Overview

Waste management is all the activities and actions required to manage waste from its inception to its final disposal. This includes collection, transportation, treatment, and disposal of waste together with monitoring
and regulation. Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities.

This project is to design an automatically opening smart trash bin. The primary objective of this project is to design a trash bin that opens automatically when a person approaches. This prevents the contamination of trash bins by hand, so enhances hygiene factors. Even it helps users save time. This project has widespread applications and can be promoted as a very useful concept.

Goals

1. Enable user's easy disposal of trash
2. Provoke user's attention on proper disposal of garbage to keep the university premise clean
3. Introduction of an indicator to show the level of garbage to facilitate regular cleaning of garbage bins
4. Cost-effective design to facilitate easy production and easy maintenance
5. It can sense all types of waste material whether it is in the form of solid or liquid. The system is simple. If there is any problem with any equipment in the future, that part is easily replaceable with a new one without any difficulty or delay.

Specifications

We have introduced the following features to this SMART TRASH® bin.

- Automatically opens the lid when a person approaches the bin.
- LED indicator panel to display the level of trash to the users.
- Automatically stop opening the lid when the trash bin is full to prevent unnecessary loading.
- A separate maintenance switch is embedded to open the lid when the bin is full.
- A rechargeable battery makes the bin portable and enables an uninterrupted power supply.

Milestones

I. First Meeting and brainstorming

The initial meeting happened on 14th March, 2016 around 4.00 pm at Computer Lab, Department. All nine members were presented that day and presented their ideas. After about one hour of discussion, we came to a design and listed the items we needed to purchase.

II. Purchasing Items

Our first target is to look for a dustbin which suits our design and the budget. On 16th of March, 2016 we purchased the dustbin.

Other components ICs, Sensors, Boards, LEDs, Resistors, etc. were purchased on the 18th of March, 2016.

III. Design the Dustbin and PCB

We gathered on the 19th of March,2016, and customized the dustbin the way we needed it to be. It took half of that day to customize the dustbin. Remaining time we designed the PCB with Eagle software.

IV. Construct the PCB

The PCB was constructed on 24th March, 2106 at the Advanced Physics Laboratory. It was easier to construct the PCB since we designed the PCB earlier.

V. Coding and Integrating

We gathered again on several weekends to develop the Smart Trash Bin

Materials and Methods

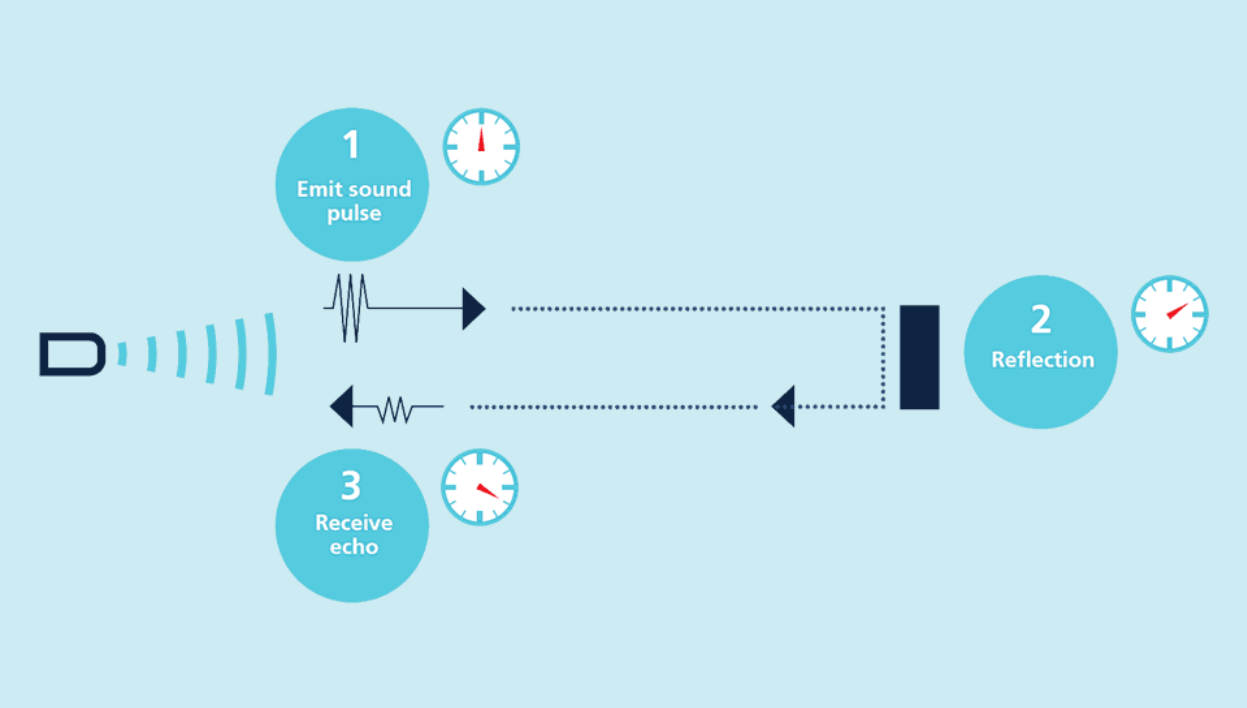
Ultrasonic Range Distance Sensor.

