Journal of Electrical and Electronics Engineering
Vol. 1, No. 2, December 2016, Pages 46-51

Smart Trash Bin With Solar Cell

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ABSTRACT

Smart Trash Bin with Solar Cell is a device which can help the people to increase their awareness about environmental hygiene. With an automatic lid and volume level indicators, people do not need to touch the lid to open it and check whether the bin is already full or not. This smart trash bin will send alerts when they are getting full. If the first ultrasonic sensor detected an object, the automatic lid will be open, while the second ultrasonic sensor detect inside of the trash bin whether it is already half full, half-quarter full or totally full to trigger the indicator to start working. The automatic lid and volume level indicators will be implemented by using Arduino UNO program. And due to the eco-friendly consideration, this device uses a solar cell to produce power to activate it.

Keywords: Smart Trash Bin, Ultrasonic Sensor, Servo Motor, Solar Cell, Environmental Awareness

ABSTRAK

Tempat sampah pintar menggunakan solar cell merupakan alat yang dapat membantu meningkatkan kesadaran masyarakat dalam menjaga kebersihan lingkungan. Dengan penutup otomatis dan dilengkapi indikator volume untuk memonitor isi tempat sampah, masyarakat tidak perlu menyentuh penutup saat membuka dan memeriksa apakah tempat sampah sudah penuh atau tidak. Tempat sampah pintar ini akan mengirimkan peringatan ketika sudah dalam kondisi penuh. Jika sensor ultrasonik pertama mendeteksi sebuah benda di dekat penutupnya, maka penutup otomatis akan terbuka. Selanjutnya sensor ultrasonik kedua akan memonitor apakah isi tempat sampah sudah setengah penuh, tiga perempat penuh, ataupun penuh sama sekali., dan memicu indikator untuk mulai bekerja. Pengaturan penutup otomatis dan indikator volume pada tempat sampah pintar ini dilakukan dengan menggunakan program Arduino UNO. Dengan pertimbangan aspek ramah lingkungan, maka perangkat ini menggunakan sel surya sebagai sumber tenaga untuk mengaktifkannya.

Kata kunci: Tempat Sampah Pintar, Sensor Ultrasonik, Motor Servo, Sel Surya, Kesadaran Lingkungan

I. INTRODUCTION

Many times we see some people are less concerned with the cleanliness. Some of them are often throw garbage out of place, thus making the environment dirty. This condition often worsened due to the trash bin placed at public places are overloaded. Ignorance of cleanliness is spoiling our environment and creates unhygienic conditions**.**

People nowadays are still less aware of environmental hygiene. Many of them are still undisciplined by not disposing of waste in the right place. The culture of throwing garbage in rivers and ditches, make it hard to reach a cleaner environment. One of the reasons that triggered this condition is because they think the bins around are not maintained properly, so they feel uncomfortable to hold the lid bins with their hands. However, to change that habit was not an easy thing to do. Cooperation between the government and the society should be well maintained in order to landfills as well as efforts to raise awareness of health and hygiene to be realized to the fullest.

In raising awareness of people to the environmental hygiene, sometimes it requires a unique way to attract people, so they do not hesitate to dispose the waste in the appropriate place. The idea on this paper is to overcome this problem which is called Smart Trash Bin with Solar Cell. This device is a smart trash bin with lid that opens automatically using sensors, several LED will blinking and a buzzer will start buzzing if the trash is almost/already full and also solar cell as it energy source.

II. MATERIAL-REQUIREMENT AND SPECIFICATIONS

This smart trash bin is designed to raise the awareness of people for not littering, as stated in the previous chapter.

Received: 10 April 2017 Revised: 30 May 2017 Accepted: 15 June 2017

With the lid open and closed automatically, makes the users do not need to touch the cover that might be a bit dirty which make them feel uncomfortable to touch it. Besides the automatic lid, this smart trash bin is also equipped with an indicator that can alert users when the trash is almost or already full. Not only that, to increase the eco-friendly level, the power source used in this work comes from a solar cell.

