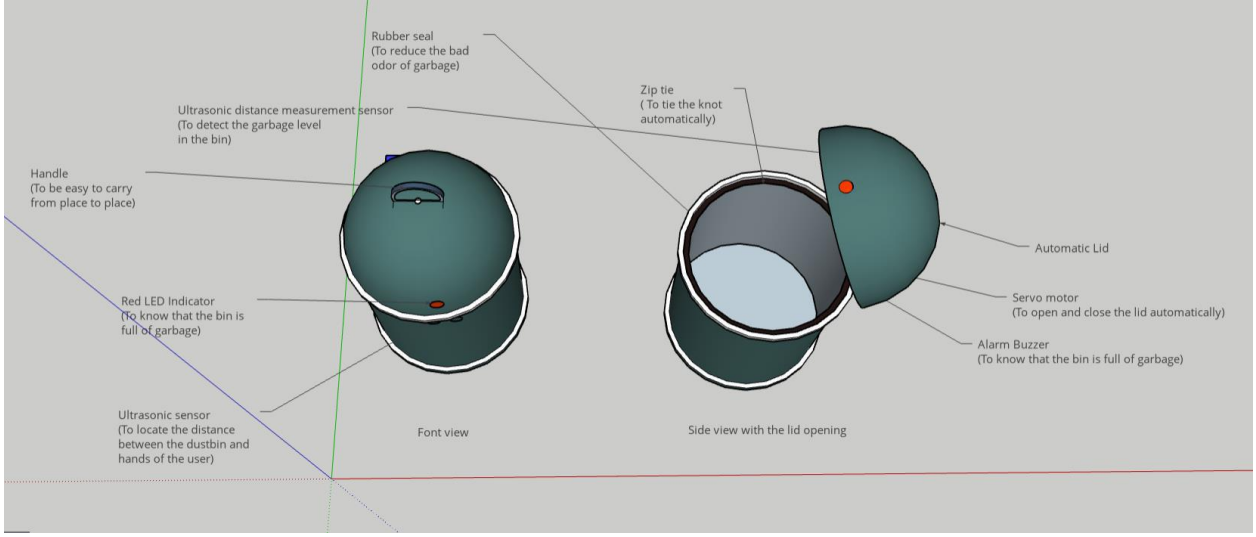


Figure 30 top view

This is the conceptual design I am presenting related to the problem and solution we have found over the past few weeks.

The problem we found was “Trash spilling out”. As a solution to this problem, we are going to add several new features and create a trash bin.

Below are the details related to the conceptual design of the trash bin that will be included with these new features.

- Automated lid- This lid is used to put the trash into the trash can without having touched it.
- Servo motor- This is used to set the lid to open and close automatically.
- Ultrasonic sensor- The front view of the trash bin fits a sensor to locate the distance between the bin and the hands of the user.
- Zip tie- A gutter is cut below the open edges of the trash bin and a zip tie is trapped in it.

Once it is known the trash is full, the zip tie tightens the knot with the help of a motor.

- Rubber seal- Rubber sealing system is used to seal the lid and trash can well.
- Ultrasonic distance measurement sensor- This sensor is placed to the top edge of the inside lid to detect the garbage level in the bin.
- Alarm Buzzer and Red LED indicator- These are applied to make it easier for humans to know after the bin is full of trash.
- Handle- This handle is used to move the trash can from place to place easily

Design Selection and Criteri

The five of us created 5 unique designs separately. Four of the designs we created are similar in shape to the cube. One of them is vertically cube shaped (**Ann's Design**) and other three are horizontally cube shaped (**Vilan's, Vinal's, Thinuri's Design**). The remaining design is cylindrical in shape (**Kasuni's Design**). Everyone was well-designed according to the best of their knowledge.We have selected one of those five designs according to these criteria.

1. **Clarity**

All designs were good, but Vilan's one was very detailed as he included a lot of things that needed to be included were made clear. He has made a good attempt to present the features of the system in his design and some important features have been demonstrated such as sensor to detect the person, type of motors to lift the lid considering the weight of the lid, zip tie mechanism, rubber seal. Anyone can get a very clear idea by looking at his design. Also, he has included many photos in many angles which helps to give the main idea to the customer.

2. **Usability**

In Vilan's design, he has mentioned the reason of choosing the components which can be done the work that we needed to do. Such as, he gave the reason for choosing IR sensor (to detect the people) in comparison to Ultrasonic describing the main points that it will be the best choice as it has the suitable range and the angle of coverage as we required there. Also, Vilan has mentioned some extra tools in his design which were missed by other four members. For an example, he included about having a manual button for zip tying which was not mentioned in our solution that we proposed. Also, he has included two tyers and handle which helps to make our product portable.

3. **Scalability**

We considered about the shape and the size of the dustbin in here. In both Vilan's and Ann's designs the have drew a person near the dustbin to give the best idea of its size. But Vilan's one is very clear, and viewer can get the idea of its size straightly. From that we can get a rough idea of the scale of the dustbin. None of us have included the exact measurements (height, cross sectional area, or volume, weight) of the product in our conceptual designs but we included them in the final design.

4. **Stability**

Also, there were two main shapes among our conceptual designs as I mentioned above. They are cube-shaped and cylindrical-shaped. We chose the cube shape for our design as it is more stable than the cylindrical one. The cylindrical shape one is more likely to roll over when happening sever weather conditions such as strong winds. Cylindrical shape is unique and attractive, but our focus is on preventing trash spilling out. So, we decided to choose cube shape to make as final product. Also, this leads to increase the safety of the product.

5. **Performance**

We chose to make our product according to the Vilan's design. But we added some more parts from other member's designs. We get an idea from Kasuni's one to include a buzzer to give the signal when the trash level is reached its maximum. We thought it will be a special and unique feature which can get the attraction of the customers as it will give the signal and make their work easier. Also, in Vilan's one, he has included power supply unit and has described how it works. In addition to that, he has included the closer view of the zip tie mechanism to give the right idea to the customer about its working process.

6. **Marketability**

Our final decision was to make our product according to Vilan's conceptual design as we thought it can reach the targeted market successfully. Because it is portable (with tyers and handle), robustness (although plastic, it is strong), the cost to the customer is minimum and it suits both indoors and outdoors. So, we thought that was the best design among our conceptual designs as it would meet customer needs in the same way.

Responsibility Identification

Table 18 responsibility identification

Product Development Team	Responsibilities
Purchasing	• Materials planning • Buying raw materials • Outsourcing parts • Sub-assembles • Quality control
Design Engineering	• Layout drawing • Detailed and Assembly drawings • Detail design performance analyses • Bills of materials • Patent, trademarks & copyrights
Industrial design	• Product trim details • Finish details • Product packaging
Manufacturing Engineering	• Fixer design fabrication • Process planning • Process equipment refurbishment • Equipment installation
Industrial Engineering	• Materials & Product flow • Material handling equipment • Faculty layout remodeling • Assembly planning (machines & workers) • Inventory warehousing
Production	• Worker training • Workforce scheduling • Tooling change over • Acceptance testing
Sales and Marketing	• Advertising campaign • Product launch • Owner's manual • Product warranty • Product literature

Responsibility Identification

Table 19 responsibility identification

Group Members	Contribution
Vilan Jayawardene	• Made the final design (product) • Contributed to both final report and final presentation • Actively participate in doing all past assignments • Made the final video
Vinal Gamage	• Actively participate in doing all past assignments • Contributed when making the final design • Contributed to both final report and final presentation • Helped Vilan to make the final video
Kasuni Dissanayake	• Gave a good contribution in every week when doing the past assignments • Done a lot in final presentation • Contributed when making final report • Gave the necessary ideas and helped in making the video
Thinuri Isaka	• Actively participate in doing all past assignments • Contributed to make final report • Helped Kasuni when making the final presentation • Gave the necessary ideas and helped in making the video
Anne Perera	• Gave a good contribution in every week when doing the past assignments • Contributed to make final report • Helped Kasuni when making the final presentation • Gave the necessary ideas and helped in making the video

