International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 9, Issue 5, May 2020||

Smart Trash Monitoring System using Internet of Things (IOT)

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ABSTRACT: The increase in population, has led to tremendous degradation in the state of affairs of hygiene with respect to waste management system. The spillover of waste in civic areas generates the polluted condition in the neighboring areas. It may aggravate numerous severe diseases for the nearby people. This will humiliate the appraisal of the affected area.The detection,monitoring and management of waste is one of the primary problems of the present aera.The traditional way of manually monitoring the waste in waste bin is a cumbersome process and utilizes more human effort,time and cost which can easily be avoided with our present technology. For eliminating or mitigating the garbage's and maintains the cleanness, it requires 'smartness based waste management system. This paper is proposed IOT based smart waste clean management system which checks the waste level over the dustbins by using Sensor systems. Once it detected immediately this system altered to concern authorized through IoT. For this system used Microcontroller as an interface between the sensor system and IoT system. This is ensued the greenish in the environment and support for swach bharat for cleanness.This is our solution a method in which waste management is automated.This is an innovative way to keep our cities clean and healthy.

KEYWORDS: Waste management system, Garbage, IOT, Microcontroller, swach bharat

1. INTRODUCTION

To obtain a cleaner , healthier and greenish environment. We are living in an age where task and system are fusing together with the power of IOT to have a more efficient system of working. To reduce human efforts and cost. To automate garbage monitoring. To detect , monitor and manage waste effectively. Nowadays there are tons of flats and apartments which have been built in the rapid urbanization area. There are several issues related to urbanization .One such is waste management. The overflowing of garbage is a sanitary issue which may cause disease. Moreover it is a waste of fuel to travel around a complex area to find some of the garbage are full and some are not full. Also on rare days , problem might arise where truck capacity is full and garbage left uncleansed. However the present system is inefficient.

Fig 1:Overflow of garbage

II. HARDWARE REQUIRED

2.1PIC MICROCONTROLLER

The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

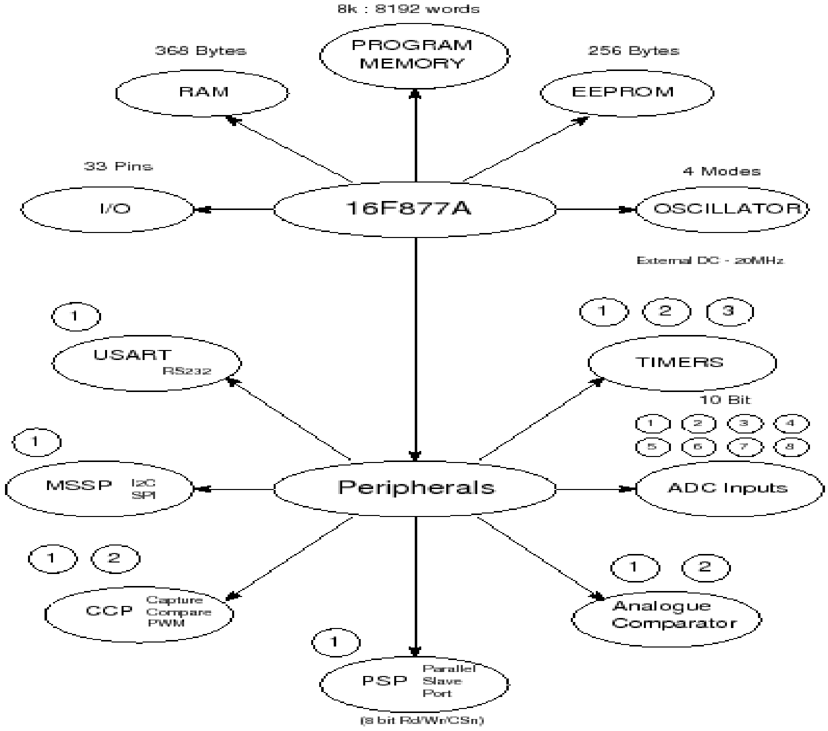

Fig2:Peripherals of PIC microcontroller

2.2 HCS401 ULTRASONIC SENSOR

Ultrasonic sensor (also known as **transceivers** when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

