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Smart Dustbin

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Abstract : Recently, the increase in population and urbanization has led to an increase in waste production. There are several problems with the currently existing system that are being identified. This will reflect the need for a new efficient system for monitoring and managing the garbage. The main issues causing the prototype of the smart dustbin was people with disabilities or senior citizens sometimes not able to lift that dustbin cap to litter and poor waste disposal way. This project aims to integrate and test run the hardware (design of the dustbin) and software (Arduino Uno) to operate in the ideal working environment. The scope of the project should be viewed as a guide to ensuring that the project does not deviate from the goals to be reached at any point it is implemented. The waste should be in less than a 5-meter range from the dustbin and is limited for households or office use. This project presents the implementation of a prototype of an ultrasonic sensor for the use of the electric dustbin looking at the seriousness of the waste management issue. The prototype designs weigh the pros and cons of owning a smart dustbin and as well designing and implementing the simulation of the prototype through SolidWorks 2019 software.

Keywords: Smart Dustbin, Hardware, Arduino Uno, SolidWorks

1. Introduction

Initially, back in the 1800s, the origin of dustbin was used as temporary rubbish storage but it was widely used only around the 1900s. The evolution of the dustbin's evolution changed vastly as the dustbin wasn't manufactured yet. Instead, other objects were alternatively reused to serve the purpose of the dustbin, among the objects used are biscuit tins in the early 1900s, medium-sized galvanized bins

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in the 1950'ss and larger size plastic bins in the 1960s as shown in **Figure 1**. However, the concept used to throw rubbish in these dustbins were throwing rubbish directly into the bin being with or without the presence of a lid. [1].

Figure 1: NY Department of Street Cleaning, circa 1900; collectorsweekly.com [2]

Malaysia now produces about 23,000 tonnes of garbage each day. However, according to Jayashree Sreenivasan (2012) [3] by 2020, this figure is anticipated to grow to 30,000 tonnes. However, by 2020, this figure is anticipated to rise to 30,000 tonnes. The quantity of garbage created continues to rise as a result of rising population and growth, with only around 5% of waste being recycled. Cities all around the world are scrambling to develop methods to alleviate the load of garbage management. A new type of bin, the smart bin, uses T's Internet of Things (IoT) [4] as one of its tactics to create a far more effective trash management system. Cities that install smart bins can cut the number of garbage pickups required by up to 80%, resulting in fewer workers needed, pollution, fuel usage, and traffic congestion [5].

Dustbin has always have been underrated without realizing its importance and significance in our lives. It holds a very vital role in the process of organized and narrative waste management. The dustbin's usage is not only limited to the household need but is also significant to the public health services such as hospitals and environmental management. This reveals the relationship between waste management. Waste bins with unclosed lids, and accumulating wastes around the bin can lead to an ideal breeding ground for insects.

This project intends to solve or minimize several issues regarding the waste management system. Firstly, the throwing of garbage by the opening and closing of the dustbin is considered unhygienic and it will create an unhygienic condition for the surrounding environment and create a bad smell which can lead to spreading some deadly disease. Next, the manual waste management system leads to delay of the rubbish removal that makes people uncomfortable to get near to dustbin when wants to litter. Finally, people with disabilities or senior citizens are sometimes not able to lift those dustbin caps to litter, those automatic dustbins caps will ease them when littering.

This project focuses on the development of an Arduino-based smart dustbin monitoring system that can be operated using a local area network (LAN) server. The project can be divided into three main milestones: 1) The construction of a dustbin system that is ready to integrate with the Arduino system, 2) The development of Arduino Uno program to control the movement of the dustbin and 3) To integrate

the dustbin (hardware) and Arduino Uno program (software) so that the product can operate in the ideal working environment.