Detailed design

Front, top and side elevation

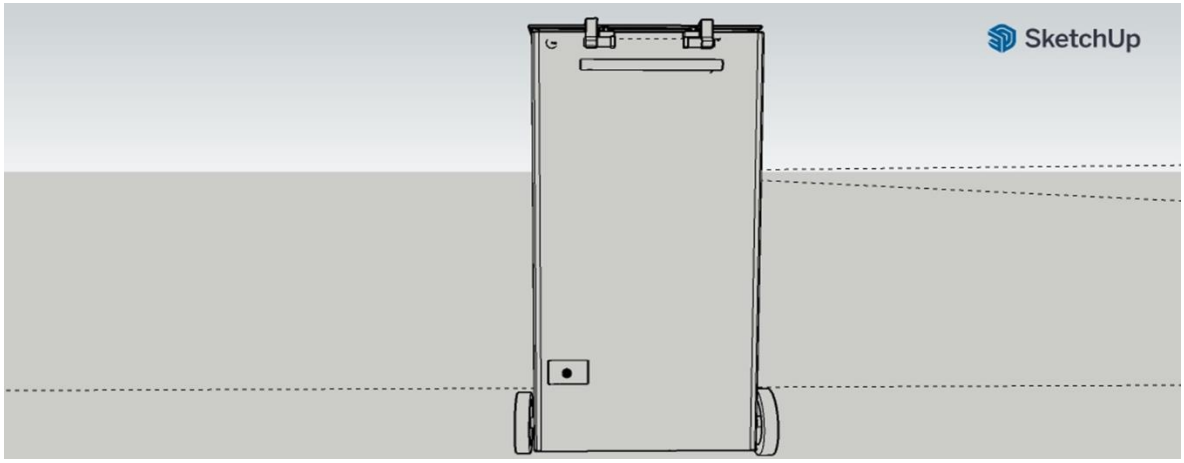


Figure 31 back view

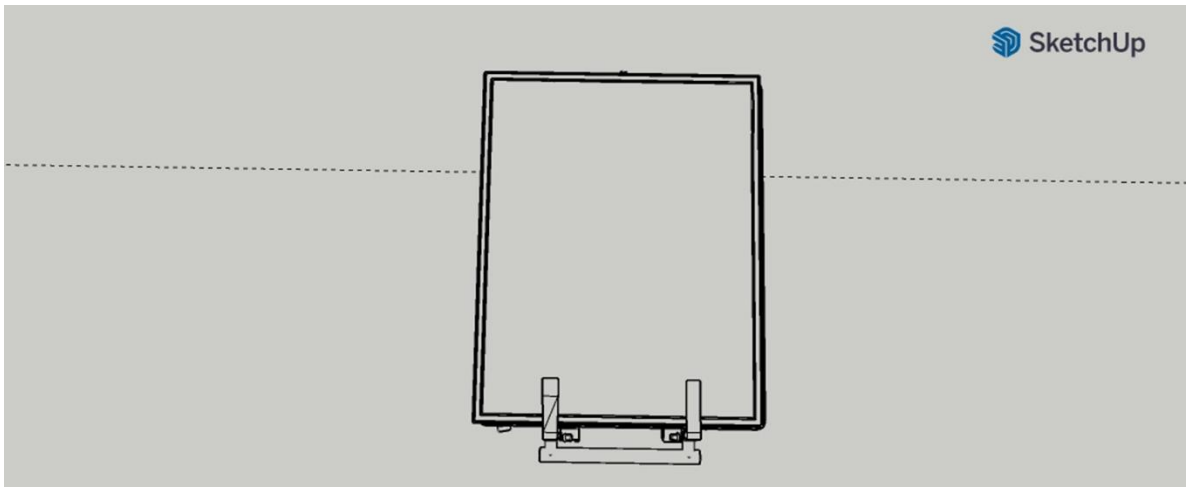


Figure 32 top view

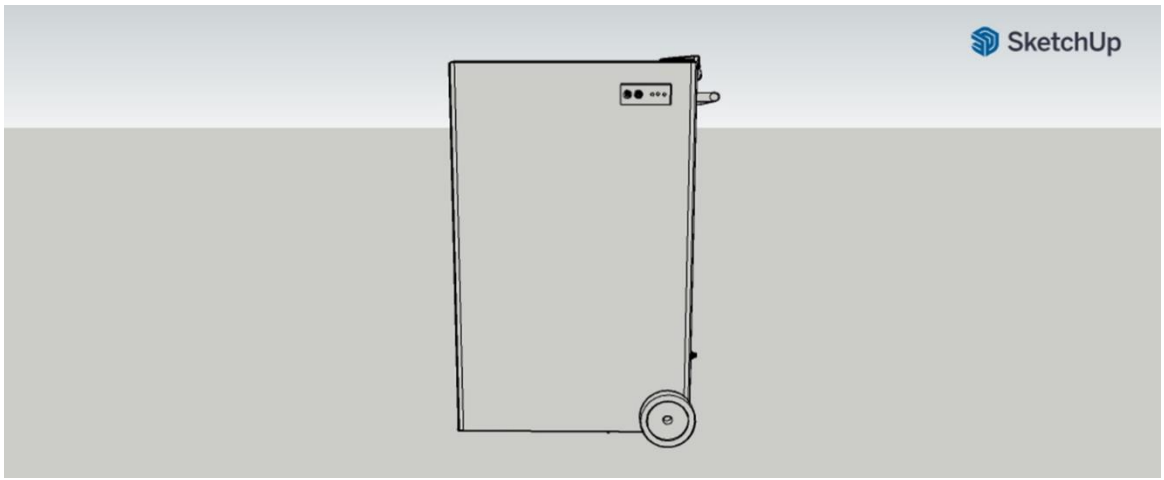
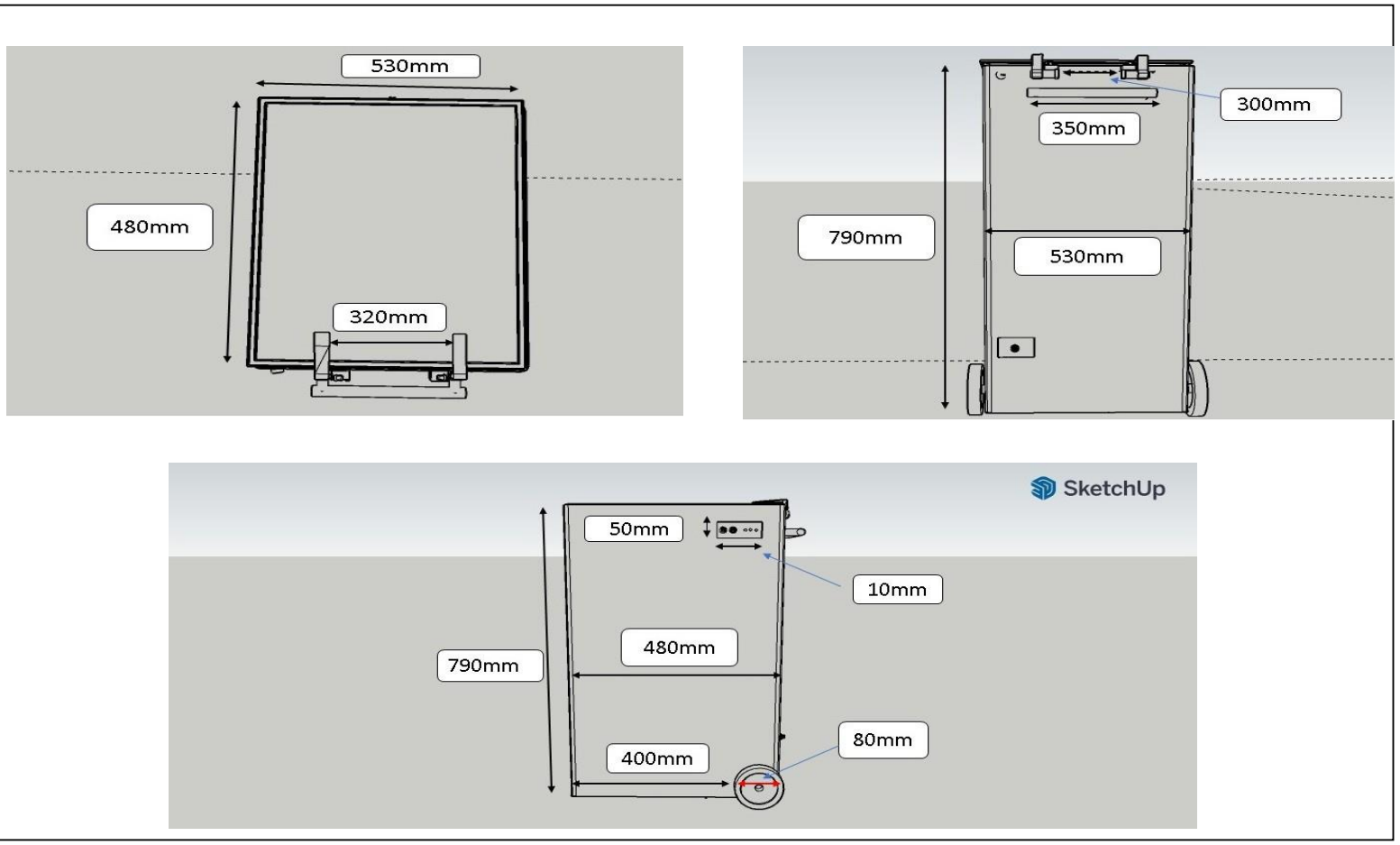