Fig 3:Ultrasonic sensor

2.2.1 ULTRASONIC WORKING

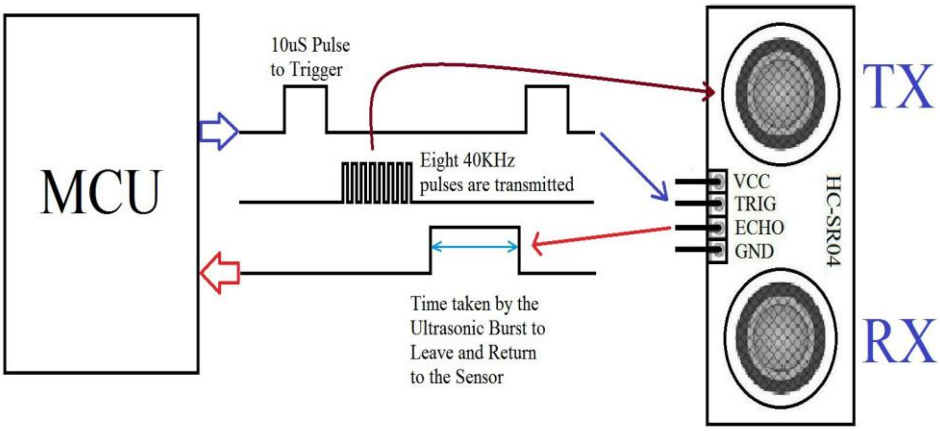

Fig 4:Working of ultrasonic sensor

2.3 GSM MODEM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. The working of GSM modem is based on commands, the commands always start with AT (which means Attention) and finish with a <CR> character. For example, the dialing command is ATD<number>; ATD3314629080; here the dialing command ends with semicolon.
The AT commands are given to the GSM modem with the help of PC or controller. The GSM modem is serially interfaced with the controller with the help of MAX 232. Here max 232 acts as driver which converts TTL levels to the RS 232 levels. For serial interface GSM modem requires the signal based on RS 232 levels. The T1_OUT and R1_IN pin of MAX 232 is connected to the TX and RX pin of GSM modem

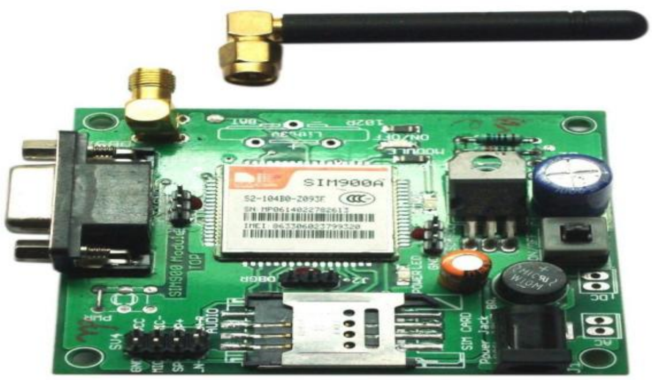

Fig 5: GSM modem

2.4 METAL DETECTION SENSOR

It is used to detect the unwanted metal or any type of explosive material. The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected.

Fig 6:Metal detection sensor

2.4.1 FEATURES

- Operating voltage: 5VDC ,
- Input current: 150mA,
- Output: Digital
- Metal detected indicator with led

2.5 NODE MCU-IOT MODULE

2.5.1ESP-12E BASED NODE MCU

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications.