2. Materials and Methods

2.1 Materials

As mentioned previously, this project focuses on the development of a smart dustbin system that consists of an upgraded dustbin design that is integrated with a middleware developed using Arduino Uno. To fulfil the project objectives, the materials needed are as below:

i. Arduino Uno
ii. Ultrasonic sensor HCSRO4
iii. Servo tower proSG90
iv. 9V battery clip
v. Male to female cables
vi. Dustbin
vii. Bolts
viii. Motor mounting bracket
ix. Battery
x. Metal string

2.2 Methods

The development of a prototype dustbin involves certain mechanical systems such as the bolts, hinge pin and pulley and belt. The materials chosen will allow facilitating the manufacturing process and design of the dustbin.

The conducted research includes from the initial analysis until the product is produced. In producing a project, the title plays a significant role in the execution of this project. It has to be related to the main ideas and research of the project. A suitable title is chosen and proposed, which upon the supervisor's approval the title will be fixed.

Thorough research and advanced study are done, to find theoretical knowledge and the exploration of facts thus constructed to complete a well-functioned product. The coding is developed until it fulfils the functions facilitated in the project requirement. Then, the design and analysis of the product were carried out before the product development. After that, the test run of the project should be carried out through simulation to ensure the functionality of the machine. An integrated preview was done to complete a design with an improved appearance of the machine after the success of the test run. Finally, a final report was written and submitted on time. **Figure 2** represents the detailed methodology flow of the project which consists of three important milestones. The first milestone focuses on constructing a dustbin design that is ready for integration with the Arduino Uno system. This step is crucial for successful integration with the controlling system. The authors have to consider the location of the electrical system and the mechanism for the integration with the Arduino Uno system.

The next milestone is to develop the programming using the Arduino Uno system. Before proceeding with the programming task, the authors outlined several steps and functions that the program needs to fulfil. This will ensure the development of a trouble-free middleware. The final milestone is the integration of the smart dustbin mechanical setup with the Arduino Uno system. This process consists of a couple of trial and error sessions to find the best working 'tune' for the smart dustbin system. Several test runs needed to be done to make sure the dustbin system works as planned.

