"SMART DUSTBIN"

A PROJECT REPORT

Submitted by

GROUP: 41

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In fulfillment of the course
EMBEDDED SYSTEM DESIGN
In
INFORMATION AND COMMUNUCATION TECHNOLOGY

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• Motivation:

→ With increase of population, the scenario of cleanliness with respect to garbage management is degrading tremendously. In city there are many public places where we see that garbage bins or dustbins are placed but are overflowing. This creates unhygienic condition in the nearby surrounding. Also creates ugliness and some serious diseases, at the same time bad smell is also spread and it also degrades the valuation of that area.

→ To avoid such situation we come up with a project called "**Smart Dustbin**" which is a GSM based Garbage and waste collection bins overflow indicator system for Smart Cities.

→ Over main motivation behind this project is the ongoing campaign **Swachh Bharat Abhiyan** (Clean India Movement) launched on October 02, 2014 at Rajghat, New Delhi, by the Prime Minister of India **Narendra Modi** which is India's largest ever cleanliness drive to clean the streets, roads and infrastructure of the country's 4,041 statutory cities and towns.

• Description:

→ As people are getting smarter so are the things. While the thought comes up for Smart cities there is a requirement for Smart waste management. The idea of Smart Dustbin is for the Smart buildings, Colleges, Hospitals and Bus stands.

→ Smart dustbins is a new idea of implementation which makes a normal dustbin smart using **Infrared Sensors** for garbage level detection and sending message to respective municipal authorities updating the status of the bin using **GSM modem**.

→ Even this is a touch free dustbin so, when any person reaches near to it, the lid of it will open automatically so there is no need to open that dirty lid by your hands.

→ This project also include a Green LED to indicate that the dustbin is Empty and a Red LED to indicate the Full condition.

→ As soon as the garbage inside the dustbin reaches as the approx. level of 90% a Buzzer will turn ON for few seconds to tell the user not to use this dustbin and Red LED will be turned on until it's Empty again.

→ Till the dustbin is empty again, the lid will not open so that no one can through garbage into it and create mess.

• Final Outcome:

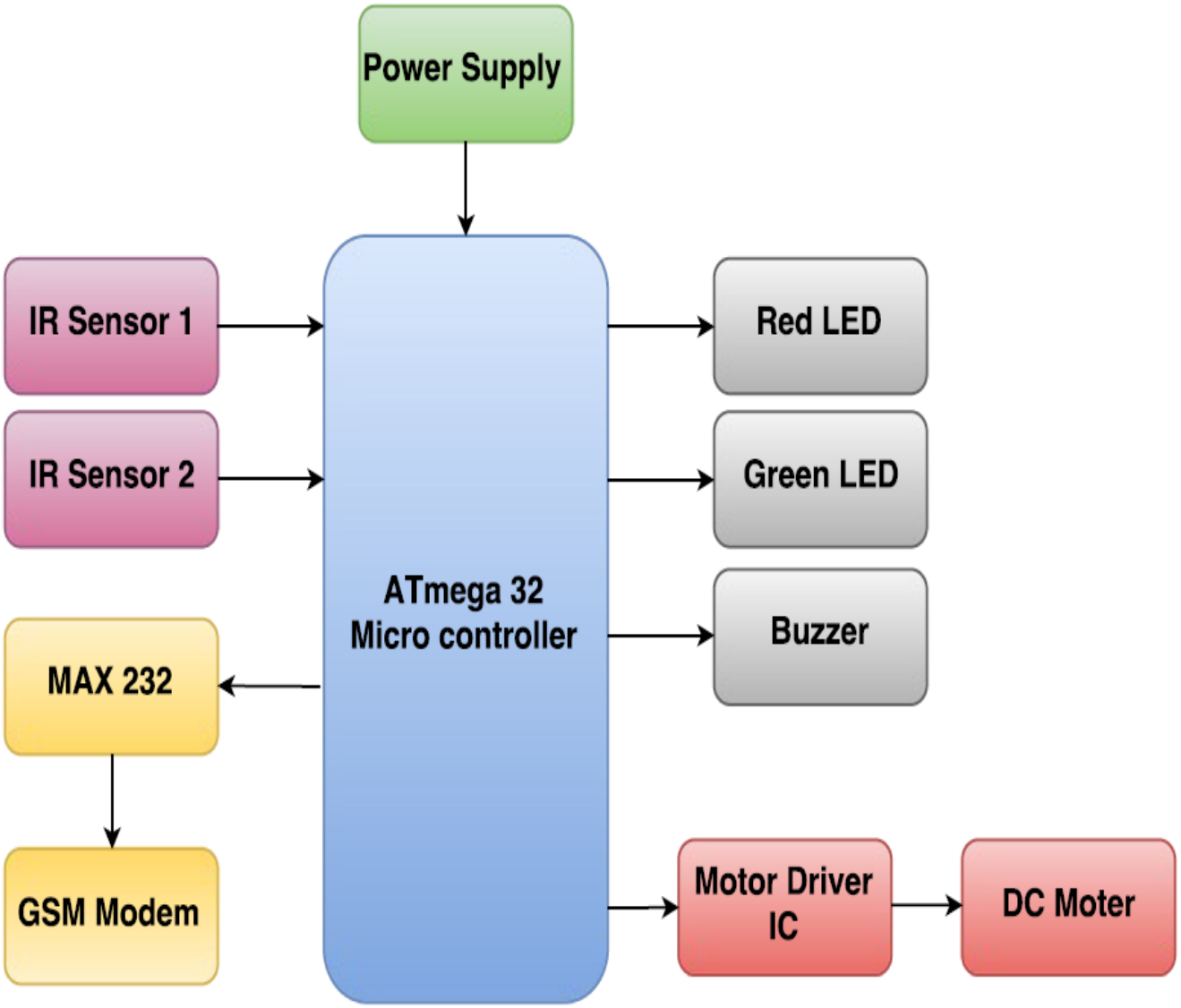
→ This project will send an **SMS** to respective municipal authorities which contains the details about the overflown dustbin.

→ Lid of dustbin will be opened when any person reaches near to it.