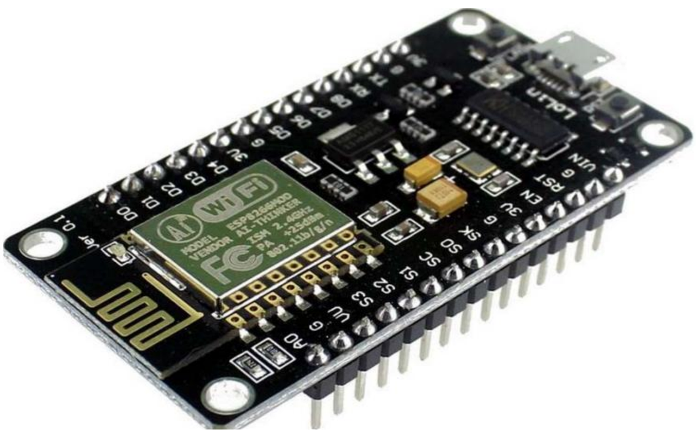

Fig 7:ESP-12E BASED NODEMCU

Integrated SOC of NODE MCU

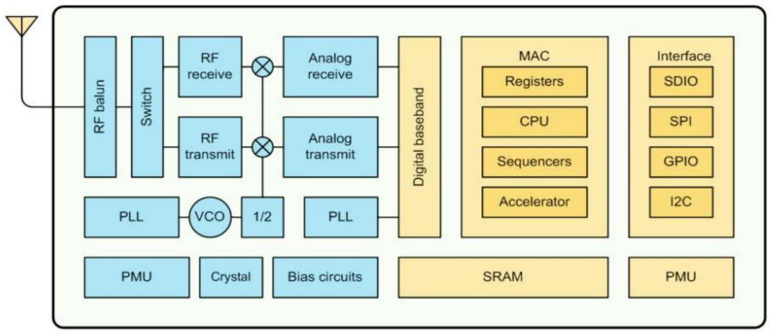

Fig 8:Integrated SOC of NODE MCU

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Integrated wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement

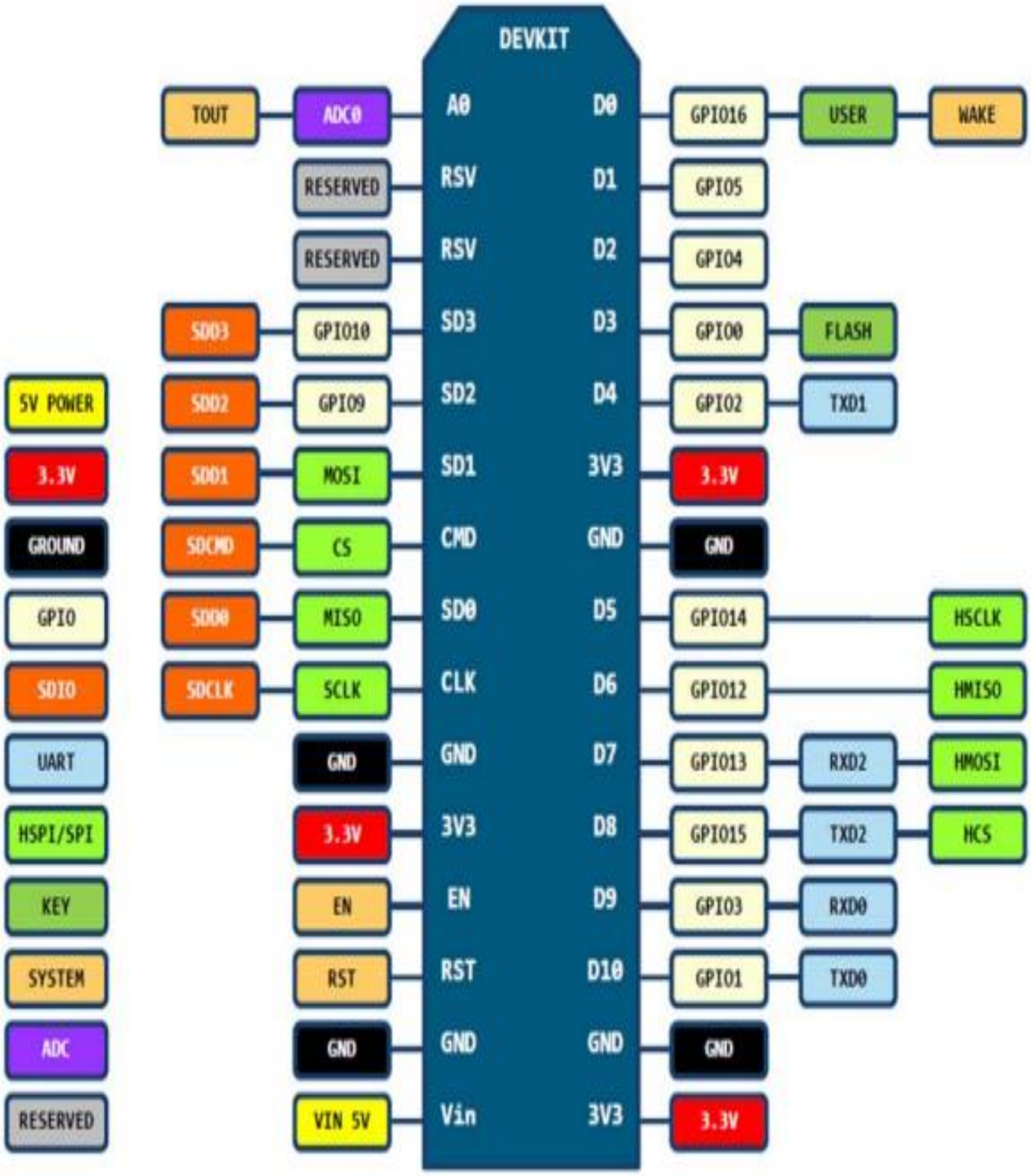

Fig 9:NODEMCU Pin configuration

ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controller based design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated Wi-Fi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area