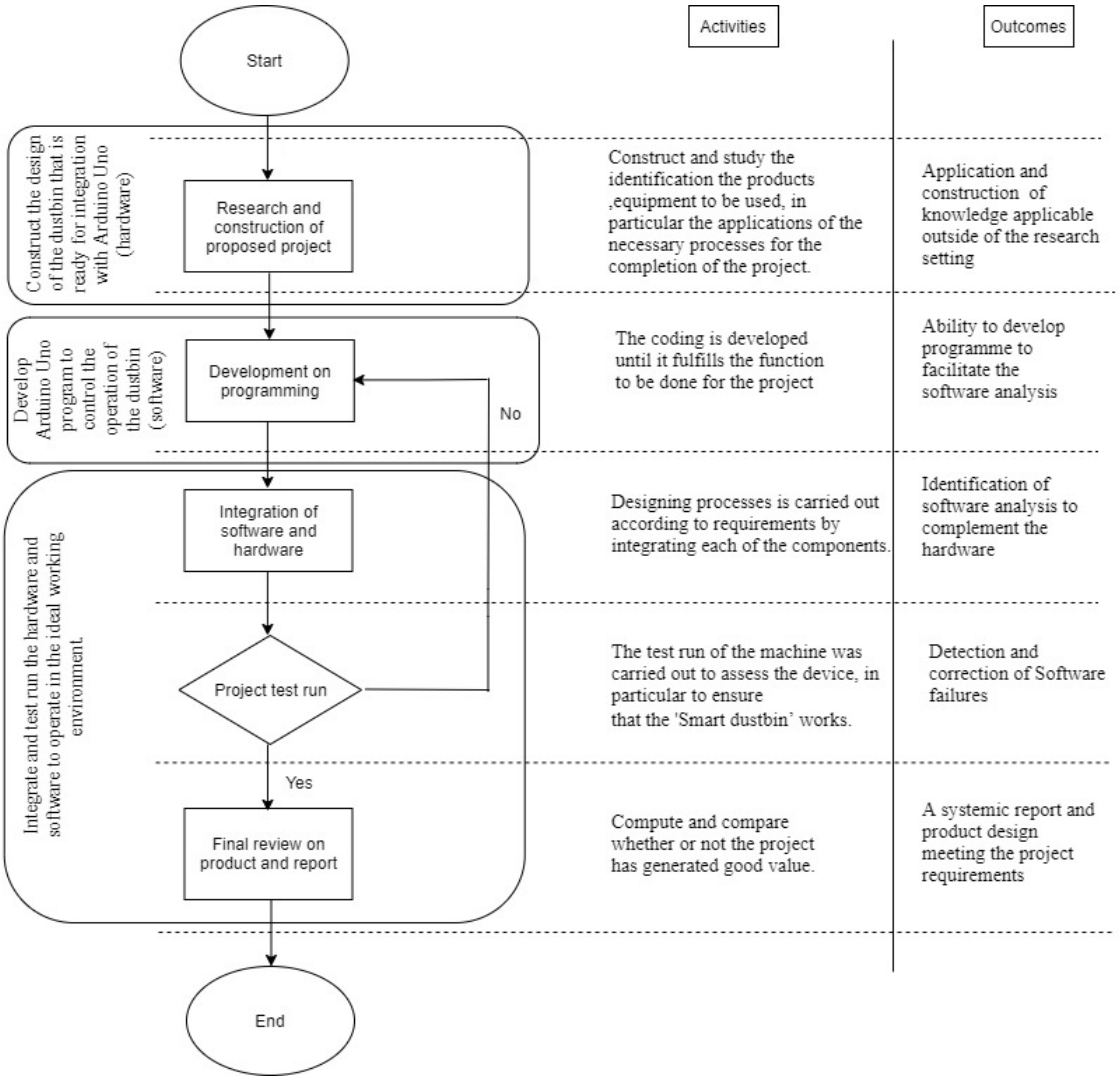

Figure 2: Methodology flowchart

2.3 Component breakdown list

Figure 3 shows the components of the smart dustbin. Generally, the components can be divided into two main categories: 1) Electrical system & 2) Mechanical system. The electrical system consists of the Arduino Uno system, Ultrasonic sensor HCSRO4, Servo tower proSG90 and battery clip. The whole system is powered by a 9V battery which is equipped with male to female cables.

The mechanical system of the smart dustbin is an integration of a belt drive system, dustbin body, bolts and motor mounting brackets. As stated before, this project aims to integrate the two main systems to get a working product.