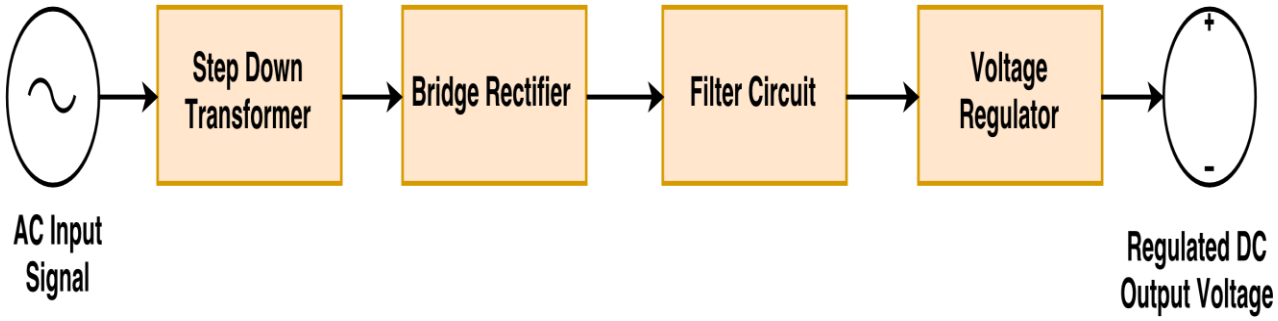
→ **LED** that indicate that whether dustbin is full or not?
- ✓ Red LED indicates dustbin is FULL
- ✓ Green LED indicates dustbin is EMPTY

→ **Buzzer** that indicate overflown situation.

• Block Diagram:



✓ DC Power Supply



• Components needed:

- ✓ AVR ATmega32 Micro Controller
- ✓ Infrared Sensor
- ✓ MAX232
- ✓ GSM Modem
- ✓ DC Motor
- ✓ Motor Driver IC
- ✓ LED - 2
- ✓ Buzzer
- ✓ Step Down Transformer
- ✓ Bridge Rectifier
- ✓ Filter circuit
- ✓ Voltage regulator
- ✓ Resistors
- ✓ Capacitors
- ✓ Jumpers
- ✓ Wires

• Selection Criteria of Components:

→ An **Infrared Sensor** is an electronic device that emits light in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Here it is used to find the overflow condition of the dustbin, we could also use Weight Sensor but it's not so good idea because it is quite difficult to predict by the weight of the dustbin that is it full or not? Because there exist many different kind of garbage having different volume and weight which may miscalculate and misguide our users.

→ Here, we are using **ATMega32** because, it is a best match to fulfil our different requirements due to its 40-pin PDIP and it is also widely accepted and we could also do many additional updates on the project in future like As soon as the dustbin is full, it moves in the predefined path to reach the larger container with the help of Line follower robot or having the person detector in front of dustbin etc.

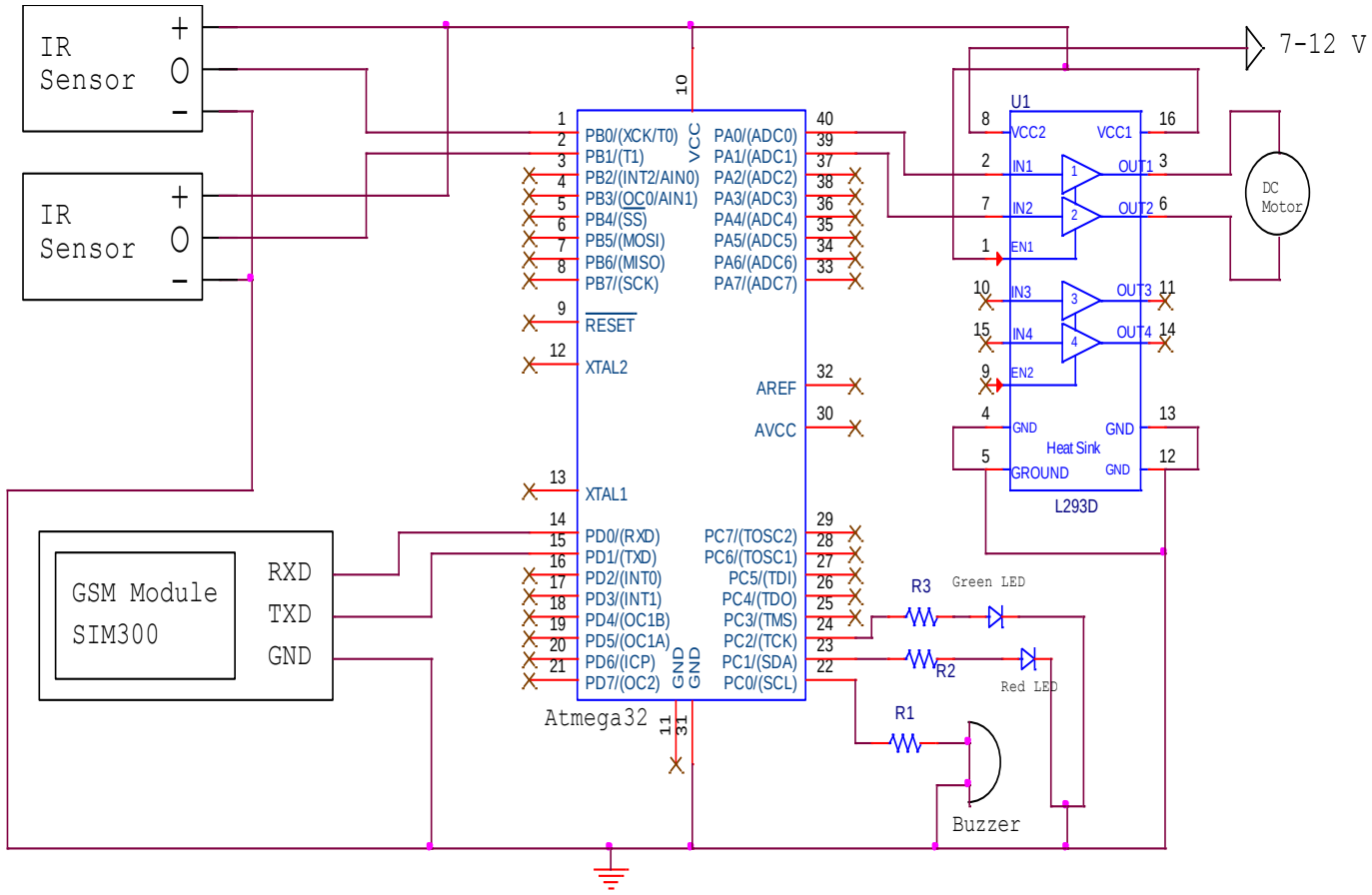
→ **GSM** (Global System for Mobile communications) **Modem** can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily using GSM.