2.5.2ESP-12E ARCHITECTURE

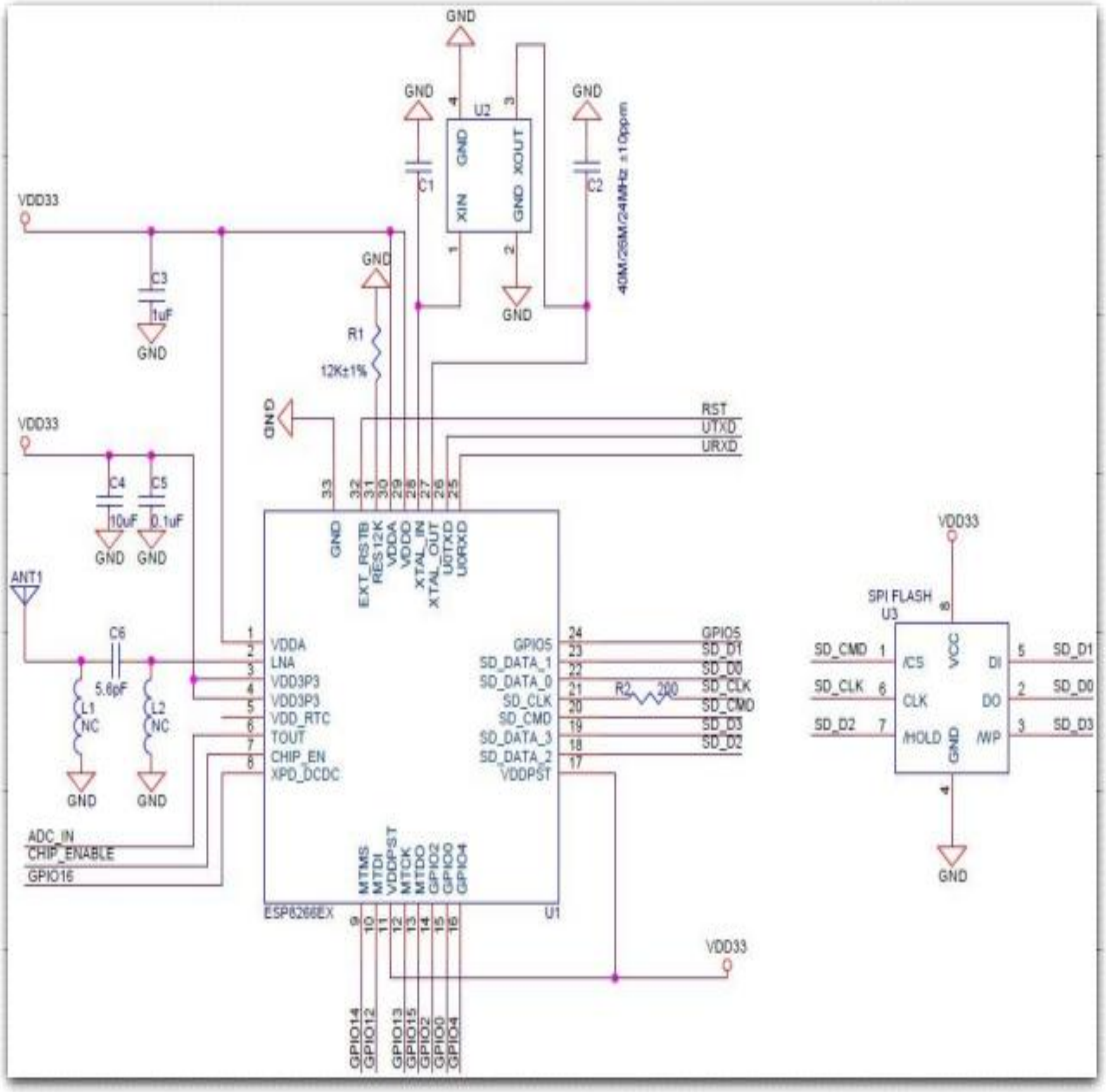

Fig 10:Schematic diagram of WIFI module

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2.5.3 INTERFACE

Interface	Pin Name	Description
HSPI	IO12(MISO) IO13(MOSI) IO14(CLK) IO15(CS)	SPI Flash 2, display screen, and MCU can be connected using HSPI interface.
PWM	IO12(R) IO15(G) IO13(B)	Currently the PWM interface has four channels, but users can extend the channels according to their own needs. PWM interface can be used to control LED lights, buzzers, relays, electronic machines, and so on.
IR Remote Control	IO14(IR_T) IO5(IR_R)	The functionality of Infrared remote control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38KHz.
ADC	TOUT	ESP8266EX integrates a 10-bit analog ADC. It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously. This interface is typically used in sensor products.
I2C	IO14(SCL) IO2(SDA)	I2C interface can be used to connect external sensor products and display screens, etc.

The GPIO(General Purpose Input/Output) allows us to access to pins of ESP8266 , all the pins of ESP8266 accessed using the command GPIO, all the access is based on the I/O index number on the Nodd MCU dev kits, not the internal

Interface	Pin Name	Description
UART	**UART0:** TXD (U0TXD) RXD (U0RXD) IO15 (RTS) IO13 (CTS) **UART1:** IO2(TXD)	Devices with UART interfaces can be connected with the module. Downloading: U0TXD+U0RXD or GPIO2+U0RXD Communicating: UART0: U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debugging: UART1_TXD (GPIO2) can be used to print debugging information. By default, UART0 will output some printed information when the device is powered on and is booting up. If this issue exerts influence on some specific applications, users can exchange the inner pins of UART when initializing, that is to say, exchange U0TXD, U0RXD with U0RTS, U0CTS.
I2S	**I2S Input:** IO12 (I2SI_DATA) ; IO13 (I2SI_BCK); IO14 (I2SI_WS); **I2S Output:** IO15 (I2SO_BCK); IO3 (I2SO_DATA); IO2 (I2SO_WS).	I2S interface is mainly used for collecting, processing, and transmission of audio data.