Transmits an ultrasound sound wave to the obstacle and receives the echo of that wave. Detects the distance to the obstacles ahead by calculating the time taken for the sound wave to travel to the object and come back to the sensor.

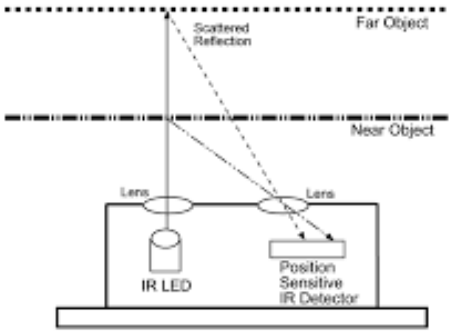
Ultrasonic principle:

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected as echo signals to the sensor, which itself computes the distance to the target based on the period between emitting the signal and receiving the echo.

As the distance to an object is determined by measuring the time of flight and not by the intensity of the sound, ultrasonic sensors are excellent at suppressing background interference.



Sharp IR Range Finder Sensor.



Transmits a narrow beam of infrared rays into the obstacle and detects the reflected beam by its receiver. Calculate the distance to the obstacle using the reflected angle of the IR beam.

Servo Motors.

This is a special motor which has a high torque but it is restricted to rotate only an angle of 180^0.

But there is an inbuilt position sensor in this motor so users can give commands to rotate an desired angle.
The story of Servo Motor is entirely different from that of a DC Motor. A Servo Motor is a type of actuator that provides high precision control of linear or angular position. A typical servo motors consists of four things (or parts): a DC Motor (or AC Motor), a gear unit, a position and speed sensing device and a control unit.Servo Motors are used in applications where very high precision motion is required like assembly robots, computer numeric controls etc.

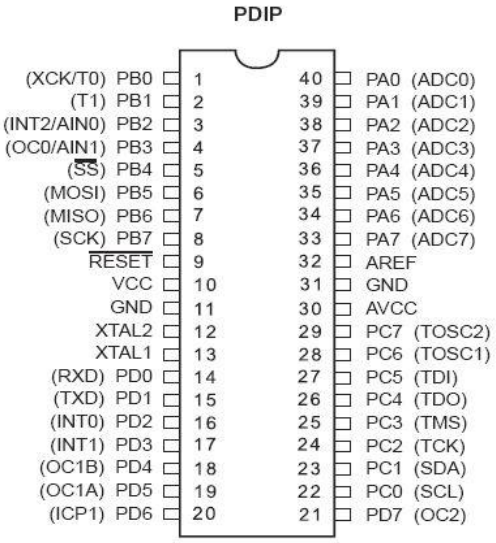
Typically, simple servo motors consists of three wires. These are usually color coded as Red, Brown and Orange (may vary with different models). The Red wire is used for supply, the Brown wire is used for ground and the Orange wire is used for control signal.Here, the control signal will determine the position of the servo motor's shaft. The control signal is usually a PWM signal but this PWM signal is not used to control the speed of the motor as in case of a DC Motor. But rather, it is used to determine the position of the servo meter.

The DC Motor in the servo motor is powered as per the control signal it receiver. As per the feedback from the position sensing system (like a potentiometer), when the servo achieves the desired position, the power to the motor is terminated.Even though the power supply to the motor inside the servo motor is not constant, the overall power should be constant as the servo motor has a dedicated system that controls the power.The servo motor used in this project is Tower Pro SG90. It is a small but powerful servo motor that can produce a torque of 1.8 kgf.cm.

Atmega32A Microcontroller.

The most important part of the system is the microcontroller. It synthesis the sub components of this trash bin.

The pin diagram of the Atmega32A microcontroller is given below:



PIN count: Atmega32 has got 40 pins. Two for Power (pin no.10: +5v, pin no. 11: ground), two for oscillator (pin 12, 13), one for reset (pin 9), three for providing necessary power and reference voltage to its internal ADC, and 32 (4×8) I/O pins.