The trash bin consists of two sensors for automatic lid and the indicator using an ultrasonic sensors and an Arduino UNO as its microcontroller. Power used in this work is solar power, which is absorbed by the solar cell and then stored in the battery. When the battery's power is getting low, we need to put this smart trash bins under the sun in order to occur the battery charging process. So we do not need to buy a new battery to replace the old one because the battery in this work-can be recharged.

A. The requirement material

For this smart trash bin with solar cell device, the author use:

- 1 trash bin as main body of this device
- 1 Arduino UNO R3 as the microcontroller of the device
- 2 Ultrasonic Sensor as the input of a signal to the microcontroller
- 1 Servo motor SG 90 as the output from the microcontroller
- 2 Red LEDs as indicator of the trash bin
- 1 Buzzer as indicator of the trash bin
- 1 Battery 6V
- 1 Solar Cell (11cm × 6cm × 0.25cm)

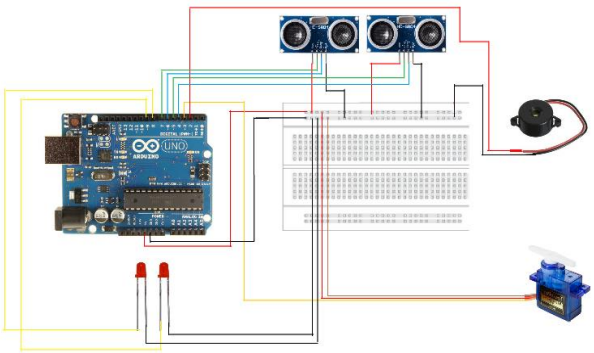

Figure 1. Smart Trash Bin with Solar Cell System

III. DESIGN CONSTRUCTION AND IMPLEMENTATION

The purpose of this project is to create a device that can help raise awareness of people to preserve environmental hygiene with not littering. In this part, the process of making the smart trash bin with solar cell will be described. The process starts from the beginning, those are:

- Hardware design which consists of a trash bin, servo motors, ultrasonic sensors, LEDs, buzzer, solar cell, battery.
- Software design which consist of programming which are used to control the circuit created by Arduino IDE.

From figure 2, servo motor will move when the ultrasonic sensor #1 detect an object. After the object entered into the bin, the ultrasonic sensor #2 will detect the volume level of the trash bin. If the volume of the bin has reached half full, then LED #1 will light up. If the volume reaches three-quarter full, LED #2 will also light up.

When the trash bin is already full, the buzzer will begin to beep and LEDs remains on. The power used to activate this device comes from the rechargeable battery. When the power of the battery is weak, it is need to be charged under sunlight with using solar cells. Overall the block diagram for this work could be seen in the block diagram below.

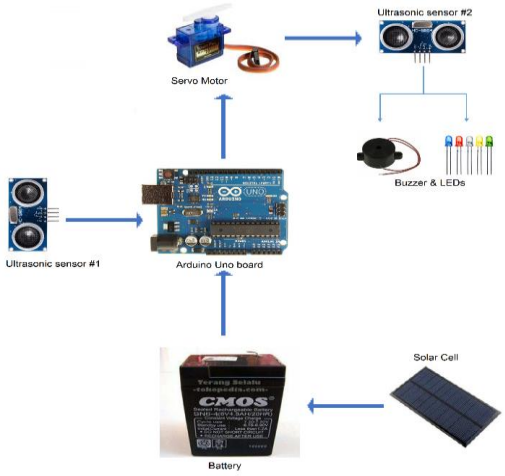

Figure 2. Block Diagram of Smart Trash Bin with Solar Cell

A. Hardware Design

The main body of this device is made of plastic just like the common trash bin. From the Figure 2 , it can be seen that the device has 2 ultrasonic sensors, servo motor, 2 red LED, buzzer, solar cell and battery which located inside of the acrylic box as the power source. One ultrasonic sensor located in outside of the bin to detect an object, and the other one put inside as the input of signal to the microcontroller. The LEDs putted in the front side of the bin and a buzzer in the right side as the indicator of volume level. Servo motor also putted inside as the motor to drive the lid. Solar cell located in the left side and the battery put under the bin inside of the acrylic box along with the circuit and the Arduino UNO.