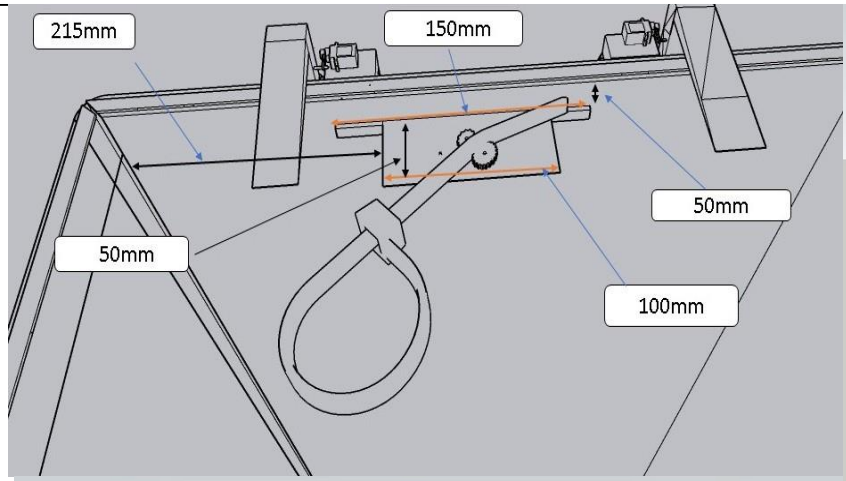
Figure 33 side view

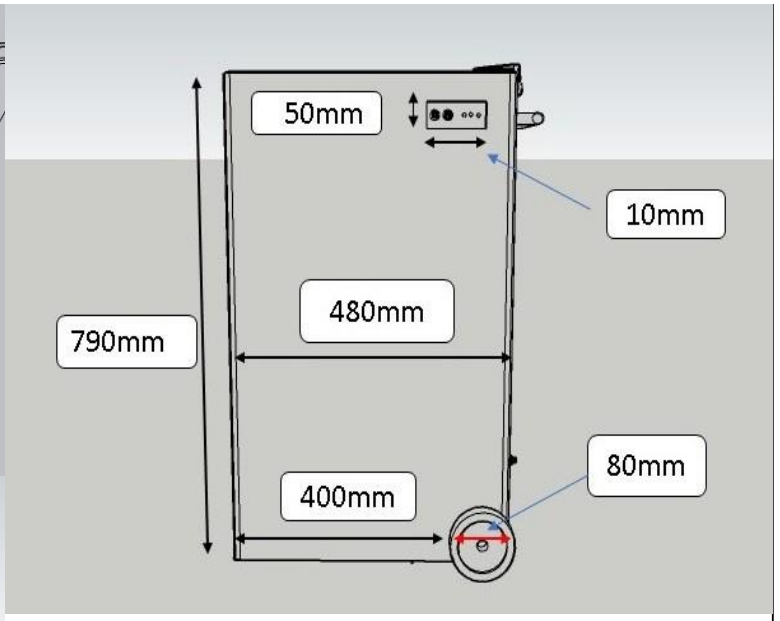
Dimensions

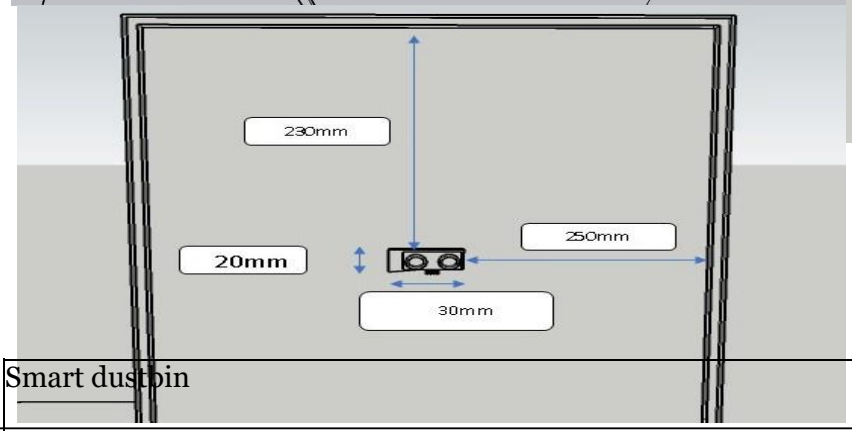


Smart dustbin	Detailed drawing 09/04/2021

Figure 34 detailed design

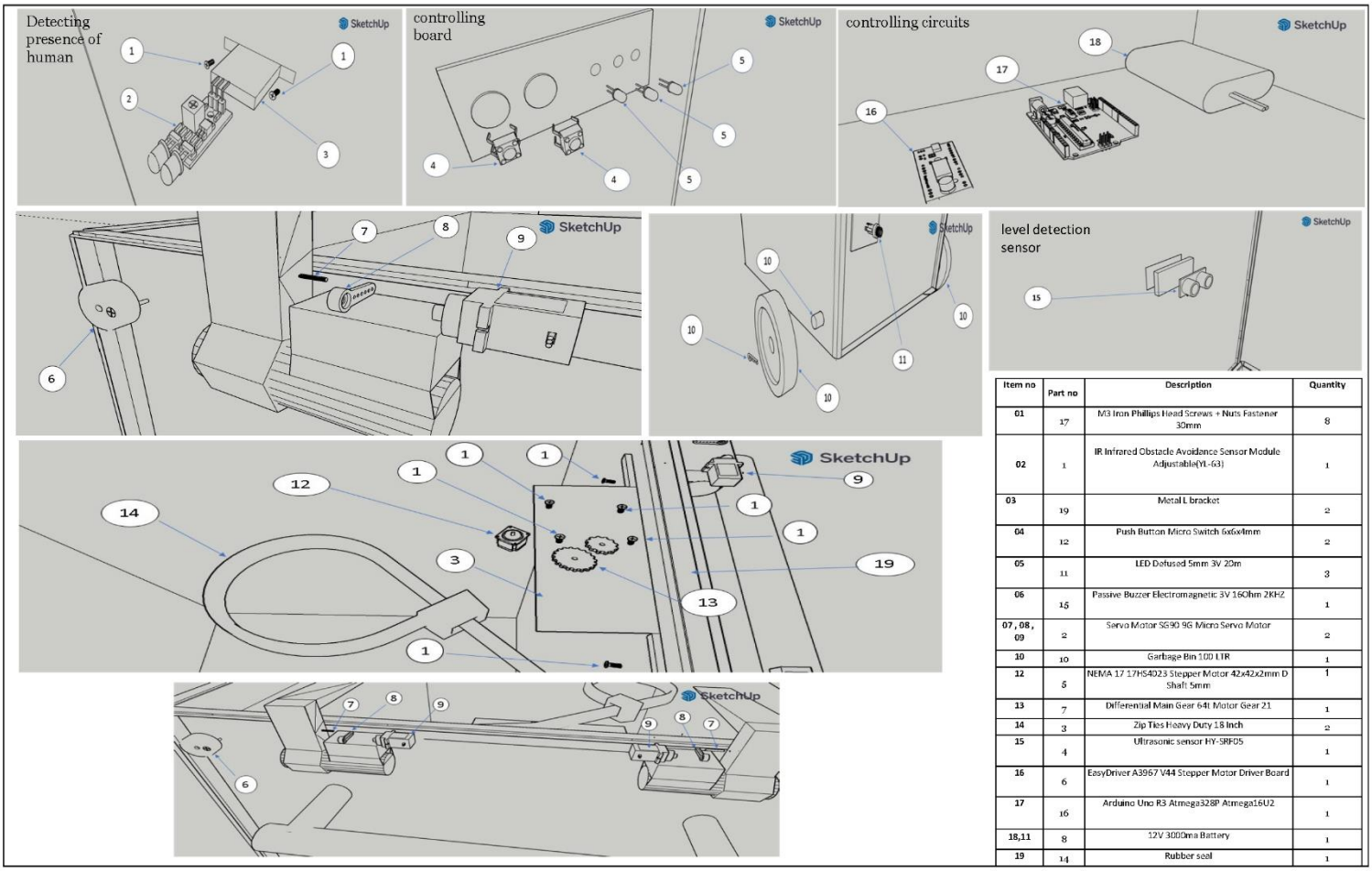






Smart dustbin	Detailed drawing
	09/04/2021

Figure 35 detailed design



Item no	Part no	Description	Quantity
01	17	M3 Iron Phillips Head Screws + Nuts Fastener 30mm	8
02	1	IR Infrared Obstacle Avoidance Sensor Module Adjustable(YL-63)	1
03	19	Metal L bracket	2
04	12	Push Button Micro Switch 6x6x4mm	2
05	11	LED Defused 5mm 3V 20m	3
06	15	Passive Buzzer Electromagnetic 3V 160hm 2KHZ	1
07 , 08 , 09	2	Servo Motor SG90 9G Micro Servo Motor	2
10	10	Garbage Bin 100 LTR	1
12	5	NEMA 17 17HS4023 Stepper Motor 42x42x2mm D Shaft 5mm	1
13	7	Differential Main Gear 64t Motor Gear 21	1
14	3	Zip Ties Heavy Duty 18 Inch	2
15	4	Ultrasonic sensor HY-SRF05	1
16	6	EasyDriver A3967 V44 Stepper Motor Driver Board	1
17	16	Arduino Uno R3 Atmega328P Atmega16U2	1
18,11	8	12V 3000ma Battery	1
19	14	Rubber seal	1

Smart dustbin	Assembly drawing	Group 05	03
	09/04/2021	EN21466830 Vilan Jayawardene EN21485640 Vinal Gamage EN21492716 Kasuni Dissanayake EN21482120 Dulanthi Perera EN21492716 Thinuri isaka	A

Figure 36 assembly drawing

Table 20 assembly drawing

Item no	Part no	Description	Quantity
01	17	M3 Iron Phillips Head Screws + Nuts Fastener30mm	8
02	1	IR Infrared Obstacle Avoidance Sensor ModuleAdjustable(YL-63)	1
03 , 11	19	Metal L bracket	2
04	12	Push Button Micro Switch 6x6x4mm	2
05	11	LED Defused 5mm 3V 20m	3
06	15	Passive Buzzer Electromagnetic 3V 16Ohm 2KHZ	1