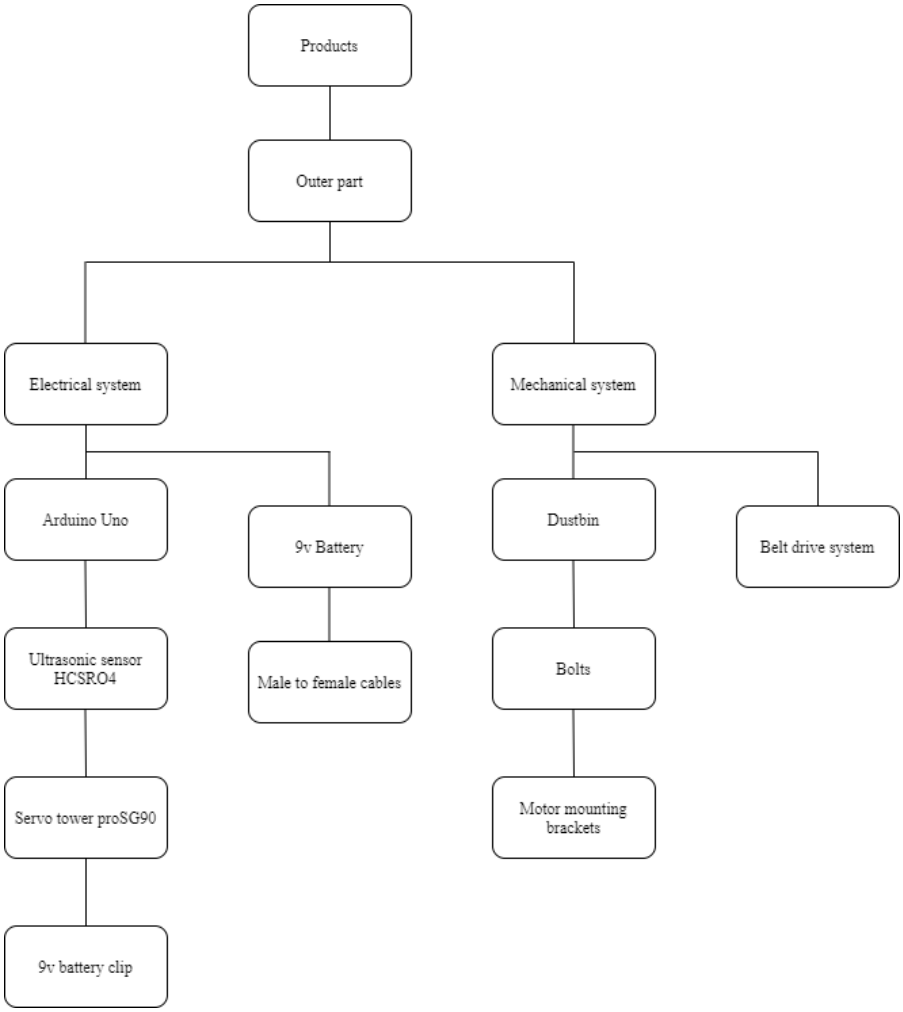

Figure 3: Components breakdown list

The library in Arduino contains a lot of different functions that can be used in the program. So, to use the function the library must be included at the top of the program. The Arduino board can control servo motors with this library. Servos feature a controlled integrated shaft and gears. The standard servos enable the shaft's position at an angle of 0,90,180 and 360 degrees. Below listed are among the main core functions:

a. servo Main; → It creates a function to control a servo. Normal UNO board can connect up to 12 Servo tower proSG90 and 3 servo motors connected to the board as shown in **Figure 4.**

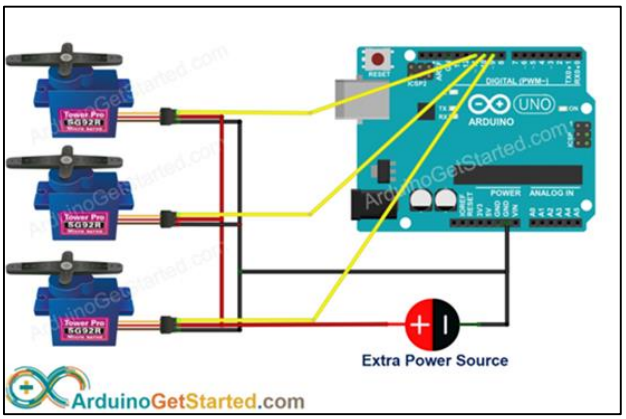

Figure 4: Connection of 3 Servo tower proSG90 with Arduino Uno

b. *Servo.write(0)*; The write(degrees) method sets the servo's position to the supplied degrees. Servos may be turned in any direction between 0 and 180 degrees. The servo receives the value and controls the shaft. Thus it will allow the shaft to move to its directed angle set [4]. On a continuous rotation servo, this will set the servo's speed at 0 and 180 where the speed is maximum in one direction and the other, whereas 90 allows the shaft to be stationary.

c. The next important area is the *void loop()* function where it is executed once the *setup()* is completed. It runs over and over again every time it has been called upon. The loop is what describes the logic of the code and it enables the repetition of the code based on the variable. The *void loop()* function contains the main body of our code.

d. *Void setup()*; After the curly brackets are inserted in this function, the code listed in the curly brackets will be executed once.