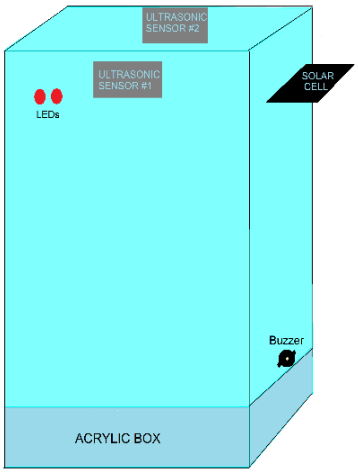

Figure 3. Hardware Design

B. Arduino Connection

Arduino UNO is the brain of this device as described on the configuration below. The microcontroller processes the input detected by the ultrasonic sensors controls the servo motor, LEDs and buzzer to do the output. The power source to the Arduino UNO is provided from the battery. It has an output 6V and 4.5 Ah.

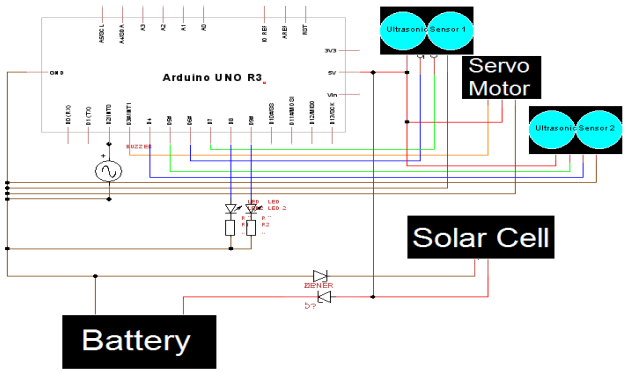

Figure 4. Arduino Connection

C. Software Implementation

To implement the program to the microcontroller, the author used Arduino IDE 1.0.6. There are two main functions which must be mentioned in the Arduino IDE programming. The first function is setup(), which runs only once at the beginning. The second function is loop(), which will run continuously in a loop until the power to the Arduino is off.. This is the code that author use in th device:

```
#define trigPin2 7
#define echoPin2 6
#define trigPin 5
#define echoPin 4
#define buzzer 2
#define led 8
#define led2 9

long duration, duration3, distance;
#include<Servo.h>

Servo myservo;

void setup()
{
 Serial.begin(9600);
 pinMode(trigPin2,OUTPUT);
 pinMode(echoPin2,INPUT);
 pinMode(led,OUTPUT);
 pinMode(led2,OUTPUT);
 pinMode(buzzer,OUTPUT);
 pinMode(trigPin,OUTPUT);
 pinMode(echoPin,INPUT);
 myservo.attach(3);
}

void loop()
{
 long duration2,distance2;

 digitalWrite(trigPin,LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin,LOW);
 duration2 = pulseIn(echoPin,HIGH);
 distance2 = (duration2) / 29 / 2;

 if(distance2 > 10)
 {
  openclose();
 }

  lighting();

}

void openclose()
{
 long duration, inches, cm;

 digitalWrite(trigPin2,LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin2,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin2,LOW);

 duration = pulseIn(echoPin2,HIGH);


 cm = duration / 29 / 2;
```

```
      if(cm < 10)
      {
        myservo.write(90);
        delay(150);
      }
      else
      {
        myservo.write(0);
      }
       delay(1000);
     }

     void lighting()
     {
      digitalWrite(trigPin, LOW);
      delayMicroseconds(2);

      digitalWrite(trigPin, HIGH);
      delayMicroseconds(10);

      digitalWrite(trigPin, LOW);
      duration3 = pulseIn(echoPin, HIGH);

      //Calculate the distance (in cm) based on the speed
of sound.
      distance = duration3/58.2;
      Serial.println(distance);
      if (distance < 1){
        digitalWrite(led, HIGH);
        digitalWrite(led2, HIGH);
       digitalWrite(buzzer,LOW);
      }
        else if (distance < 8){
        digitalWrite(buzzer,HIGH);
        digitalWrite(led, HIGH);
        digitalWrite(led2,HIGH);
        }   else if (distance < 13){
        digitalWrite(led, HIGH);
        digitalWrite(led2,HIGH);
        digitalWrite(buzzer, LOW);
      } else if (distance < 17){
        digitalWrite(led, HIGH);
        digitalWrite(led2,LOW);
        digitalWrite(buzzer, LOW);
      } else if (distance > 17){
        digitalWrite(led, LOW);
        digitalWrite(led2, LOW);
        digitalWrite(buzzer, LOW);
      }
        //Delay 50ms before next reading.
      delay(50);
      }
```