07 , 08 , 09	2	Servo Motor SG90 9G Micro Servo Motor	2
10	10	Garbage Bin 100 LTR	1
12	5	NEMA 17 17HS4023 Stepper Motor 42x42x2mm DShaft 5mm	1
13	7	Differential Main Gear 64t Motor Gear 21	1
14	3	Zip Ties Heavy Duty 18 Inch	2
15	4	Ultrasonic sensor HY-SRF05	1
16	6	EasyDriver A3967 V44 Stepper Motor Driver Board	1
17	16	Arduino Uno R3 Atmega328P Atmega16U2	1
18	8	12V 3000ma Battery	1
19	14	Rubber seal	1

03 .assembling mechanism

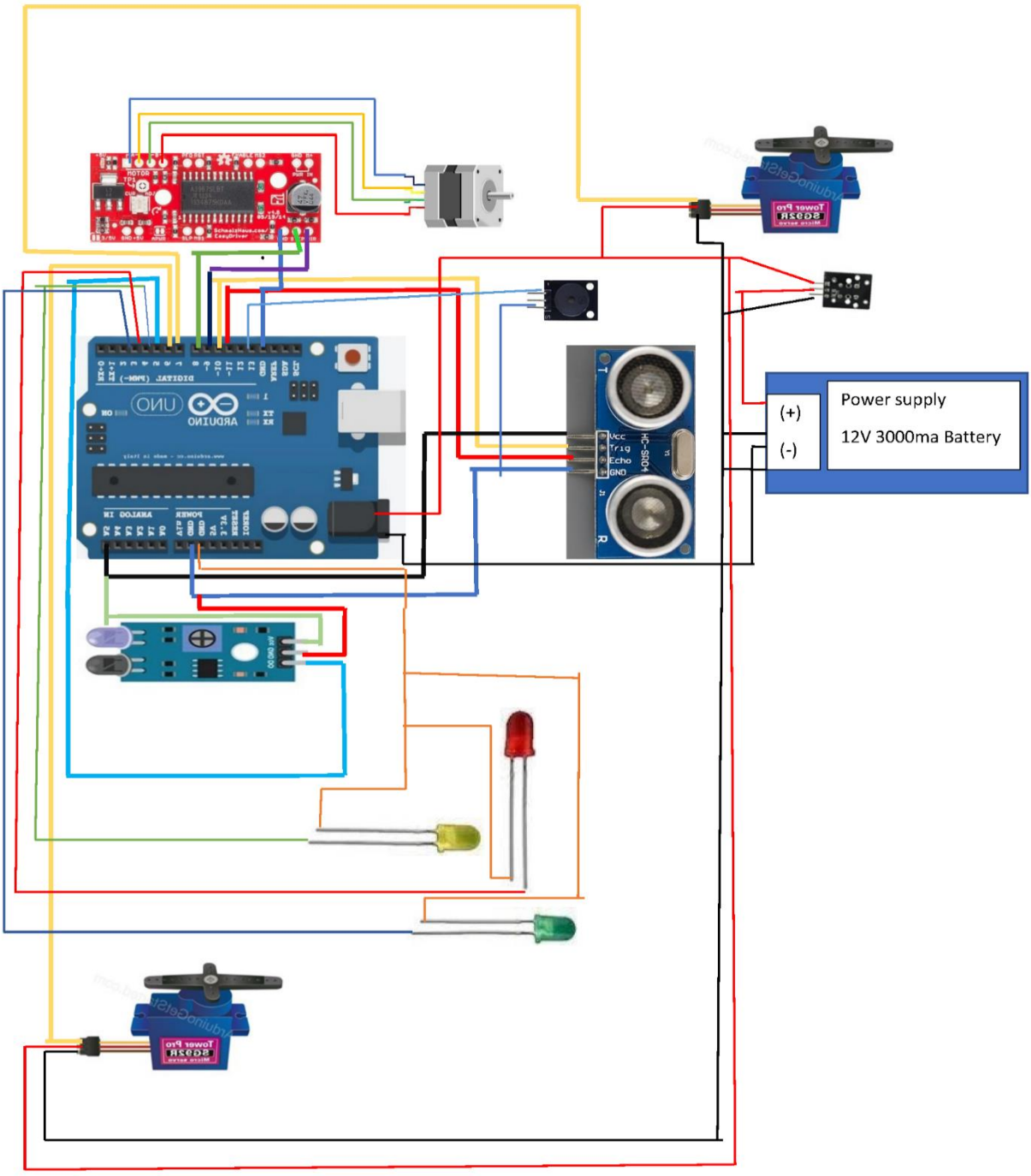


Figure 37 assembly mechanism

Bill of Material

Table 21 bill of material

	Item number	Quantity	Item name	Item description
Components used for detecting a person and opening of the lid	1	1	IR Infrared Obstacle Avoidance Sensor Module Adjustable (YL-63)	infrared sensor emits and/or detects infrared radiation to sense its surroundings
	2	2	Servo Motor SG90 9G Micro Servo Motor	servos can lift about 3.75lbs that is positioned on an arm 1cm out from the shaft Servo can rotate approximately 180 degrees (90 in each direction)
Components used to detect garbage level and sealing trash bag	3	1	Zip Ties Heavy Duty 18 Inch	Sealing the trash bag is done from the zip tie
	4	1	Ultrasonic sensor HY-SRF05	An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves
	5	1	NEMA 17 17HS4023 Stepper Motor 42x42x2mm D Shaft 5mm	The gear rod is connected to the gear rod which pulls the zip tie sealing the trash bag
	6	1	EasyDriver A3967 V44 Stepper Motor Driver Board	It provides much more flexibility and control over your stepper motor
	7	1	Differential Main Gear 64t Motor Gear 21	Pulling the zip tie from its groves