→ **DC Motor** is used in this project to open and close the lid of dustbin whenever any person come reaches to it which won't create any mess and anyone can throw garbage into dustbin without touching that dirty dustbin.

→ **Green and Red LEDs** are used to indicate the Empty and Full condition of dustbin respectively in this project which will help people know from distance that whether we should go to dump our garbage in particular dustbin or not.

→ Also a **Buzzer** is selected to be turn ON for approx. 5 Sec each time after the Overflow condition whenever any person tries to dump garbage in the bin, which tells the user not to dump here due to overflown.

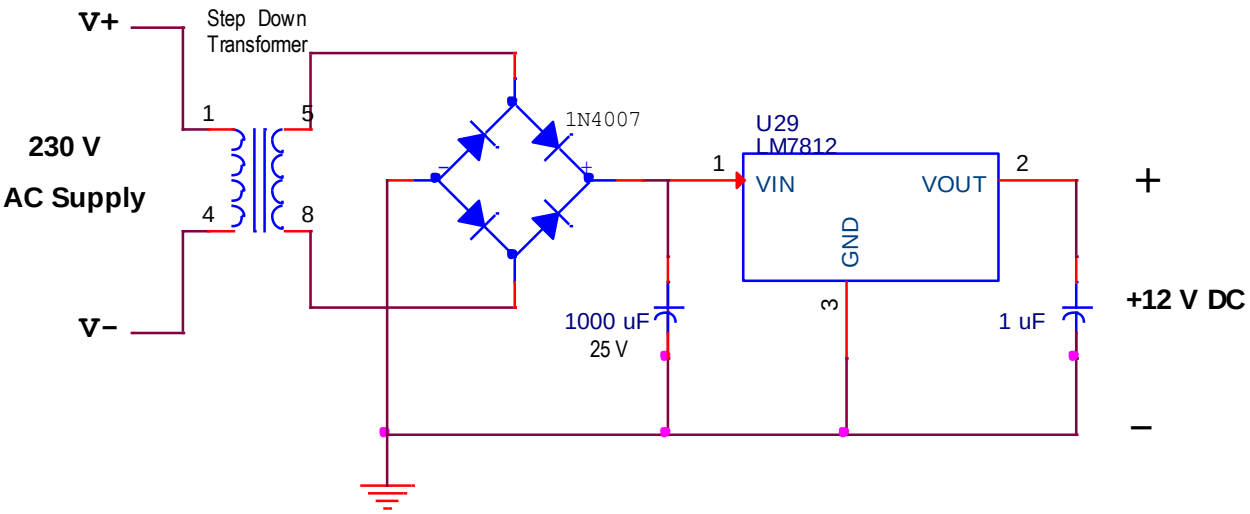
- **Circuit Diagram:**



Microcontroller Connection Circuit Diagram

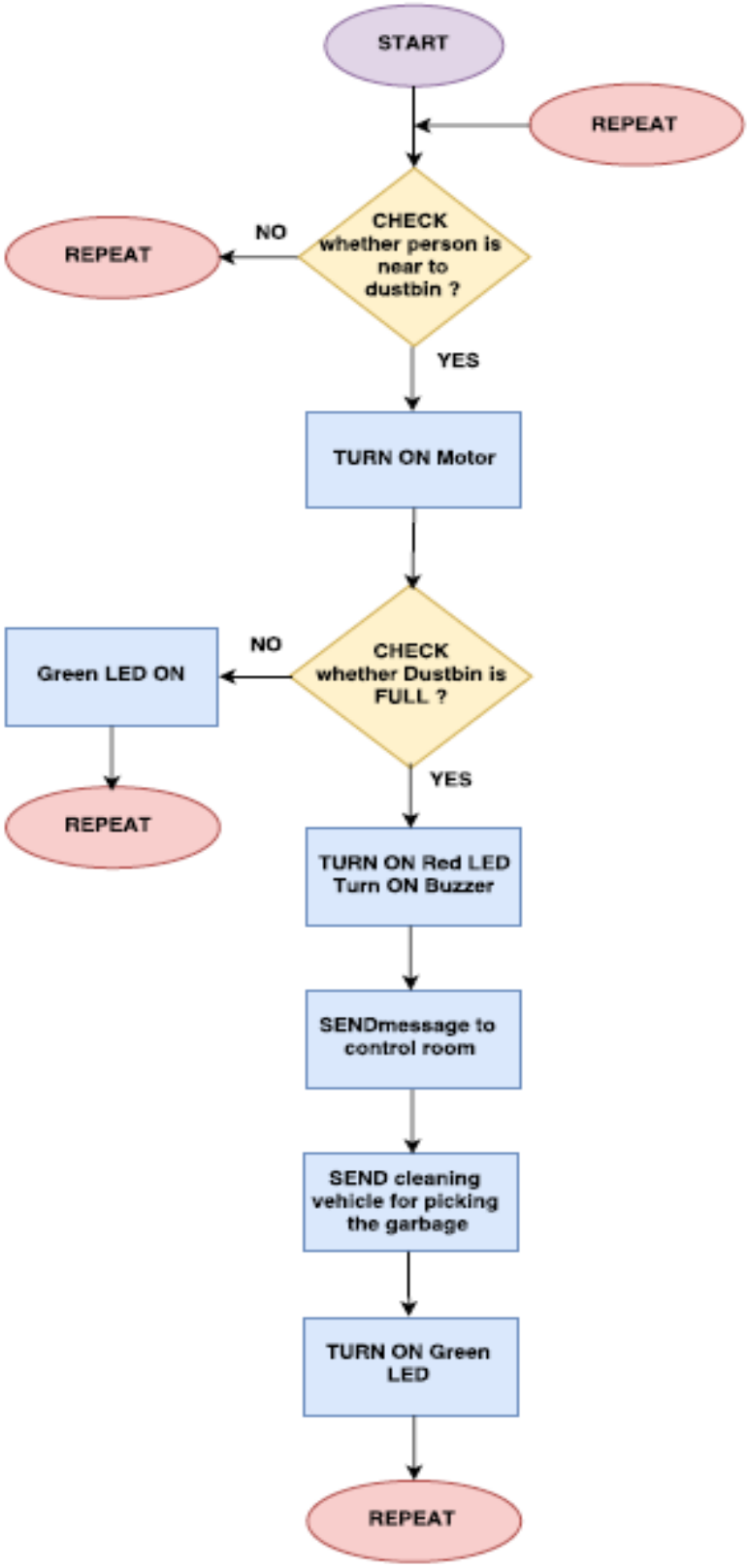
✓ Click here to view clear Circuit Diagram!