About I/O pins: ATmega32 is capable of handling analogue inputs. Port A can be used as either DIGITAL I/O Lines or each individual pin can be used as a single input channel to the internal ADC of ATmega32, plus a pair of pins AREF, AVCC & GND together can make an ADC channel.

No pins can perform and serve for two purposes (for an example: Port A pins cannot work as a Digital I/O pin while the Internal ADC is activated) at the same time. It's the programmers responsibility to resolve the conflict in the circuitry and the program. Programmers are advised to have a look to the priority tables and the internal configuration from the datasheet.

Digital I/O pins: ATmega32 has 32 pins (4portsx8pins) configurable as Digital I/O pins.

Timers: 3 Inbuilt timer/counters, two 8 bit (timer0, timer2) and one 16 bit (timer1).

ADC: It has one successive approximation type ADC in which total 8 single channels are selectable. They can also be used as 7 (for TQFP packages) or 2 (for DIP packages) differential channels. Reference is selectable, either an external reference can be used or the internal 2.56V reference can be brought into action. There external reference can be connected to the AREF pin.

Communication Options: ATmega32 has three data transfer modules embedded in it. They are

- Two Wire Interface
- USART
- Serial Peripheral Interfac

Analog comparator: On-chip analog comparator is available. An interrupt is assigned for different comparison result obtained from the inputs.

External Interrupt: 3External interrupt is accepted. Interrupt sense is configurable.

Memory: It has 32Kbytes of In-System Self-programmable Flash program memory, 1024 Bytes EEPROM, 2Kbytes Internal SRAM. Write/Erase Cycles: 10,000 Flash / 100,000 EEPROM.

Clock: It can run at a frequency from 1 to 16 MHz. Frequency can be obtained from external Quartz Crystal, Ceramic crystal or an R-C network. Internal calibrated RC oscillator can also be used.

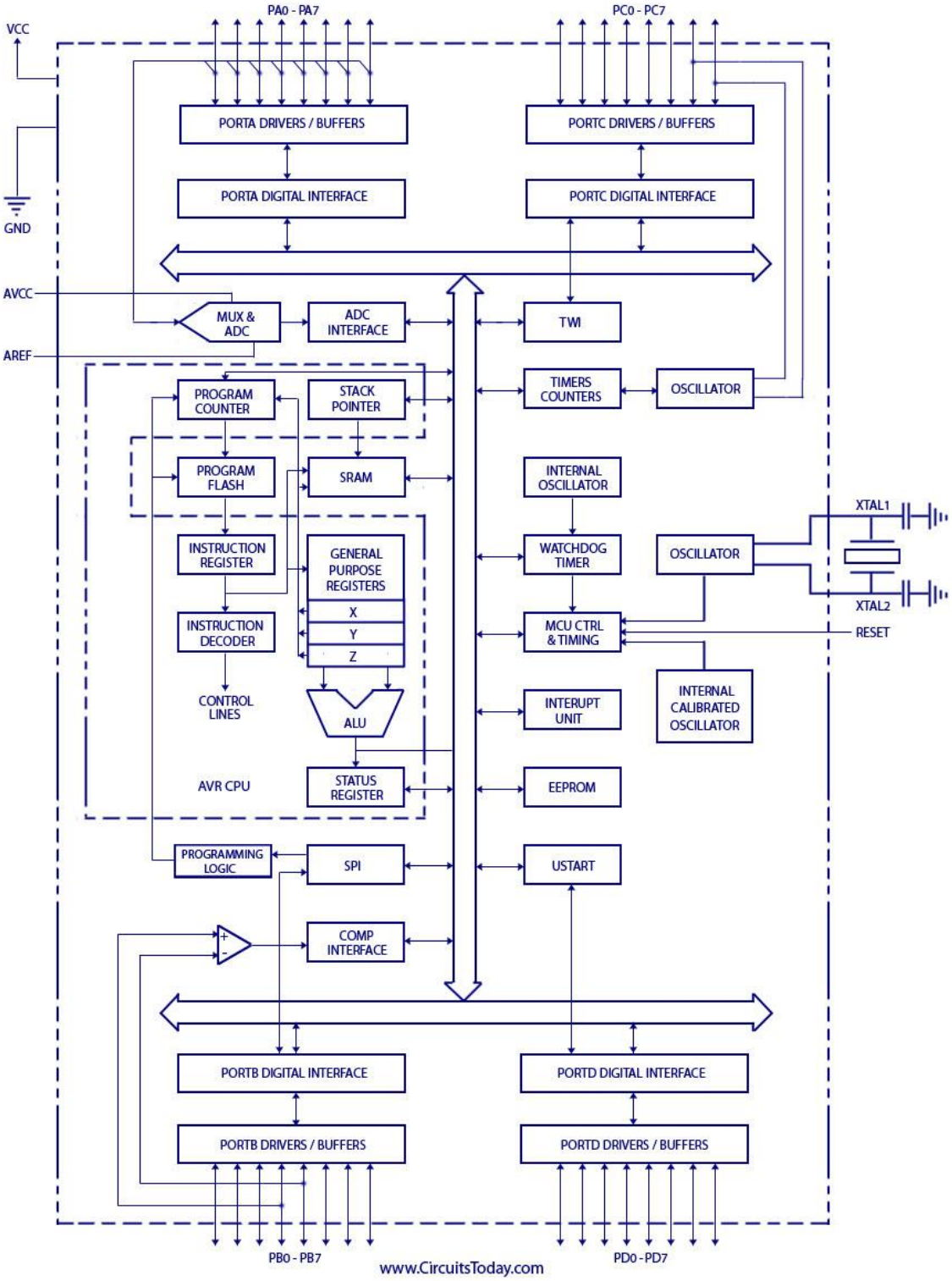
More Features: Up to 16 MIPS throughput at 16MHz. Most of the instruction executes in a single cycle. Two cycle on-chip multiplication. 32 × 8 General Purpose Working Registers