GPIO pin, for example, the pin ‘D7’ on the Node MCU dev kit is mapped to the internal GPIO pin 13, if you want to turn ‘High’ or ‘Low’ that particular pin you need to called the pin number ‘7’, not the internal GPIO of the pin. When you are programming with generic ESP8266 this confusion will arise which pin needs to be called during programming, if you are using NodeMCUdevkit, it has come prepared for working with Lua interpreter which can easily program by looking the pin names associated on the Lua board. If you are using generic ESP8266 device or any other vendor boards please refer to the table below to know which IO index is associated to the internal GPIO of ESP8266.

Nodemcu dev kit	ESP8266 Pin	Nodemcu dev kit	ESP8266 Pin
D0	GPIO16	D7	GPIO13
D1	GPIO5	D8	GPIO15
D2	GPIO4	D9	GPIO3
D3	GPIO0	D10	GPIO1
D4	GPIO2	D11	GPIO9
D5	GPIO14	D12	GPIO10
D6	GPIO12		

D0 or GPIO16 can be used only as a read and write pin, no other options like PWM/I2C are supported by this pin. In our example in chapter 5 on blinking the blue LED, the blue LED in connected to GPIO2, it is defined as Pin4 (D4) in Lua script.

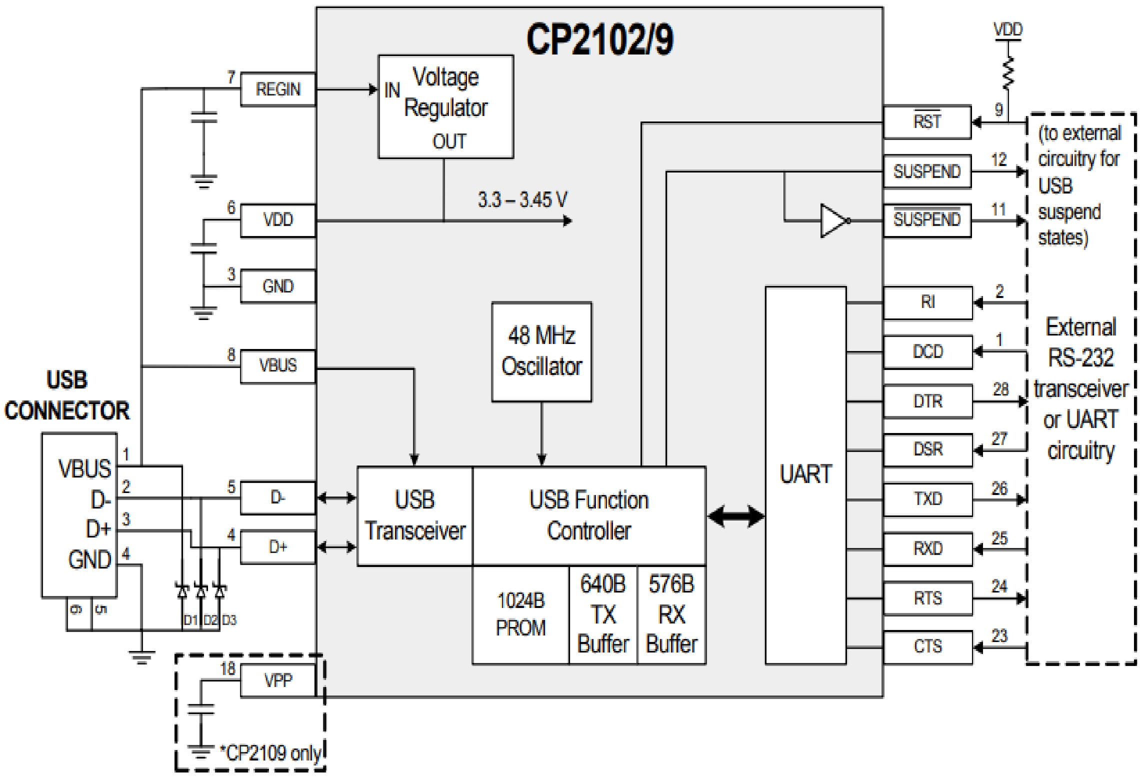

Fig 11:USB and UART connection with WIFI

2.6 LCD (Liquid Crystal Display)

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.