Components used for charging device	8	1	12V 3000mA Battery	Rechargeable Li-ion battery that can be used multiple times
	9	1	12.6V 1.3A SMPS Charger	Connects mains power with on board battery system
Other components	10	1	Garbage Bin 100 LTR	
	11	1	LED 3mm Water Clear 20mA	LEDS that will allow displaying information battery level.
	12	2	Push Button Micro Switch 6x6x4mm	For making and breaking of electric current in a circuit
	13	1	Jumper Wire	Wires to connect microcontroller with each electronic component
	14	1	Rubber seal	serve as a static seal between flat surfaces
	15	1	Passive Buzzer Electromagnetic 3V 16Ohm 2KHZ	The buzzer is a sounding device that can convert audio signals into sound signals
	16	1	Arduino Uno R3 Atmega328P Atmega16U2	The board has 14 digital I/O pins, 6 analogue I/O pins
	17	8	M3 Iron Phillips Head Screws + Nuts Fastener 30mm	Attaching components to the metal L bracket.
	18	2	Metal L bracket	Allowing components to be screwed and attached

Economics in design

Table 22 economics in design

Item name		**Cost per 1 (LKR)**	**Quantity**	**Total (LKR)**
for detecting a person and opening of the lid	IR Infrared Obstacle Avoidance Sensor Module Adjustable (YL-63	Rs.130.00	1	Rs.130.00
	Servo Motor SG90 9G Micro Servo Motor	Rs.330.00	2	Rs.660.00
detect garbage level and sealing trash bag	Zip Ties Heavy Duty 18 Inch	Rs.22.00	2	Rs.44.00
	Ultrasonic sensor HY-SRF05	Rs.225.00	1	Rs.225.00
	NEMA 17 17HS4023 Stepper Motor 42x42x2mm D Shaft 5mm	Rs.1,250.00	1	Rs.1,250.00
	EasyDriver A3967 V44 Stepper Motor Driver Board	Rs.380.00	1	Rs.380.00
	Differential Main Gear 64t Motor Gear 21	Rs.50.00	1	Rs.50.00

charging device	12V 3000mA Battery	Rs.2,290.00	1	Rs.2,290.00
	12.6V 1.3A SMPS Charger			
Other components	Garbage Bin 100 LTR	Rs.6,975	1	Rs.6,975.00
	LED Defused 5mm 3V 20m	Rs.2.5.00	3	Rs.7.50
	Push Button Micro Switch 6x6x4mm	Rs.6.00	2	Rs.12.00
	Jumper Wire	Rs.180.00	1	Rs.180.00
	Rubber seal	Rs.200.00	1	Rs.200.00
	Passive Buzzer Electromagnetic 3V 16Ohm 2KHZ	Rs.50.00	1	Rs.50.00
	Arduino Uno R3 Atmega328P Atmega16U2	Rs.1,571.00	1	Rs.1,571.00
	M3 Iron Phillips Head Screws + Nuts Fastener 30mm	Rs.7.5.00	8	Rs.60.00
	Metal L bracket	Rs.20.00	2	Rs.40.00
Total cost				**Rs. 14124.50**

Sunk and Opportunity Cost

Sunk Cost

A sunk cost is a cost that has already been incurred and cannot be recovered. Sunk costs are contrasted with prospective costs, which are future costs that may be avoided if action is taken.

A sunk cost refers to money that has already been spent and cannot be recovered.

Table 23 sunk cost

Small scale	Cost (Rs /=) (Per month)
Cost of the software used in the system (Arduino)	1790
Communication cost (One member to another)	400
Buying equipment's for trash can	2000
Total	4190

Opportunity Cost

Opportunity cost is the profit lost when one alternative is selected over another.

The concept is useful simply as a reminder to examine all reasonable alternative before making a decision.

In the previous assessment as we considered that some materials are the best for the designing this trash bin, so the same opportunity costs are there for both small and large scale.

Table 24 opportunity cost

Opportunity cost	
	Cost (Rs/=) (Cost per month)
Cost of using IR sensor instead of ultrasonic sensors when measuring the trash level	130
Cost of using SG995 servo motor instead of stepper motor when sealing the trash bag	330
Total	460

Fixed and Variable costs

Fixed Cost

A fixed cost is a cost that does not change with an increase or decrease in the amount of goods or services produced or sold.

Table 25 fixed cost

Fixed cost			
Small scale	Cost (Rs/=) (Cost per month)	Large scale	Cost (Rs/=) (per month)
Maintenance of the trash can	5000	Depreciation	500
Advertising	15000	Rental cost	20,000
Cost of developing software used	4000	Property taxes	1800
		Utility payments	4000
		Labor cost (per month)	10,000
Total	24000		36,300

Variable cost

A variable cost is an ongoing cost that changes in value according to factors like sales revenue and output.

Variable costs mainly include raw materials and distribution costs of the trash can

Table 26 variable cost

Variable cost			
Small scale (per trash bin)	Cost (Rs/=)	Large scale	Cost (Rs/=) (per month)
Cost of raw materials (such as gear rods, red, orange buttons, tires ...)	14,024.50	Cost of raw materials	1402450
Labor cost	400	Wages and commissions	80,000
Cost for the electricity	200	Cost of assembly	50,000
Cost of packaging	200	Cost of packaging	10,000
		Part time staff for designing the trash can	30,000
Total	14,824.5		1572,450

Recurring and Nonrecurring costs

Recurring Costs

- Recurring costs are occurring repeatedly at regular intervals.
- It happens again and again during the from the manufacture process to the disposal.
- Most of the variable costs are recurring costs as they repeat with each unit of output.
- Fixed costs which are paid on a repeatable basis are also recurring costs.

Table 27 recurring cost

Recurring costs	
Small scale (for one trash bin)	**Cost per month (Rs /=)**
Costs of direct labor	30000
Depreciation expense	1000
Electricity	1000
Transport costs	1000
Total	40000

Nonrecurring Costs

- The costs that not to be repeated are called as nonrecurring costs.
- This type of cost happens only one time during the manufacturing process.

Table 28 non recurring cost

Nonrecurring costs	
Small scale (for one trash bin)	**Cost per month (Rs /=)**
Costs of materials/equipment	14024.5
Receiving and shipping	2000

Sales commissions	1000
Total	17024.5

Direct and Indirect costs

Direct Costs

- Direct costs are the costs that can be directly related to the products or services being produced.
- They are directly attributable to the object, and it is financially feasible to do so.
- Direct costs are those for activities or services that benefit specific projects.

Table 29 direct cost

Direct costs	
Small scale (for one trash bin)	**Cost per month (Rs /=)**
Direct materials	14024.5
Costs of equipment	2000
Costs of direct labor	30000
Sales commissions	1000
Depreciation expense	1000
Total	48024.5

Indirect Costs

- The costs which are not directly accountable to a cost object is called as indirect cost.
- These types of costs are not going to connect directly with the product.
- They are difficult to allocate to a specific output or activity.
- Indirect costs may be either fixed or variable.

Table 30 indirect cost

Indirect costs	
Small scale (for one trash bin0	**Cost per month (Rs /=)**
Indirect raw materials	100
Electricity	1000
Rental cost	20000
Production salaries	5000
Total	26100

A Proposal to Minimize the Cost

Investment cost

The capital for the manufacturing process must be done within the budget. We need to see and reduce the cost for each step in- manufacturing.

1.Costs when purchasing the components for the device

- Gain the advantage of pitching the right demands for a lower cost and acquiring the best materials, researching, and learning the current demand rates, the prices per material from websites. We must try to negotiate the prices with different vendors to obtain the components at a reasonable price.

2.Inventory Optimization

- We must check the inventory carefully, in order to take advantage of existing supplies. Make a list of cheapest raw material suppliers and we can start contacting them to elaborate.

3.Optimizing Labor, Tools, and machinery

- Always take qualified employees will save money and time. Though skilled labors demand higher pay rates, unskilled labors make expensive errors that might harm even the customer base.
- When assembling electronic circuits expensive tools and equipment are not needed because it is not much complicated.
- Since the product is not made in batches expensive machines are not required

4. Transportation

- This must be done by a guaranteed delivery service. If we can cover one area with one delivery, we can reduce the cost of delivery charges. When ordering the materials, we must take goods by one dealer.

Operation & Maintenance Costs

- This product should be operated according to the instructions given by the instructions in the user manual.
- This device must be inspected by a skilled technician in every 6 months for maintenance purposes.

Annual Expenses Later Year

- The rubber seal should change every year for better experience, or it depends according to customer usage.

Environmental and Social Consequences

- This device can be used both indoors and outdoors. This device is mostly designed for outdoor usage such as hospitals, main cities.

Unrecyclable components

Components that take a long-time duration to decay and cannot be reusable. But with research and advancements in technology they could become resources now a days. We have to limit these unrecyclable components because it is harder to dispose.