Debug: JTAG boundary scan facilitates on chip debug.

Programming: Atmega32 can be programmed either by In-System Programming via Serial peripheral interface or by Parallel programming. Programming via JTAG interface is also possible. Programmer must ensure that SPI programming and JTAG are not be disabled using fuse bits; if the programming is supposed to be done using SPI or JTAG.

Atmega32 block diagram

Block Diagram - ATmega32(AVR) - 8-bit Microcontroller



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LCD display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

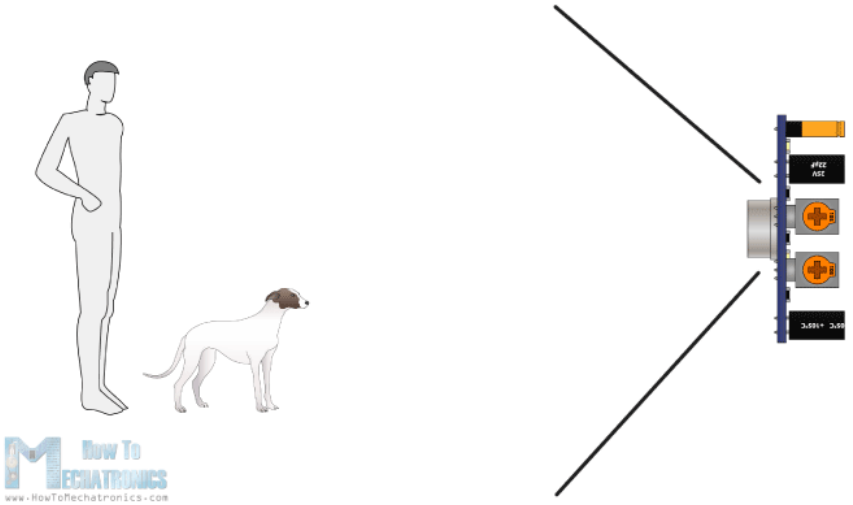
Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

6V Sealed Lead Acid Battery.

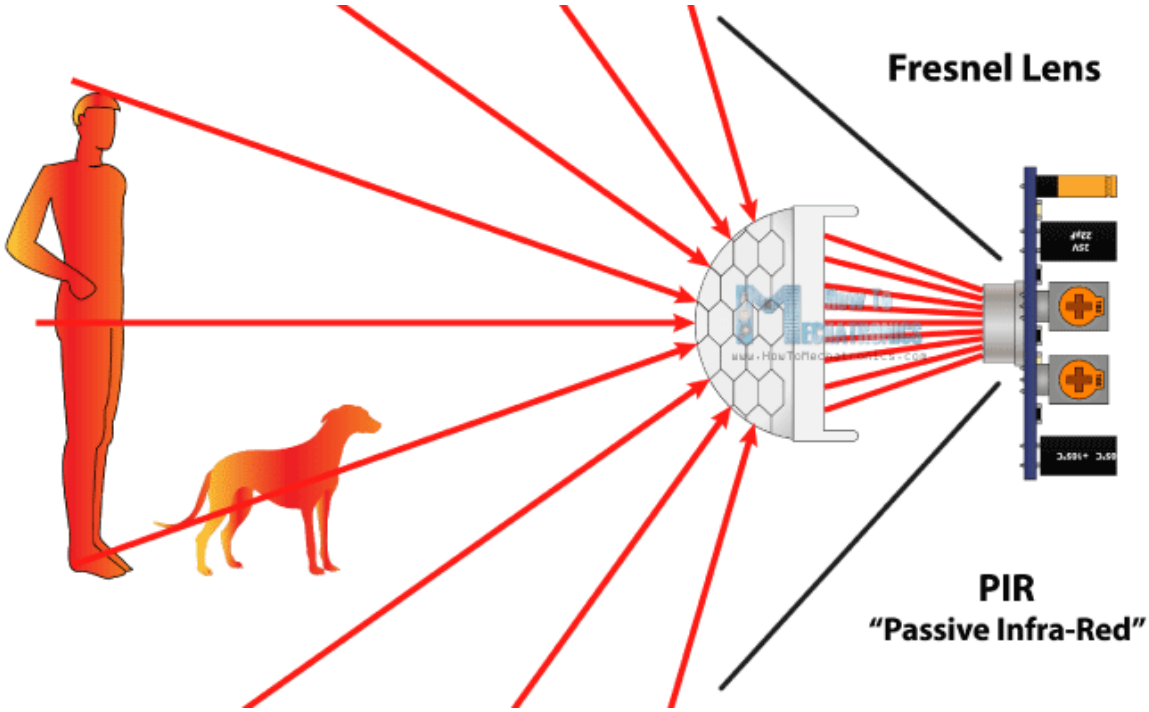
The lead acid battery uses the constant current constant voltage (CC/CV) charge method. A regulated current raises the terminal voltage until the upper charge voltage limit is reached, at which point the current drops due to saturation.