- Power Supply Design Circuit:



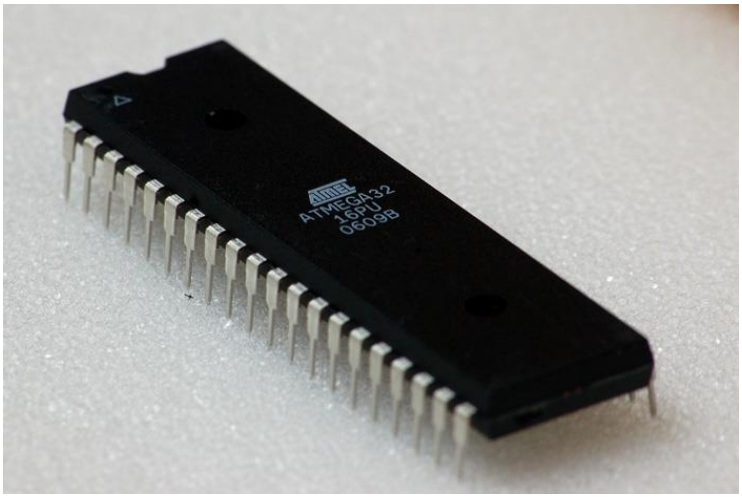
Power Supply Design Circuit

- **Flow Chart:**


START
REPEAT
CHECK whether person is near to dustbin ?
NO
REPEAT
YES
TURN ON Motor
CHECK whether Dustbin is FULL ?
NO
Green LED ON
REPEAT
YES
TURN ON Red LED Turn ON Buzzer
SENDmessage to control room
SEND cleaning vehicle for picking the garbage
TURN ON Green LED
REPEAT

- **Datasheet of Major Components:**

✓ AVR ATmega32 Micro Controller:



→ High-performance, Low-power
→ 8-bit Microcontroller
→ Architecture: Advanced RISC
→ 32 × 8 General Purpose Working Registers
→ 131 Powerful Instructions – Most Single-clock Cycle Execution
→ 32KB flash memory, 1KB EEROM , 2KB SRAM
→ 32 Programmable I/O Lines
→ 40-pin PDIP
→ Operating Voltage: 4.5V - 5.5V
→ Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
→ One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode

✓ Infrared Sensor:

→ Very low supply current

→ Supply voltage: 2.5 V to 5.5 V

→ Photo detector and preamplifier in one package

→ Internal filter for PCM frequency

→ Insensitive to supply voltage ripple and noise

→ PIN 1: OUT

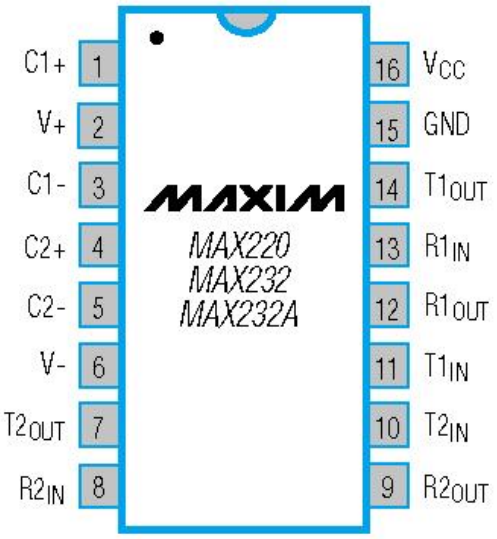
→ PIN 2: GND

→ PIN 3: Vs

→ Improved immunity against ambient light

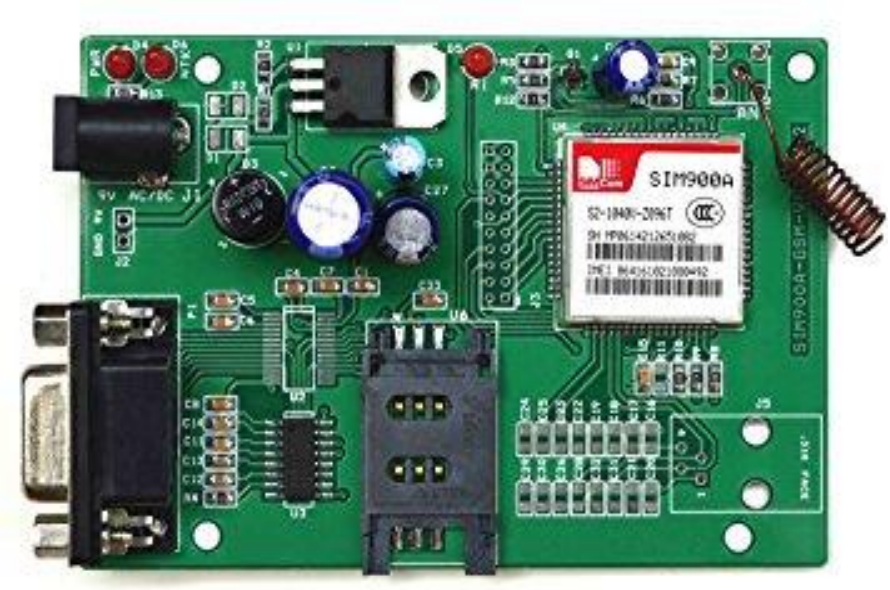
→ Detection: Indicated by active high Output

✓ MAX232:



→ Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
→ Operates From a Single 5-V Power Supply With 1.0-µF Charge-Pump Capacitors
→ Operates up to 120 kbit/s
→ Two Drivers and Two Receivers
→ ±30-V Input Levels
→ Low Supply Current: 8 mA Typical
→ ESD Protection Exceeds JESD 22 – 2000-V Human-Body Model (A114-A)
→ Upgrade With Improved ESD (15-kV HBM) and 0.1-F Charge-Pump Capacitors is Available With the MAX202

✓ GSM Modem:



→ Dual-Band GSM/GPRS 900/1800 MHz

→ RS232 interface for direct communication with computer or MCU kit

→ Configurable baud rate

→ Power controlled using 29302WU IC

→ ESD Compliance

→ Enable with MIC and Speaker socket

→ With slid in SIM card tray

→ With Stub antenna and SMA connector

→ Input Voltage: 12V DC

✓ DC Motor:

- → DC Supply: 4 – 12 V
- → RPM: 30 at 12 V
- → No Load current: 50 mA at 12 V
- → Load current: 300 mA(max) at 12 V
- → Torque: 5 Kg-cm at 12 V
- → Total length: 46 mm
- → Motor diameter: 36 mm
- → Brush type: precious metal
- → Output shaft: centred
- → Shaft diameter: 6 mm
- → Motor weight: 100 gm

• Connecting GSM Modem with AVR microcontroller:

GSM Modem RS232 is built with Dual Band GSM engine- SIM900A.
GSM modem (GSM Sim 900A) is used to make audio calls, SMS and DATA transfer application in M2M is a machine to machine interface that enables networked devices to exchange information. With the use of MAX232 chip we are able to connect GSM modem with microcontroller.
It can be used in Access Control Devices, Supply Chain Management and Security System.

✓ Details of GSM Modem:

- Working Frequency: 900 MHz to 1800 MHz
- Baud Rate: 9600 to 115200
- Internal TCP/IP stack to connect internet via GPRS
- SIM card holder
- Built in network status LED.

✓ Working Principle:

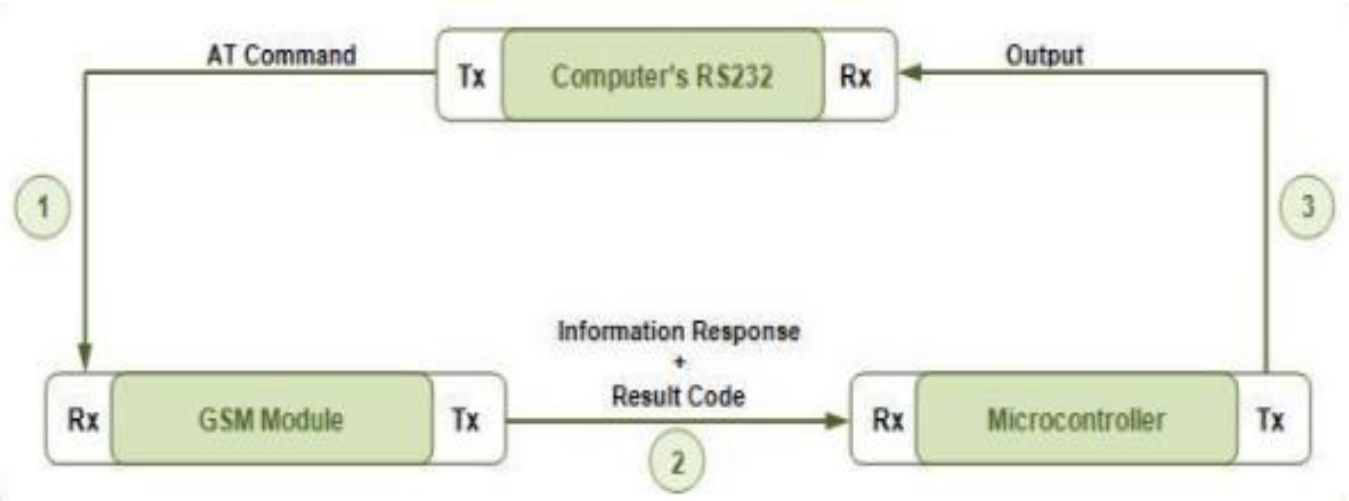
GSM modem doesn't have a keypad and display to interact with; it accepts AT commands through a serial interface. Every Commands starts with AT that's why they are called AT commands; here AT stands for attention.
Connecting GSM modem with microcontroller with use of MAX232 IC:

1. Connect T1IN (transmit pin of MAX232) to the transmitter pin of microcontroller and R1out (receive pin of MAX232) to the receiver pin of microcontroller.
2. Connect T1out pin of MAX232 to the transmitter pin of GSM modem and R1IN pin of MAX232 to receiver pin of GSM modem.

Following steps are used to send text message to a mobile phone through GSM modem:

1. Select GSM modem in text mode.
2. Send mobile number of the recipient to the GSM modem.
3. Send text message string to GSM modem.
4. Send ASCII code of CTRL + Z (0x1A) to GSM modem to transmit the message to mobile phone.

✓ Circuit Diagram:



✓ Code to connect GSM Modem with Microcontroller:

```
#include<string.h>
void usart_initialize()
{
    UCSRB=0x08; //Tx Enable
    UCSRC=0x86; // Data Size : 8-bit, Stop Bit:1,No parity
    UBRRL=0x33; // X= (Fosc/(16(Desired Baud Rate)))-1
    //    =(8*10^6/(16 *9600))-1
    //    =52.08-1
    //    =51 (Dec)
    //Here, URSEl=0, so Fosc is divided by 16 if it was 1                    //Fosc would Have
been divided by 8
}

//USART Send
void usart_send(unsigned char ch)
{
    while(UCSRA.B5==0); // Wait till UDR is empty
    UDR=ch; //Write the value to be Tx
}

void main()
{
```

```
    unsigned char str[] =
"AT\r\nAT+CSMINS?\r\nAT+CREG?\r\nATE1\r\nAT+CMGF=1\r\nAT+CSCS=\"GSM\"
\r\nAT+CSMP=17,167,0,16\r\nAT+CMGS=\"+91**********\"\rHi  I am sim300\n";

    int str_len=strlen(str);
    int i=0;
    usart_initialize();

    while(1)
    {
            usart_send(str[i++]);  //Send data
            if (i>=str_len)  // Till string Length
            {
                    i=0;
                    usart_send(26);
                    delay_ms(2000);
                    break;
            }
            delay_ms(300);
    }

   }
```

• Connecting IR Sensor with AVR microcontroller:

IR sensor is an electronic device that emits in order to sense some aspects of the surrounding. It can measure the heat as well as the motion of the object; these types of sensor will not emit an infrared radiation but it will detect an infrared radiation. Generally all objects radiate some of infrared radiation which is not visible to our eyes but it can be detected by IR sensor.

It can be used to detect any object or moment of the object. IR sensor with higher capabilities are used in Night Vision Devices, Infrared Astronomy and Infrared Tracking etc.