Table 31 proposal for design for the environment

Goals	The power supply unit of the trash bin	Using a Solar system to gain power when used in outdoors
	The material that is used to make the dustbin.	The structure can be made by recyclable plastic.
	The mechanism of the zip tie	Using an hydraulic system for long lasting usage
	Pollution Prevention	The zip tie which ties automatically should be fully airtight so no hazardous gases pollute the area.

This product is almost an environmentally friendly product and will be more if we could do the necessary changes of the above product.

Making Cost Equations

$$C = D + \frac{(I + F)}{Q}$$

$$C = (A+B+E+G+H) + \frac{(J+K+L+M+N+P+R)}{Q}$$

C – Total cost

D – Direct cost per unit

A-Direct materials

B-Costs of equipment

E-Costs of direct labor

G-Sales commissions

H-Depreciation expense

I - Indirect costs

J-Indirect raw materials

K-Electricity

L-Rental cost

M-Production salaries

F – Fixed costs

N-Regular maintenance of the trash bin

P-Advertising

R-Cost of developing software used

Q – Quantity

D – Direct cost per unit

Table 32 direct cost per unit

Costs	Price per month (Rs)
1) Direct materials	14024.50
2) Costs of equipment	2000
3) Costs of direct labor	30000
4) Sales commissions	1000
5) Depreciation expense	1000
Total	48024.5

I – Indirect cost per unit

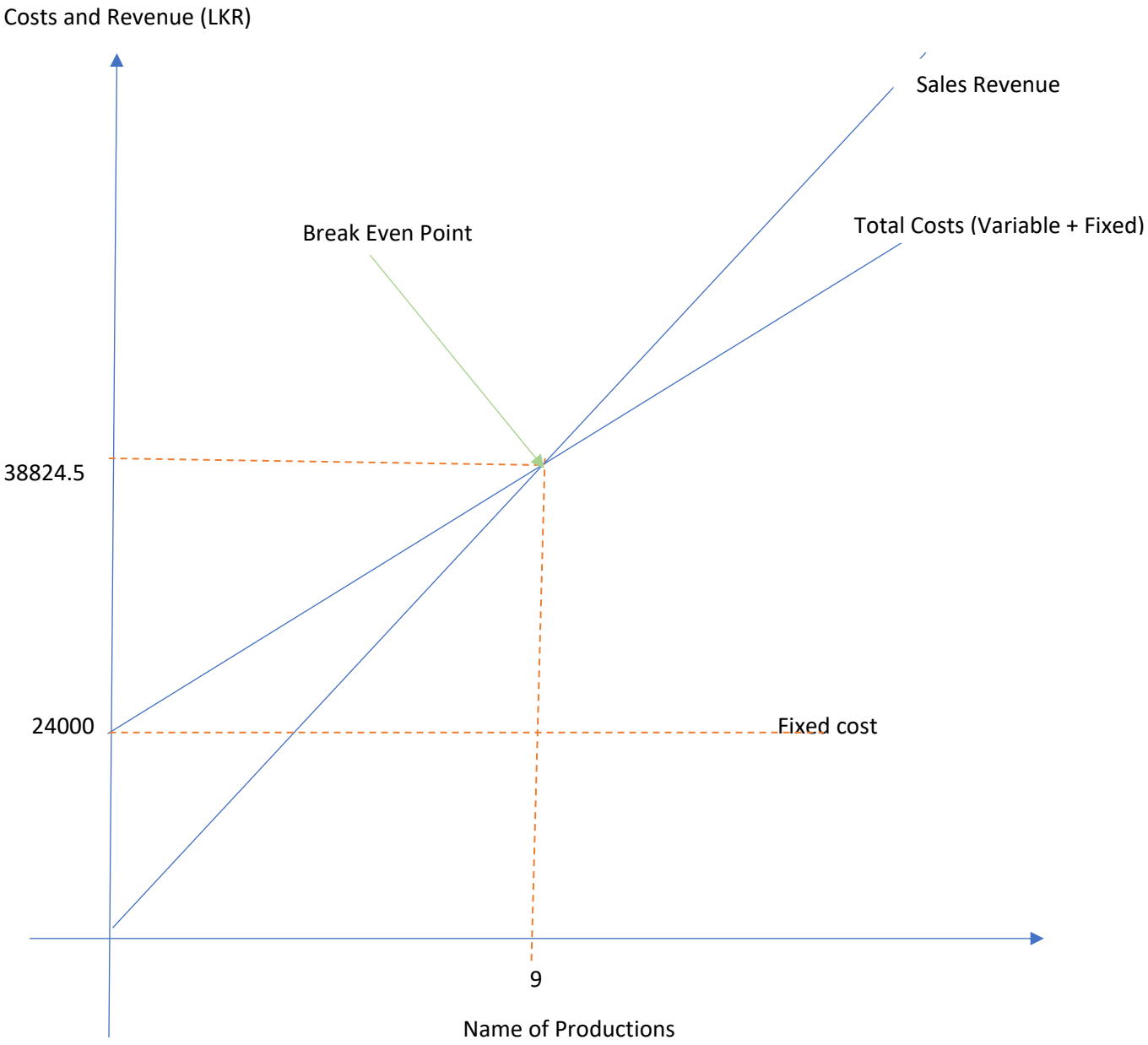
Table 33 indirect cost

Costs	Price per month (Rs)
1)Indirect raw materials	100
2)Electricity	1000
3)Rental cost	20000
4)Production salaries	5000
Total	26100

F- Fixed cost per unit

Table 34 fixed cost

Costs	Price per unit (Rs)
1) Regular maintenance of the trash can	5000
2) Advertising	15000
3) Cost of developing software used	4000
Total	24000



This estimate was calculated only by considering small scale production.

- Revenue per unit – 17500 lkr
- Variable cost per unit – 14824.5 lkr
- Fixed Cost – 24000 lkr

Break-even Point (units) = Fixed Costs/ (Revenue per unit - Variable cost per unit)

= 24000 / (17500 – 14824.5)

= 8.970 approximately 9

Table 35 make/buy decisions

Item	**Make/Buy**	**Justification**
1) IR sensor(active)	Buy	It is an optoelectronic component and its mechanism is complicated to build. Due to our lack of knowledge to set up that mechanism and limited budget to pay for labor costs, we decided to buy that.
2) Ultrasonic sensor	Buy	
3) Servo Motor SG90	Buy	It is complicated to make and also the motor contributes a lot to the performance of our dustbin. Therefore, it is cheaper to buy a quality one.
4) Stepper Motor	Buy	
5) Zip Ties Heavy Duty 18 Inch	Buy	It is not practical to make a zip tie because we have to spend some time on that. So, it is more advantageous to buy.
6)Easy Driver 44	Buy	We haven't enough knowledge to set up an easy driver. Therefore, we decided to purchase one.
7) Gear rod	Buy	It needs a higher manufacturing cost and a large power plant. Therefore, it is more profitable to buy without making.
8) 12V 3000mA Battery	Buy	We decided to buy it because it is available in standard industry sizes as we required. Also, it has inherently safe chemistry and longest life than we create.
9) 12.6V 1.3A SMPS Charger	Buy	It needs an initial cost to make and we cannot afford that because of the limited budget.
10) Garbage Bin 100 LTR	Buy	The raw materials that need to make the trash bin are not readily available. And also, it makes no sense to make it because our product is small. When we consider the cost of making our bin, it is higher than the price we buy. Therefore, we think to buy it from a shop.
11) LED Defused 5mm 3V 20m	Buy	We buy them because they have an exceptional color range to choose from as we want and they are reliable than making. Also, it takes some time to make.

12) Push Button Micro Switch 6x6x4mm	Buy	Proper plan is needed to set up a switch and it is more expensive compared to network time frames. So, it is cheaper to purchase a one.
13) Jumper Wire	Buy	Manufacturing wires requires high accuracy machinery and it needs a high cost. Therefore, we decided to buy.
14) Rubber seal	Buy	We have to get the skill labors for making a rubber seal. We cannot afford that since the budget is limited.
15) Passive Buzzer Electromagnetic 3V 16Ohm 2KHZ	Buy	Making a buzzer is a little hard and time consuming to build. Therefore, we decided to buy one.
16) Arduino Uno R3 Atmega328P Atmega16U2	Buy	It is not easy to make Arduinos as it needs to be advanced knowledge of sub-component. It also requires the latest equipment to manufacture. So, it is better to purchase.