PIR sensor

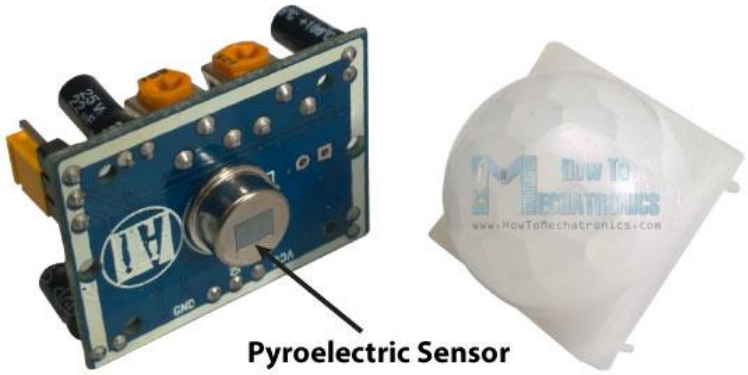
The module consists of a Pyroelectric sensor which generates energy when exposed to heat. That means when a human or animal body will get in the range of the sensor it will detect a movement because the human or animal body emits heat energy in a form of infrared radiation. That's where the name of the sensor comes from, a Passive Infra-Red sensor. And the term "passive" means that sensor is not using any energy for detecting purposes, it just works by detecting the energy given off by the other objects.



The module also consists a specially designed cover named Fresnel lens, which focuses the infrared signals onto the pyroelectric sensor.



The module has three more pins with a jumper between two of them. These pins are for selecting the trigger modes. The first one is called “non-repeatable trigger” and works like this: when the sensor output is high and the delay time is over, the output will automatically change from high to low level. The other mode called “repeatable trigger” will keep the output high all the time until the detected object is present in sensor’s range.



Garbage container

A waste container is a container for temporarily storing waste and is usually made out of metal or plastic. The curbside dustbins usually consist of three types: trash cans (receptacles made of metal or plastic), dumpsters (large receptacles similar to skips) and wheelie bins (light, usually plastic bins that are mobile). All of these are emptied by collectors, who will load the contents into a garbage truck and drive it to a landfill, incinerator or consuming crush facility to be disposed of.