✓ Details of IR sensor:

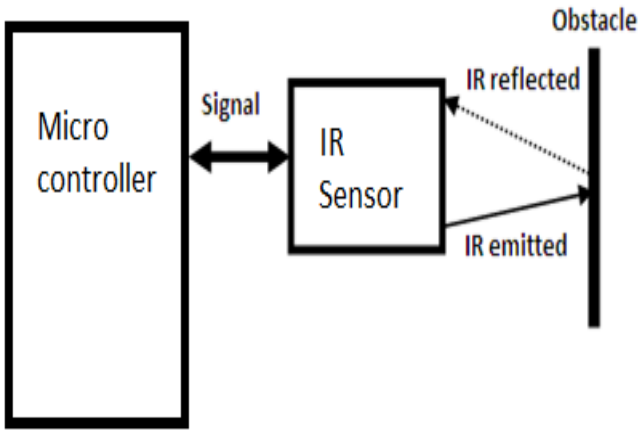
- Nominal Frequency: $1MHz$
- Supply Voltage: $3.3V \pm 10\%$
- Input Current: Max $35mA$
- Operating Temperature: -40°c to 85°c
- Start Up Time: Max $10mS$

✓ Working Principle:

When there is an object near IR sensor the output of sensor will be high and when there is no object output is low.

1. Connect the output of IR sensor to the pin of the microcontroller; this pin will be input pin for the microcontroller.
2. If Input pin is 1 then LED will blink else it will not.

✓ Circuit Diagram:



✓ Code to connect IR sensor with microcontroller:

```
#include <avr/io.h>

int main(void){
    DDRA= 0x00;    //Input Port to take output of IR sensor
    DDRB= 0x01; //Port to control LED

    while (1)
    {
            if(PINA == 1)
            {       //Output of sensor is high: there is an object
                    PORTB= 0x01; //LED will turn ON
            }
            Else
            {        //Output of sensor is low: there is no object
                    PORTB= 0x00; //LED will turn OFF
            }
    }
}
```

• Connecting DC Motor with AVR microcontroller:

DC-motor is a rotary electrical machine that converts direct current electrical energy into mechanical energy. All types of DC-motor have same internal mechanism, either electromagnetic or electronic. Speed of DC-motor can be controlled by a variable supply voltage of by changing current in its field.
It can be used in some tools and toys, fan, blower, conveyor, lift and spinning machine etc.

✓ Details of DC-motor:

- RPM: 30
- Voltage: 4-12V (Max: 36V)
- Current: 45mA
- Gear Ratio: 100:1

✓ Working Principle:

Working principle of DC-motor is that when a current carrying conductor placed in magnetic field, it experiences a mechanical force. Direction of this mechanical force is given by Fleming's left-hand rule.

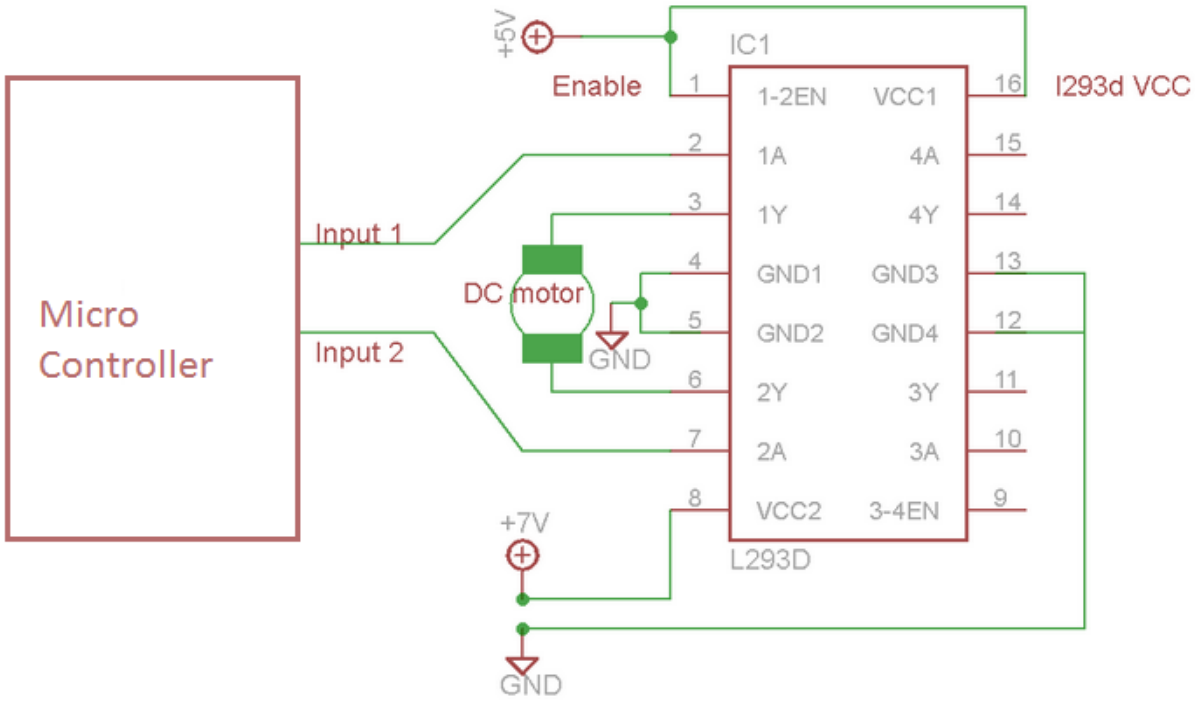
- Following are the steps to connect DC-motor with microcontroller:
  (Here, we are using L239D motor driver IC to drive motor)

1. Connect Pin: 1 &16 of IC to Vcc and Pin: 3, 4 & 12,13 to Gnd of the microcontroller.
2. Connect Pin: 2 & 6 of IC to any Port pin of microcontroller these pins of IC are inputs of IC, these inputs are used to drive the motor. Details to drive motor using these inputs is shown in below table:

Input: 1	Input: 2	Motor Rotation
0	0	Stop
0	1	Anti- clock wise
1	0	Clock wise
1	1	Stop

3. Connect Pin: 3 & 5 of IC to DC- motor.
4. Provide input value from microcontroller to operate motor in a particular direction or to stop motor.