Methodology

We started doing assignments for the EPDC module from 28th of June, as we made our group on that day. Our first assignment was to find some update problems what we face in our daily lives as well as those related to industry or cultivation. We found many problems and selected only best 5 of them. Also, we had to decide one solution that fits each problem we have found. Then we done a presentation regarding the problems and our solutions. After that, Mr. Deelaka, one of the instructors, told us to select the Poor Garbage Management one as our identified problem as the solution we proposed, fits with the problem and it could be worked and would be came out as a good result.

In next week assignment we were told to find the needs, objectives, constrains and limitations of our solution (smart dustbin). In addition to that we included the Problem Statement in there. Also, we done a survey which is helped to clarify the needs and select best objectives for our product according to the customer requirements. Then, in the 4th week assignment, we included the Initial objective list, Intended objective list along with the revised problem statement. During those two weeks, we learnt about the difference between needs and objective, how to do a survey to collect information.

We made one Mind map and one Ishikawa diagram as the 5th week assignment. Mind map was not a new thing for us, but the Ishikawa diagram was, as we learnt it for the first time during the lecture. We draw both diagrams and showed it to our instructor and made some changes according to her advice. In next week we had to make 5 conceptual designs one by one, and we were told to use specific software or app to draw our designs. All the members done it and gained marks successfully for that assignment. We used 'Sketch Up' to draw all 5 designs. It was the first experience for all five members, but we succeed it.

In next week, we had to do our assignment under the topic of Conceptual design & Evaluation of alternative for a smart dustbin. There, we included Functional decomposition diagram, User interaction activities, Functions & Sub-functions, Input & Output of each function, Alternatives, Physical principles, Working principles and Abstract embodiment of each alternative. At last, we added the Alternative combination table (Morphological Matrices). All those were new for us, but we learnt them from the lecture in that week. So, we could complete it anyhow. From the 8th week, our mid semester examination was started and the deadline for that week's assignment was extended by the lecture, as many students requested to do it. So, we completed the next assignment during the 9th week. There, we were told to make the Economics in Design. Under that specific topic, we included, Bill of material, Cost estimate (Bottom-up-approach), Sunk & Opportunity Costs, Fixed & Variable Costs, Recurring & Nonrecurring Costs, Direct & Indirect Costs, Break Even Analysis, A proposal to minimize the cot, A proposal for design for the environment, Make/Buy Decision and lastly the Marketing Plan. All those things were mentioned by the lecturer during that week's lecture. We divided all those activities what we had to do, among the members and completed it by doing part by part as it was the easiest and fastest method for complete the assignment successfully on time. Before making the final report, we have done one assignment lastly. That was Detailed drawing, Assembly drawing & Assembly mechanism. Along with those three, we attached the Bill of material, Cost estimate tables as it was required to attach.

Then lastly, we reached the final stage of this module's assignment and that was making the Final Report. In addition to that, we were told to make the final presentation and the video of our product. All those three was given to do parallelly as it might take too long to finish making them. We started to make the final report firstly. For that, we divided all the topics that we must follow when making the report, among the members equally, as doing it part by part is more successful than any method. Then, along with doing that, we started to make the presentation and the video as we thought that both of presentation and video would

take time to finish. Three girls of our group were mainly involved with the presentation while the two boys were making the video. That was how we done this. We made some changes in the content of the final report according to the instructor's advice and the feedbacks which she has given in past weeks for the previous assignments. This is the end of this project, and it will over with presenting our video. We hope we done this assignment successfully and hope it will come as a good output as we expected.

Marketing Plan

The target market:

Our target market consists of Hospitals, Houses, Universities, Restaurants.

1) **Hospitals**

Dustbin that can be installed in hospitals and medical centers dealing with the COVID-19 pandemic for contactless waste collection and disposal, leading to a safer environment for front-line workers. While we are dealing with the spread of COVID-19, hazardous waste is being generated in hospitals. They are potential sources of coronavirus and can cause further spread within the locality. This makes timely clean-up of bins vital along with other best practices for disinfection to prevent further spread of COVID-19.

2) **Houses**

The proposed dustbin will reduce the labor work, time, and cost that are very high in the traditional garbage system. smart dustbin which will help in keeping our environment clean and also eco friendly.

3) **Universities**

Garbage bins overflowing at universities due to the students careless and negligence so that breeding various animals near the trash bins and it creates unhygienic surroundings, lousy odor which leads to the spread of deadly diseases and human illness. So smart dustbin helps to create cleaner, safer more hygienic environment surrounding the universities.

4) **Restaurants**

Another target market is restaurants, we can minimize bad smell and potential spread of germs from the food waste in garbage bins. This trash bin system will reduce the manpower and save the time.

Advertising strategy

1) **TV advertisements**
   Very efficient way to deliver the product to everyone.

2) **Social media marketing**
   Social media has become a leading stream of marketing in modern world.

3) **Newspaper articles**
   This way is to introduce the product to people who are not very familiar with social media.

Current situation

- Background to sustainable offering

Smart Bin is revolutionizing that is important for managing collection operations using unique container intelligence. The creative problem solving, and situation analysis are effective for new marketing offering. The Smart Bin can be charged by 12V 3000ma Battery and that is cheapest and easily available to everyone. It is the effective revolution to prevent spreading the smell in the surrounding area. The creative problem solving is important in the marketing plan for promoting the new offering in the marketplace. This marketing plan for innovation will be effective to consider the behavior of the people.

- Environmental analysis

The strategic tools are such as SWOT analysis are important in the marketing plan for identifying the situations in the context of Smart Bin. It is the innovation and part of technology that will help to improve the environment condition by reducing the waste and will have the positive impact on the society.

- Market and customer analysis

Smart Bin helps to reduce the waste and create the friendly environment. This new offering will be important for companies. For example, hospital as well as hospitality sectors will use this bin that will prevent the bad smell in the environment. This new revolution will increase the market growth in Sri Lanka. The people will throw the waste in the right bin to reduce the environmental pollution.

The major driving factors of Smart trash bin market are as follows:

- Touchless trash bins offering convenience and preventing cross-contamination of germs
- Product innovation and technology improvement
- Smart cities and efficient waste management systems

The challenges factors of Smart trash bin market are as follows:

- Low and slow adoption of smart solutions in developing countries
- Technology providers that can convert any trash bin into a smart one restricting growth of market

The trends of Smart trash bin market are as follows:

- Entering the market with differentiated offerings
- Small and private label players increasing their presence
- The Smart trash bin market is segmented on the lines of its products, end user, retail format and regional. Based on end user segmentation it covers residential segment and commercial segment.

Timeline

Expected timeline in the beginning of the project.

- In the first day Sir told us to form groups with 5 members, this was a hard task to come up with because we haven't seen each other before. So, we came up with some bunch of new friends and got to know each other well.
- At the beginning of the project, we had no idea how long we'll take to complete it. But our deadline was on the 12th week. Therefore, we decided to complete the project within that time duration (a period of 12 weeks).
- We started and did all the work according to the rubrics, instructions given by our instructor.
- We always went through the lecture notes and the recordings which were uploaded each week.
- Even though the first marks in the presentation was at an average level we expected high on each week and sticked to the rubric marks.

Table 36 timeline

Assignment	Start Date	End Date	
Teaming up with new members	28/06/2021	28/06/2021	Week 1
Making a presentation and presented it	28/06/2021	04/07/2021	Week 2
problem explanation and needs objectives, limitations, and constraints	05/07/2021	11/07/2021	Week 3
Intended objective list and Revised problem statement	12/07/2021	18/07/2021	Week 4
Mind map and Ishikawa diagrams	19/07/2021	25/07/2021	Week 5
Developing conceptual designs	26/07/2021	01/08/2021	Week 6
Decomposition diagrams and up to selecting the best alternative and justifying it	02/08/2021	08/08/2021	Week 7
Study week for mid semester	09/08/2021	15/08/2021	Week 8
Bill of material and up to Make/Buy decisions (Economical Design)	16/08/2021	22/08/2021	Week 9
Detailed drawing, assembly drawing and assembling mechanism	23/08/2021	29/08/2021	Week 10
Preparing Final Report, presentation, animation	30/08/2021	05/09/2021	Week 11
Preparing Final Report, presentation, animation	06/09/2021	12/09/2021	Week 12

Table 37 timeline

	Week											
Tasks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Teaming up with new members and initial problem presentation												
Presenting the five individual problems												
Problem Definition and Need Assessment												
Intended objective list and Revised Problem Statement												
Mind map and Ishikawa diagrams												
Conceptual Design Development												
Decomposition diagrams and up to selecting the best alternative and justifying it												
Bill of material and up to Make/Buy decisions (Economical Design)												
Detailed drawing, assembly drawing and assembling mechanism												
Creating Final Report, Final Presentation, and animation video												
Creating Final Video, Creating Final Report, Final Presentation												

Achieved targets according to the expected timeline.