Referring to **Figure 5,** there are pins from pin 0 to 13 and this servo pin = 7 means that the servo object attaches to the servo PIN 7 to perform operations. The control pin in Arduino connects to the signal pin in the servo motor. Arduino also has 3 Gnd pins,11 Digital pins,1 pair of Rx- Tx pins,6 Analog pins, 2 Vcc pins (3.3v and 5v) [6].

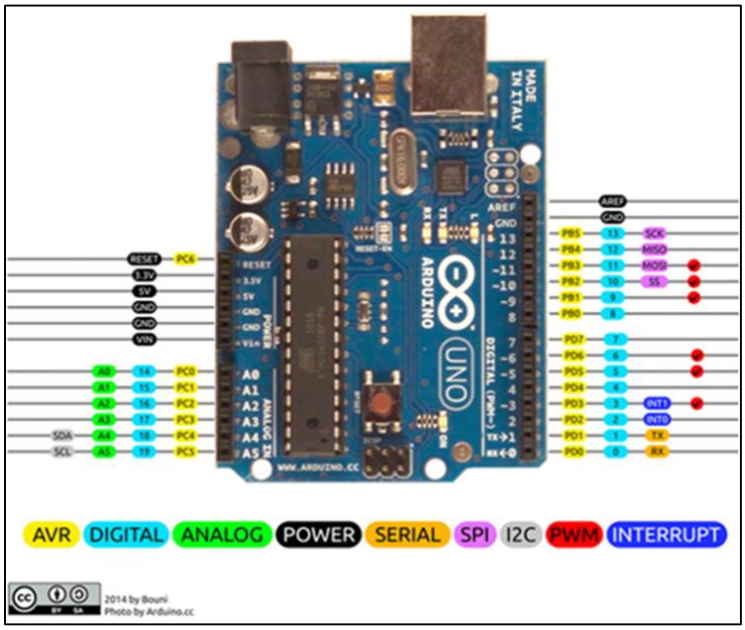

Figure 5: Arduino Uno detailed labels

Besides, the term called pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a way to break the power delivered by the electric signal by reducing it into discrete parts. The switch between supply and load controls the average value of voltage and current fed, at a fast rate. The total power supplied to the load is inversely proportional to the period and duration, the switch off. The PWM is as shown in **Figure 6** below for 0 and 180 degrees.

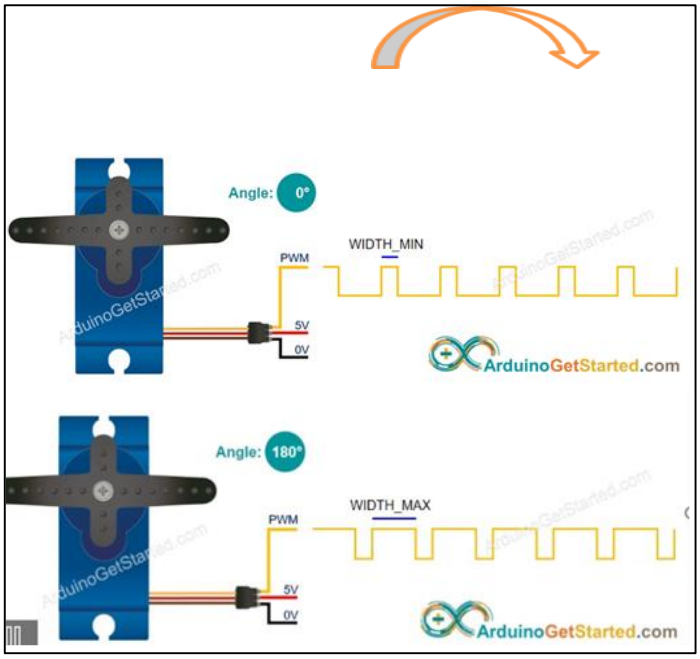

Figure 6: Pulse-width modulation of Servo tower proSG90

The TRIG Pin and ECHO pin can be seen in **Figure 7** below at the ultrasonic sensor. The TRIG pin acts as a trigger to trigger sound pulses reflected from an object. The ECHO pin acts to produce a pulse when there is a signal is received. The GND pin acts as the ground pin to be connected to the ground or 0V. The length of the pulse being received increases as the time taken for the signal transmitted to be detected increases.