Software used

Atmel Studio

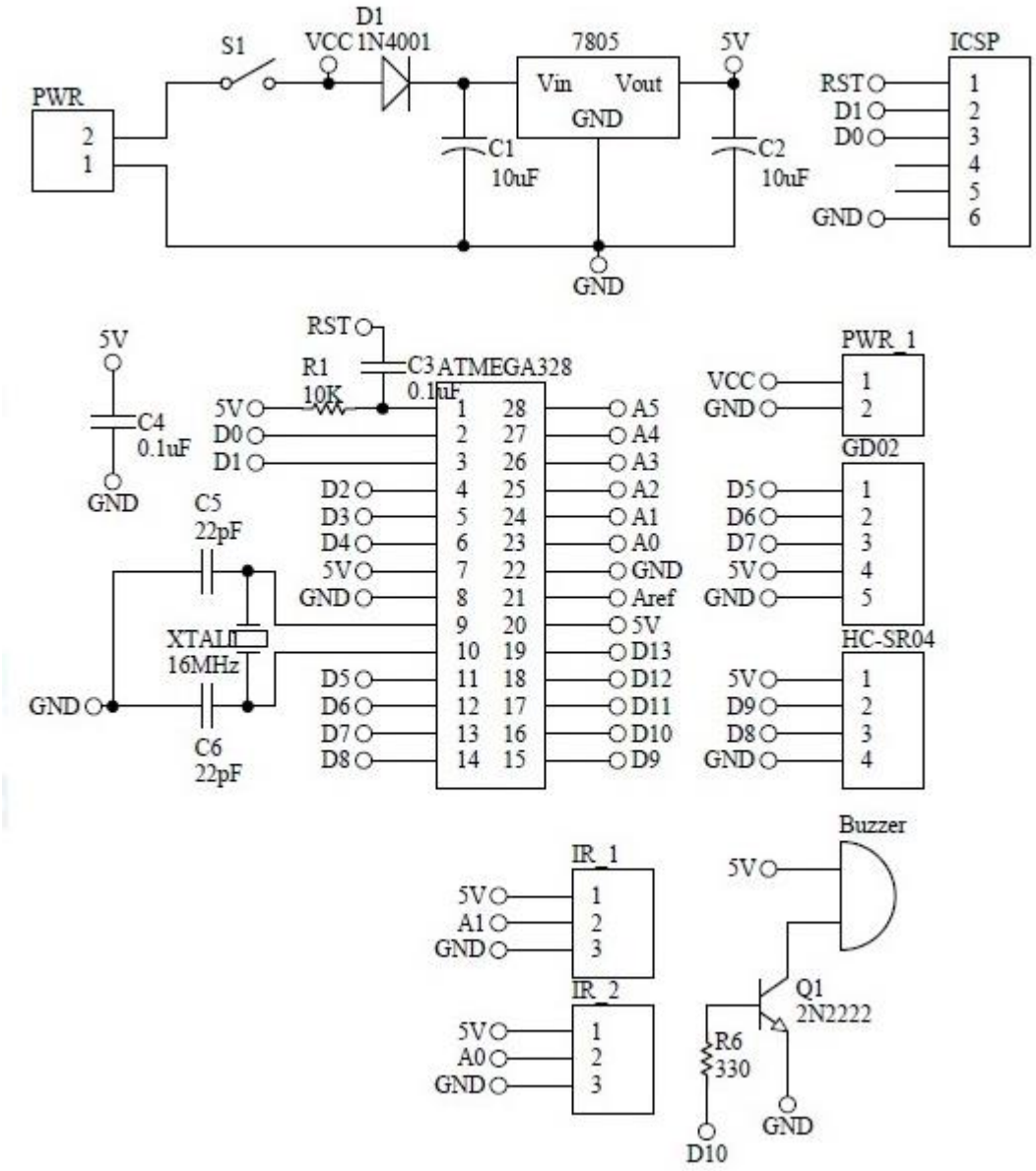
Studio 7 is the integrated development platform (IDP) for developing and debugging all AVR® and SAM microcontroller applications. The Atmel Studio 7 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. It also connects seamlessly to the debuggers, programmers and development kits that support AVR® and SAM devices.

Additionally, Studio includes Atmel Gallery, an online app store that allows you to extend your development environment with plug-ins developed by Microchip as well as third-party tool and embedded software vendors. Studio 7 can also seamlessly import your Arduino sketches as C++ projects, providing a simple transition path from Makerspace to Marketplace.