1st week- we had an online zoom session to get to know each other. Since it was our first time gathering

- 2nd week- we came up with several problems and presented during the lecture. Out of all the problems we selected the problem which was a concept for waste collection and storing. It was known as a smart dustbin concept.

- 3rd week – we came up with 5 different conceptual design we didn't even show each other because it must be unique.

- 4th, 5th ,6th,7th, and 8th week – from the conceptual design, we were able to price the product after considering the factors which would be attractive, safe, and beneficial to the customer. We chose one conceptual design and some fresh ideas of other team members to make our final design. We changed some objectives and added new ones. At this stage we had a clear picture in mind for where we must and should end up with.

- 9th,10th, 11th, and 12th week- Due to the pandemic situation campus activities were restricted. Therefore, we were told to make a 10 min video including a 2-minute presentation time, a 3minute explanation on the conceptual design and a 5-minute 3D modelling video. During this period, we as a team dedicated ourselves to produce an outstanding and unique presentation video. These weeks looks tough than ever before but we are doing good in our submissions submitting on time and taking some good effort as a great team.

Discussion

Problems faced and the solutions identified throughout the project

- In the 2nd week we did a presentation on 5 problems and 5 solutions to those problems which we found. this was given just one week of time. The problems and solutions must be in a level which we could solve.

- After selecting one out of 5 different problems we stick together and focused on the rubrics given.

- In the 3rd week rubric, we had some tricky time at took time to identify the needs, objectives, constraints, and limitations. We referred to the recordings lecture notes, and even asked some questions from our instructor while doing the work. There were many questions occurred between those mentioned above.

- We had problems while designing 3D models because as students who have only completed GCE Advanced level exams, we lack the knowledge of using software to make 3d-models, program codes for controllers and to show the simulation of components. Even though most of these can be learned with help from the internet, this requires a significant amount of time.

- lack of knowledge on how electronics components are connected to the microcontroller and how they communicate. No programming knowledge. No video editing skills. We had to download many softwares to see which will be helpful and user friendly to us. We had to do those downloading after midnight and watching some videos to catchup with those softwares. Some softwares won't support tend to crash the laptops too. It took much time to work.

Learning Experience in brief

Technical

- We learnt how to do research correctly and accurately according to the specific questions to the given in rubrics each week.
- We learnt how to include Harvard referencing in reports which we submitted.
- We learnt how to work with many software without being thought. So, we had to refer some tutorials of many software and had to download many software as well. Somehow, we were able to come up with many problems when working as a team

Non-Technical

- Teaming up with members which we even never seen and to communicate with each other, to work as a team. We learnt to listen to each member thoughts and argue with them and came to a final decision before every report which we submitted them.
- The thinking skills and patterns were changed accordingly as doing these rubrics.
- We learnt how to work in a project with different ideas and we learnt how they thought them we also learnt how to divide work between the group members, and we finally discuss them by using zoom meeting before entering to the final submission, this was a new experience for all the members.
- If we didn’t get some questions of the rubric, we used to do them in the final meeting before submission of each week deadline.

Conclusion

The purpose of this research was to minimize the threat that poses to the hospital staff and other cleaning staff involved in the disposal of waste. We identified through research carried by us that during these pandemic periods the spread of viruses such as Covid virus can occur especially happen in public places where people gather and use the same equipment such as dustbin frequently used by number of people. Through our research identified several other problems in dustbins used in a public place and we have given solutions addressing those identified problems in a budget-friendly manner. Furthermore, the given solutions can be developed by doing more research making the dustbin more versatile but due to the limited budget and time we have come up with a reasonable solution.

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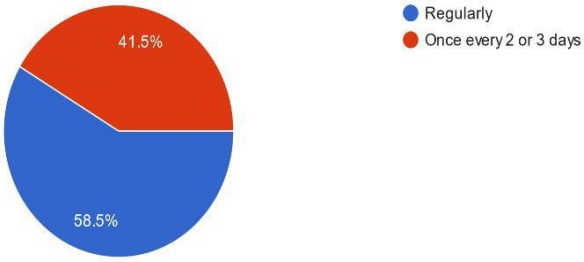
Survey report we carried out

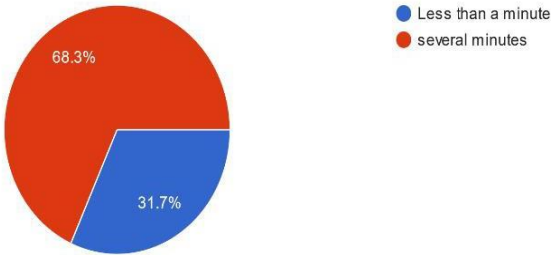
How often do you change the trash bag at you house?

41 responses



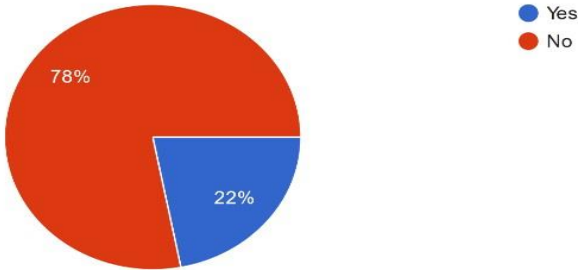
How long does it take to change trash bag?

41 responses



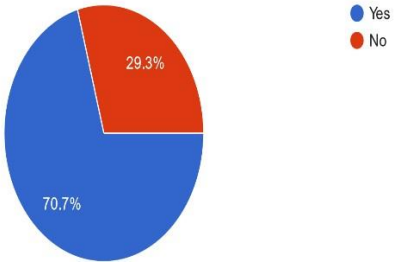
How you ever got sick after cleaning trash bag?

41 responses



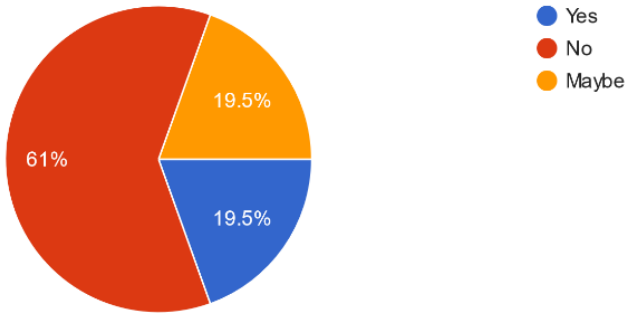
Did you ever have to deal with trash spill even though you sealed the trash bag with a knot?

41 responses



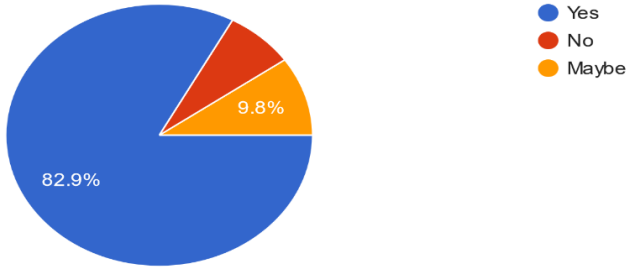
Do you prefer to knot trash bag manually using the hand?

41 responses



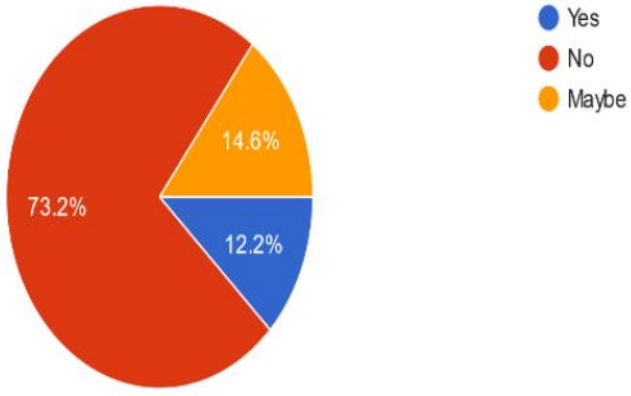
Do you pefer making the trash bin automated?

41 responses



Do you think is it safe to operate dust bins manually at public places?

41 responses



What features from the following whould you perfer?

37 responses