- Circuit Diagram:



✓ Code to connect DC-motor with microcontroller:

```
#include <avr/io.h>
#include <util/delay.h>

int main(void)
{

    DDRA= oxFF;
    //Output Port that will control inputs of L239D IC: control rotation of motor

    while (1)
    { //Infinite Loop

        PORTA= 0x01; //Motor will rotate anti-clock wise
        _delay_ms(1000); //delay of 1 second

        PORTA= 0x02; //Motor will rotate clock-wise
        _delay_ms(1000); //delay of 1 second
```

```
            PORTA= 0x00; //Motor stops;
            _delay_ms(1000); //delay of 1 second
    }

    return 0;
}
```

• Connecting Buzzer with AVR microcontroller:

Buzzer is an electronic device that converts the electronic signals into buzzing noise; which may be mechanical, electromechanical or piezoelectric.
It can be used in alarm devices, timers, electronic bell and confirmation of user input such as mouse click or keystroke.

✓ Details about Buzzer:

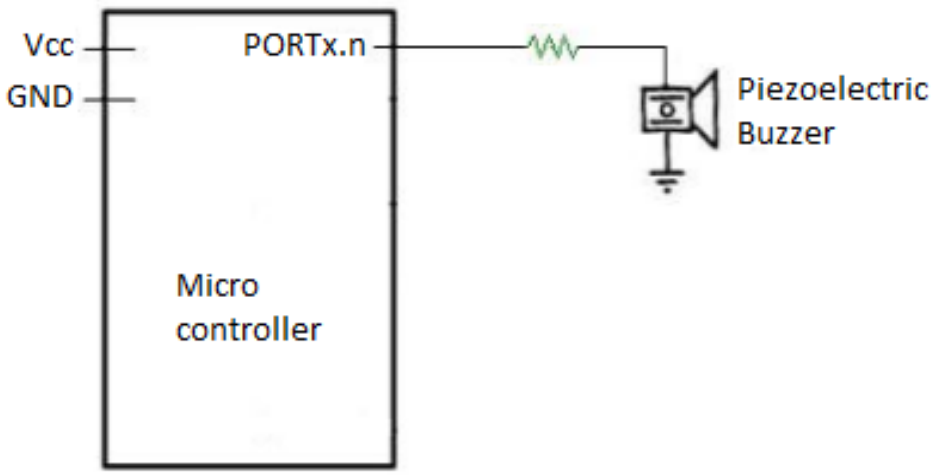
- We are using piezoelectric buzzer.
- Maximum Input Voltage: 30 V
- Sound Pressure: 70 $dBA/10cm$
- Operating temperature: $-10^{\circ}c\ to\ 70^{\circ}c$

✓ Working Principle:

Piezoelectric buzzer use the inverse piezoelectric principle to create movement of a ceramic disc to produce sound waves.
Following are the steps to connect buzzer with microcontroller:

1. Connect Buzzer with a PORT pin of microcontroller.
2. Provide Logic 1 to turn on the buzzer and Logic 0 to turn off the buzzer.

✓ Circuit Diagram:



✓ Code to connect Buzzer with Microcontroller:

```
#include <avr/io.h>
#include <util/delay.h>

int main (void)
{
        //Initializing Port
        //Connecting Buzzer with PORTA
        DDRA = 0x01; //PINo of PORTA initialize as output

        PORTA = 0x00; //Initial value

        /*Infinite Loop */
        while(1)
        {
                //Toggling the value of port after every second
                PORTA= 0x01; //Buzzer will turn ON
                _delay_ms(1000); //Delay of 1 second
                PORTA= 0x00; //Buzzer will turn OFF
                _delay_ms(1000); //Delay of 1 second
        }
}
```

• Connecting LED with AVR microcontroller:

A Light-Emitting Diode is a two-lead semiconductor light source. It is a P-N junction diode, which emits light when activated. It has many advantages lower energy consumption, smaller size, longer lifetime etc.

It can be used in remote control device, home application and in automobile application. It can be also used as indicator, flashlight etc.

✓ Details of LED:

- Supply Current: $16 - 18\ mA$ (Max:$20mA$)
- Voltage: $5V$
- Power Dissipation: $105\ mW$
- Operating Temperature: $-40^{\circ}c$ to $85^{\circ}c$

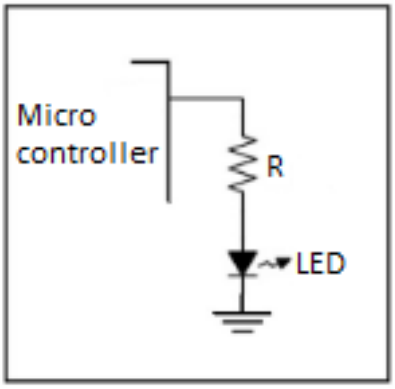
✓ Working Principle:

When a suitable voltage is applied to the LED, electrons are able to recombine with electron holes within the device, releasing the energy in the form of photons. This effect is called "electroluminescence" and the color of the light is determined by the energy gap of the semiconductor.

Following are the steps to connect LED with microcontroller:

1. Connect LED with a PORT pin of microcontroller; use resistor to control current.
2. Provide Logic 1 to pin to turn on the LED and Logic 0 to turn off the LED.

✓ Circuit Diagram:

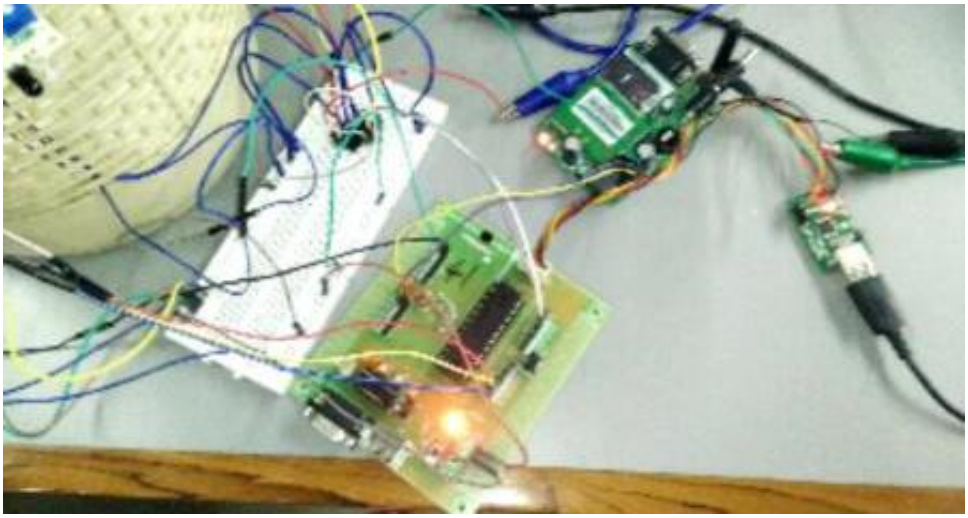


✓ Code to connect LED with microcontroller:

```
#include <avr/io.h>
#include <util/delay.h>

int main (void)
{
        //Initializing Port
        //Connecting LED with PORTA
        DDRA = 0x01; //PINo of PORTA initialize as output

        PORTA = 0x00; //Initial value

        /*Infinite Loop */
        while(1)
        {

                //Toggling the value of port after every second
                PORTA= 0x01; //LED will turn ON
                _delay_ms(1000); //Delay of 1 second
                PORTA= 0x00; //LED will turn OFF
                _delay_ms(1000); //Delay of 1 second
        }

}
```