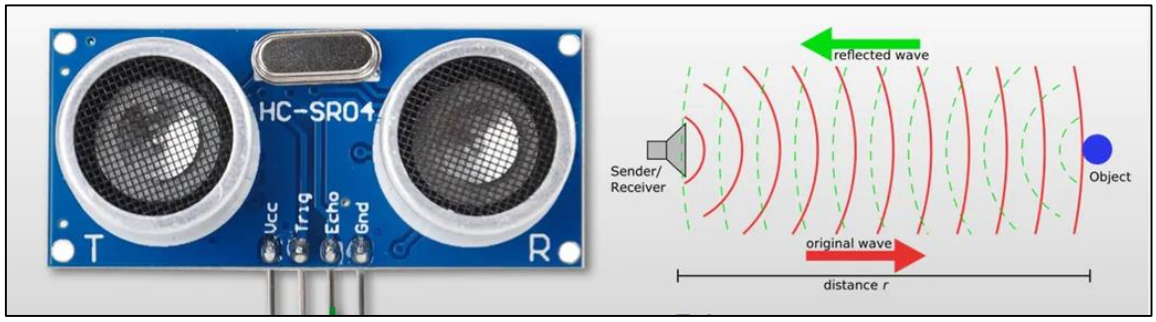

Figure 7: Ultrasonic sensor

3. Results and Discussion

This section discusses all details of the system and application used for this project. This part also describes the detailed design of the smart dustbin and the integration of hardware and software using Arduino Uno and dustbin components. **Figure 8** and **Figure 9** shows the assembled prototype of the smart dustbin and the exploded view of the prototype using SolidWorks 2019 respectively. It can be seen in both figures that the smart dustbin system is designed to be integrated with the middleware (Arduino Uno system). The working mechanism of the dustbin is similar to the normal dustbin but for this project, the dustbin design is upgraded to accommodate the electrical system and this is one of the main contributions of this project.

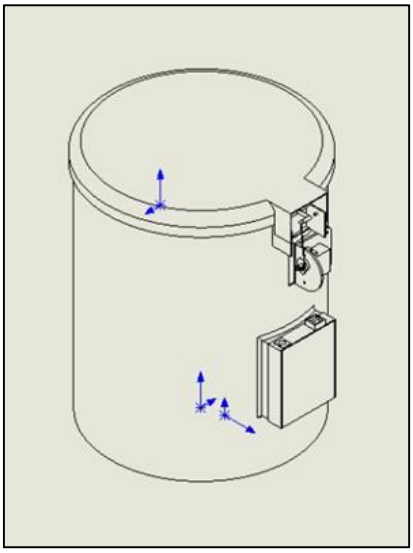

Figure 8: Assembled product

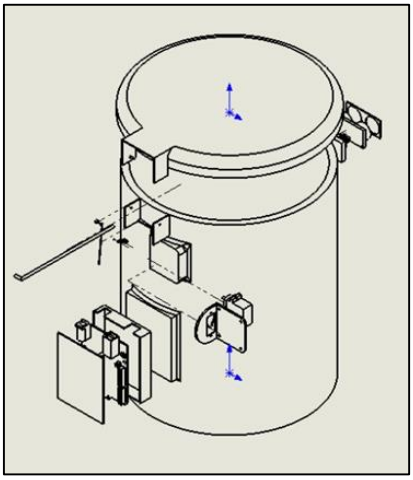

Figure 9: Exploded view

Figure 10 shows the ultrasonic sensor HCSRO4 and Servo tower proSG90's connection with Arduino Uno. The ultrasonic sensor works by sending a burst of ultrasound to the TRIG pin with a 10ms pulse and listening for the echo when it bounces off of something. It detects the obstacles with ultrasound which can emit ultrasound up until 40kHz [7].