IV. RESULTS

This device is designed to help increase the awareness of people for not littering. One of the ultrasonic sensor on the device placed outside the bin to detect an object to open the lid while the other one placed inside to detect the volume level of the trash bin. This device can work both outdoors and indoors. The sensor used in this device is a usual sensor not the waterproof one, so it can not be placed outdoors when it is raining. The picture of the device shown in Figure 5.

Figure 5. Project Device

The automatic lid of this smart trash bin will open when there is an object detected by ultrasonic sensor #1. The function of LED is as indicator of the trash bin volume level. If the trash bin is reaches half full, then the LED #1 will turn on. When the trash bin reaches three-quarter full, the LED #2 also will turn on. Last, if the trash bin already full then the buzzer will start beeping. The condition can be seen in the following figures.

Figure 6. Ultrasonic sensor #1 detect an object & the automatic lid opened

Figure 6 shows the condition where the automatic lid is opened because there is an object detected by ultrasonic sensor #1.

Figure 7. Trash bin half full

When the contents of the trash bin has reached half full as determined by the ultrasonic sensor # 2, then LED # 1 will light up as shown in Figure 7.

Figure 8. Trash bin three-quarter full

Figure 8 shows the condition of the smart trash. The main body of this device is made of plastic just like the common trash bin. The dimensions are based on the extent of the sensor range, which its measuring angle is 30˚ and its ranging distance is 2cm - 400cm. By using the tangent of trigonometric formulas, then the size of the trash bin can be determined with dimmensioning Length (2cm – 400cm) × Width (2cm – 400cm) × Depth (12.8cm – 2560cm).

Figure 9. Trash bin full

The size of the trash bin is actually small in width and the compensation was done with height. The maximum volume of trash bin is depend on the garbage weight inside the bin which is monitored by the ultrasonic sensor # 2. It can detect any kind of garbage. If the garbage inside the bin reaches at least three-quarters full, then both of the red LEDs lights up. When the smart trash bin is already full (has reached the maximum weight), then all of the indicator which is two red LED and a buzzer will be work at the same time.

Based on the experimental measurements that have been done, and in accordance with Ohm's law where voltage and current is proportional, so when the voltage increases after "sunbathed", then the current will increase as well. Here are the data after the solar cell put under the sunlight.

Table 1. Solar Cell Data

Duration of charging (hour)	Voltage increase (volt)	Current increase (ampere)
1	0.02	0.005
2	0.02	0.005
3	0.03	0.005

V. CONCLUSION

Based on the experiments, data collected, and analysis of the "Smart Trash Bin with Solar Cell", there are several conclusions that could be taken :

1. Arduino UNO, HC-SR04 ultrasonic sensor and solar cell has been successfully implemented to achieve the objectives of this work. This device can be easily used and maintained the condition in order to keep it works well and not damaged.
2. The device can control the automatic lid and indicate whether the trash bin has been half full, three-quarter full and already full.
3. The solar panel can charge the battery used in the device, although it takes a bit long time.

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