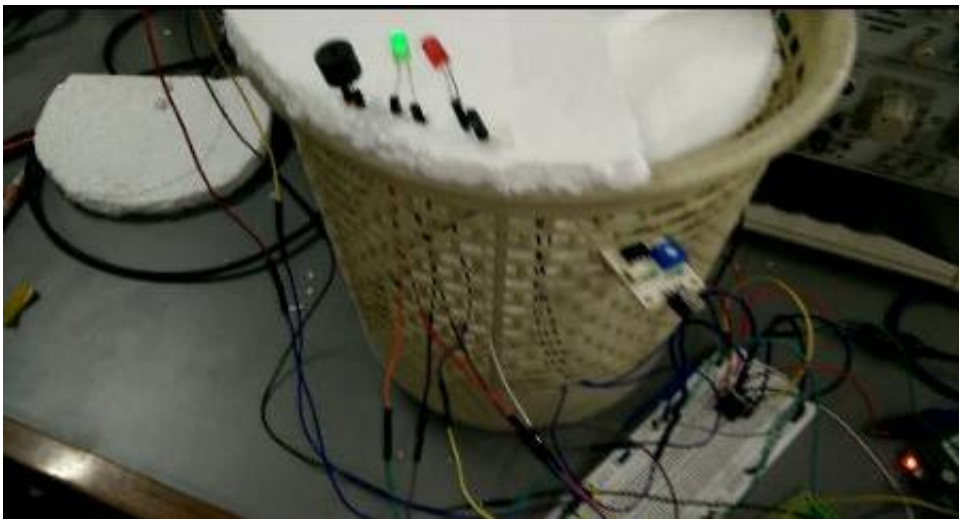
- **Final circuit Photos:**

✓ Circuit:



✓ Upper view of Dustbin:

✓ Connected sensor with dustbin:



✓ Getting final SMS in mobile phone:

- **Video:**
- Click here to play the Video!

- **Final Code:**

```
#include<string.h>

void usart_initialize()
{
 UCSRB=0x08; //Tx Enable
 UCSRC=0x86; // Data Size : 8-bit, Stop Bit:1,No parity
 UBRRL=0x33; // X= (Fosc/(16(Desired Baud Rate)))-1
          //     =(8*10^6/(16 *9600))-1
          //     =52.08-1
          //     =51 (Dec)
        //Here, URSEl=0, so Fosc is divided by 16 if it was 1                    //Fosc would
Have been divided by 8
}

//USART Send
void usart_send(unsigned char ch)
{
    while(UCSRA.B5==0); // Wait till UDR is empty
    UDR=ch; //Write the value to be Tx
}

void send_SMS(unsigned  char str[], int str_len)
 {
    int i=0;
    int cnt = 1;

    while(cnt != 5)
    {
      usart_send(str[i++]);  //Send data
      if (i>=str_len)  // Till string Length
      {
        i=0;
        usart_send(26);
        delay_ms(2000);
        cnt = 5;
        //break;
      }
      delay_ms(300);
    }
 }

void main() {
```

```
    int j=1;
    int k=0;
    unsigned char
str[]="AT\r\nAT+CSMINS?\r\nAT+CREG?\r\nATE1\r\nAT+CMGF=1\r\nAT+CSCS=\"
GSM\"\r\nAT+CSMP=17,167,0,16\r\nAT+CMGS=\"+91**********\"\rALERT!\nDustbin:
001 is filled...\n";
    int str_len=strlen(str);

    unsigned char
str1[]="AT\r\nAT+CSMINS?\r\nAT+CREG?\r\nATE1\r\nAT+CMGF=1\r\nAT+CSCS=\"
GSM\"\r\nAT+CSMP=17,167,0,16\r\nAT+CMGS=\"+91**********\"\rGarbage collected
from Dustbin 001.\n";
    int str_len1=strlen(str1);

    DDRB = 0x00;
    DDRC = 0x03;
    DDRA= 0x03;
    DDRD= 0x00;

    while(1)
    {
        if(PINB.B0 == 1)
        {

            PORTC.B1 = 1;    //red led ON
            PORTC.B2 = 0;    //green led off

            if(j == 1)
            {
                PORTC.B0 = 1;    //buzzer ON
                Delay_ms(4000);
                PORTC.B0 = 0x00;    ///buzzer off

                usart_initialize();
                send_SMS(str, str_len);
                j=0;
                k=1;
            }
            PORTC.B0 = 0x00;    ///buzzer off
        }
        else if(PINB.B0 == 0)
        {
            PORTC.B0 = 0;   //buzzer off
            PORTC.B1 = 0;   //red led off
```

```
                PORTC.B2 = 1;       //green ON
                j=1;

                if(k == 1)
                {
                        usart_initialize();
                        send_SMS(str1, str_len1);
                        k=0;
                        PORTC.B2=0;
                        delay_ms(1000);
                        PORTC.B2= 1;
                }
        }

        if(PINB.B1 == 1){
                PORTA= 0x02;
                delay_ms(1300);
                PORTA= 0x00;
                delay_ms(1300);
                PORTA= 0x01;
                delay_ms(1300);
                PORTA= 0x00;
        }
        else{
                PORTA= 0x00;
        }
    }
}
```

- **Time Line of Project:**

	Date	06-03-17	20-03-17	27-04-17	10-04-17	17-04-17
Work Done						
Project Formation		✓				
Collection of Components			✓			
Code Programing				✓		
Build Circuit					✓	
Debugging whole System						✓