The Arduino board sends a short pulse to trigger the detection that emits ultrasonic wave, then listens for a pulse on the same pin using the *pulseIn()* function which gets reflected from the object in front of it. The duration of the second pulse is equivalent to the time taken by the ultrasound wave to travel to and from the sensor. The time taken for the wave to travel is equivalent to the time taken to receive a signal deducted by the time taken to emit a particular signal. For example, if the item is 25 cm away from the sensor and the sound speed is 340 m/s (0.034 cm/s), the sound wave must travel for approximately 735 microseconds. The number you'll obtain from the echo pin, though, will be double that because the ultrasound wave must travel forward to the object and backwards to the sensor [8]. The sensor then measures the travel time with the formula time taken to travel = time taken to receive signal after reflected – time taken to emit the signal. The distance of the object is then calculated based on the time taken to be reflected [7].

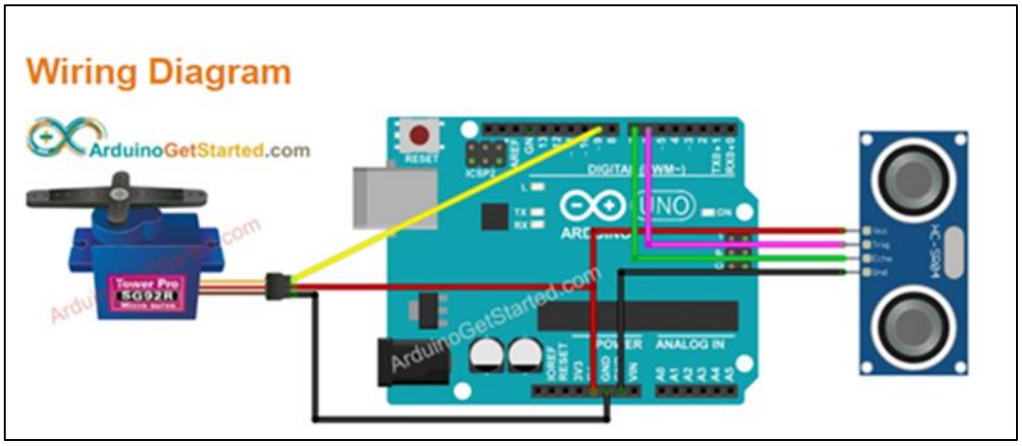

Figure 10: Ultrasonic sensor HCSRO4 and Servo tower proSG90's connection with Arduino Uno

4. Conclusion

This project presents a smart dustbin that can operate in an ideal working environment with the aid of the Arduino Uno system. This project focus on the design upgrade and system integration of the normal dustbin system with the Arduino Uno system as the middleware. The smart dustbin utilizes the ultrasonic sensor HCSR04 and Arduino Uno to facilitate the opening of the lid. The sensor can sense the distance range from 2 cm to 450 cm. Thus, the data collected will be sent to the circuit, and then to the servo motor to implement its function. This project has successfully given us more understanding about the servo motor, Arduino Uno and the ultrasonic sensor which acts as the major components in this project. Nevertheless, formed with these components can allow the integration of hardware from the gears to software. This project is considered to be a worthy elucidation to maintain a greener environment, looking into the current surroundings cleanliness situation. Besides the cost spent to complete this smart dustbin was affordable which was RM83.20. It is unlike the normal dustbins where the lids are to be open until someone closes it by themselves, it can cause harm to the people and animals. Nevertheless, this dustbin is focused to suit the needs for medium-range and domestic use.

Acknowledgement

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