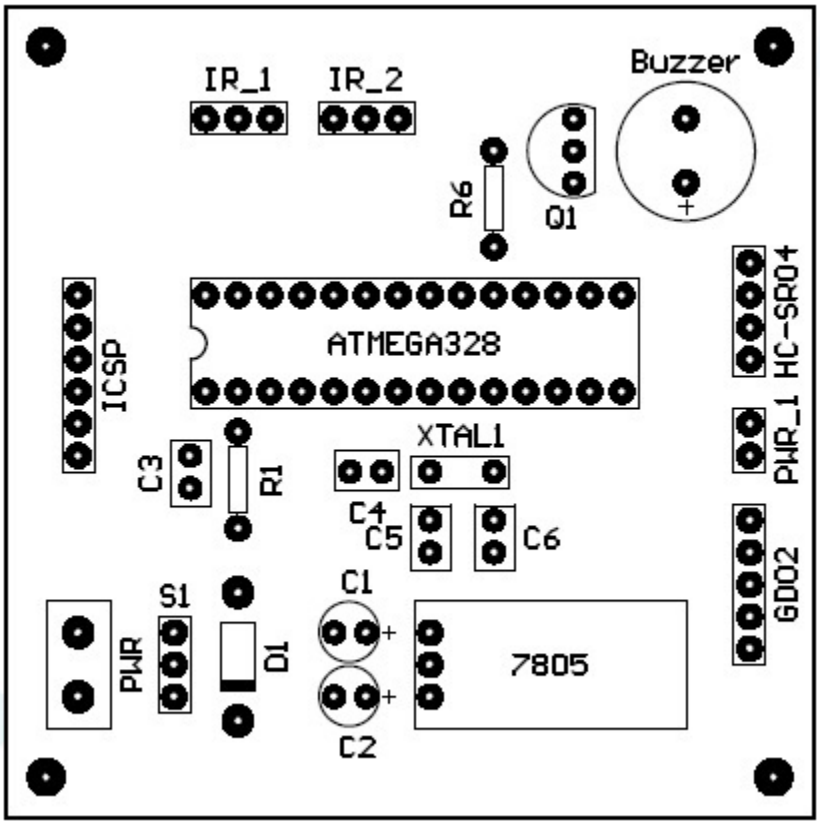
Eagle

EAGLE is a scriptable electronic design automation application with schematic capture, printed circuit board layout, auto-router and computer-aided manufacturing features. EAGLE stands for Easily Applicable Graphical Layout Editor and is developed by CadSoft Computer GmbH.

The schematic diagram



PCB layout


IR_1
IR_2
Buzzer
R6
Q1
ICSP
ATMEGA328
HC-SR04
PWR_1
XTAL1
C3
R1
C4
C5
C6
GDO2
S1
C1
PWR
D1
7805
C2

Arduino Smart Dustbin					
No	Komponen	Unit	No	Komponen	Unit
1	0.25W Resistor	2	14	Crystal 16MHz	1
2	5V Buzzer	1	15	Diode IN4001	1
3	Capacitor Ceramic	4	16	IC ATMEGA328	1
4	Capacitor Electrolytic	2	17	IC Socket 28pin	1
5	Connector 2 way housing	1	18	PCB Stand 8mm	4
6	Connector 2 way right	1	19	Pin Header 1X40	1
7	Connector 3 way housing	2	20	Pin Header Female 1X40	1
8	Connector 3 way right	2	21	Regulator LM7805	1
9	Connector 4 way housing	1	22	Slide Switch	1
10	Connector 4 way right	1	23	Terminal Block 2 way	1
11	Connector 5 way housing	1	24	Transistor 2N2222	1
12	Connector 5 way right	1	25	IR Line Tracking Sensor	2
13	Connector terminal pin	17	26	Cube Servo & G15 Driver	1

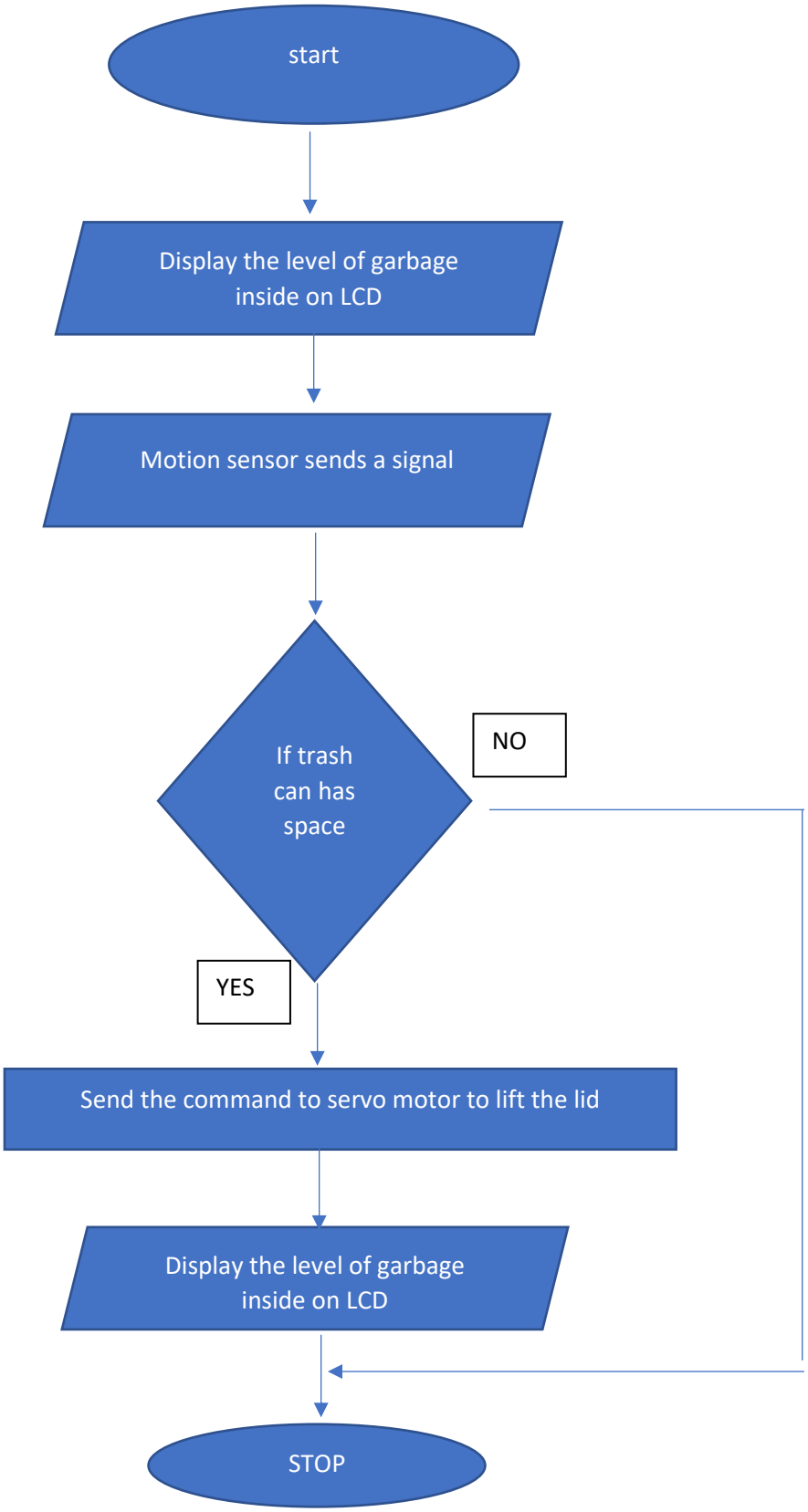
METHODOLOGY

The ultrasonic sensor or sharp sensor is used to find the height of garbage filled at different levels. At the first stage the components were initiated with arduino board for the testing purposes. After verifying the bugs, we hope to integrate it with the atmega32 microcontroller.

Another ultrasonic sensor is used to detect a person moving near the garbage can. Here we can even use a PIR motion sensor too. By this sensor, it detects the person near the trash can and send the signal to the microcontroller. Then it commands the servo motor to operate.
The servo motor is connected with the lid of the trash can.
Before sending the command to the servo motor microcontroller itself checks whether the space is available inside the trash can. If there is enough free space, then only the command will pass to the servo motor. Otherwise the lid won't open.

The level of the trash inside is detect by the previously mentioned ultrasonic or sharp sensor. Also, the dustbin always displays the amount that is filled inside the trash can, so that anyone can understand the space available there and when it is filling up, the cleaners can easily identify the cans which are to be replaced or clean.

Flow chart


start
Display the level of garbage inside on LCD
Motion sensor sends a signal
If trash can has space
NO
YES
Send the command to servo motor to lift the lid
Display the level of garbage inside on LCD
STOP

Conclusion

This modernization is positively compatible for our country and also very inexpensive to avail. So now it is the time for municipality to look over the city cleanliness thoroughly by automated smart waste bin system, with the MOTTO

"let's keep our city clean with smart waste bin"

Yes, we are being digitalized but now we have to be liberal this time for the sake of our own city by modernizing the waste bin.

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The complete disposal of trash at an appropriate time is done by this system which is the basic need in this context of time. The future prospectus may include waste segregation techniques along with this bin.

Testing beta code

```
#include <Servo.h>   //servo library
Servo servo;
int trigPin = 5;
int echoPin = 6;
int servoPin = 7;
int led= 10;
long duration, dist, average;
long aver[3];   //array for average


void setup() {
   Serial.begin(9600);
   servo.attach(servoPin);
   pinMode(trigPin, OUTPUT);
   pinMode(echoPin, INPUT);
   servo.write(0);        //close cap on power on
   delay(100);
   servo.detach();
}

void measure() {
 digitalWrite(10,HIGH);
digitalWrite(trigPin, LOW);
delayMicroseconds(5);
digitalWrite(trigPin, HIGH);
delayMicroseconds(15);
```

```
digitalWrite(trigPin, LOW);
pinMode(echoPin, INPUT);
duration = pulseIn(echoPin, HIGH);
dist = (duration/2) / 29.1;    //obtain distance
}
void loop() {
  for (int i=0;i<=2;i++) {   //average distance
    measure();
   aver[i]=dist;
    delay(10);             //delay between measurements
  }
 dist=(aver[0]+aver[1]+aver[2])/3;

if ( dist<50 ) {
//Change distance as per your need
 servo.attach(servoPin);
  delay(1);
 servo.write(0);
 delay(3000);
 servo.write(150);
 delay(1000);
 servo.detach();
}
Serial.print(dist);
}
```