2.6.1.PIN DIAGRAM

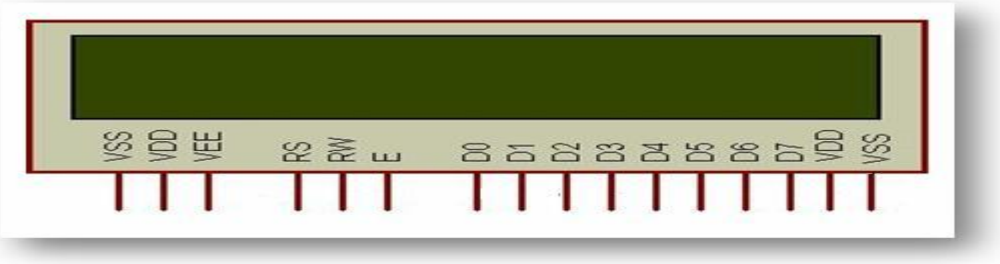

Fig 12:Pin diagram of LCD

2.7APR 9600 VOICE IC

The APR9600 has a 28 pin DIP package. Supply voltage is between 4.5V to 6.5V. During recording and replaying, current consumption is 25 mA. In idle mode, the current drops to 1 mA. The APR9600 experimental board is an assembled PCB board consisting of an APR9600 IC, an electrets microphone, support components and necessary switches to allow users to explore all functions of the APR9600 chip. The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2 kHz. The board measures 80mm by 55mm.

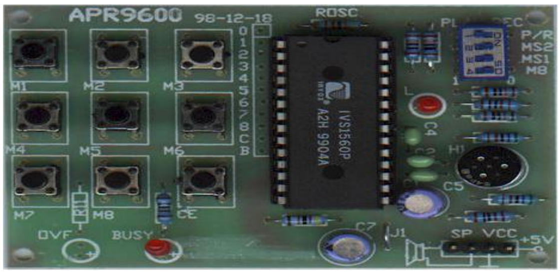

Fig 13:APR9600 Experimental board

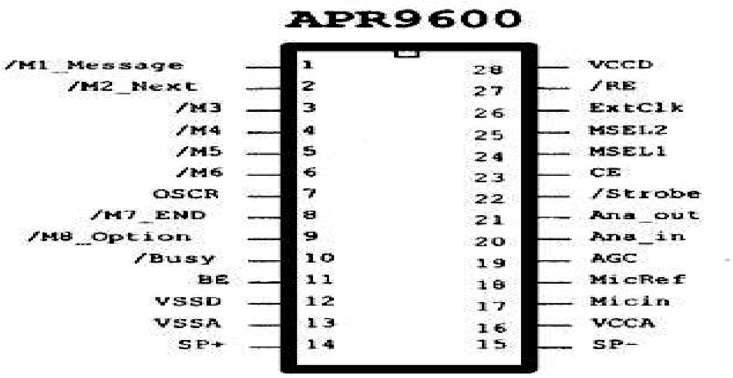

Fig 14:APR Pin diagram

The circuit diagram of the module is shown in Figure 2.14 The module consists of an APR9600 chip, an electrets microphone, support components, a mode selection switch (-RE, MSEL1, MSEL2 and – M8) and 9 keys (-M1 to –M8 and CE). The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2 kHz. Users can change the value of the ROSC to obtain other sampling frequencies. It should be noted that if the sampling rate is increased, the length of recording time is decreased. An 8-16 Ohm speaker is to be used with the module. Users can select different modes using the mode selection switch. The module is measured 80mm´55mm.

Connection points (0-8, C and B) can connect to other switches or external digital circuits. In this cased, on-board keys M1 to M8 and CE are by-passed.

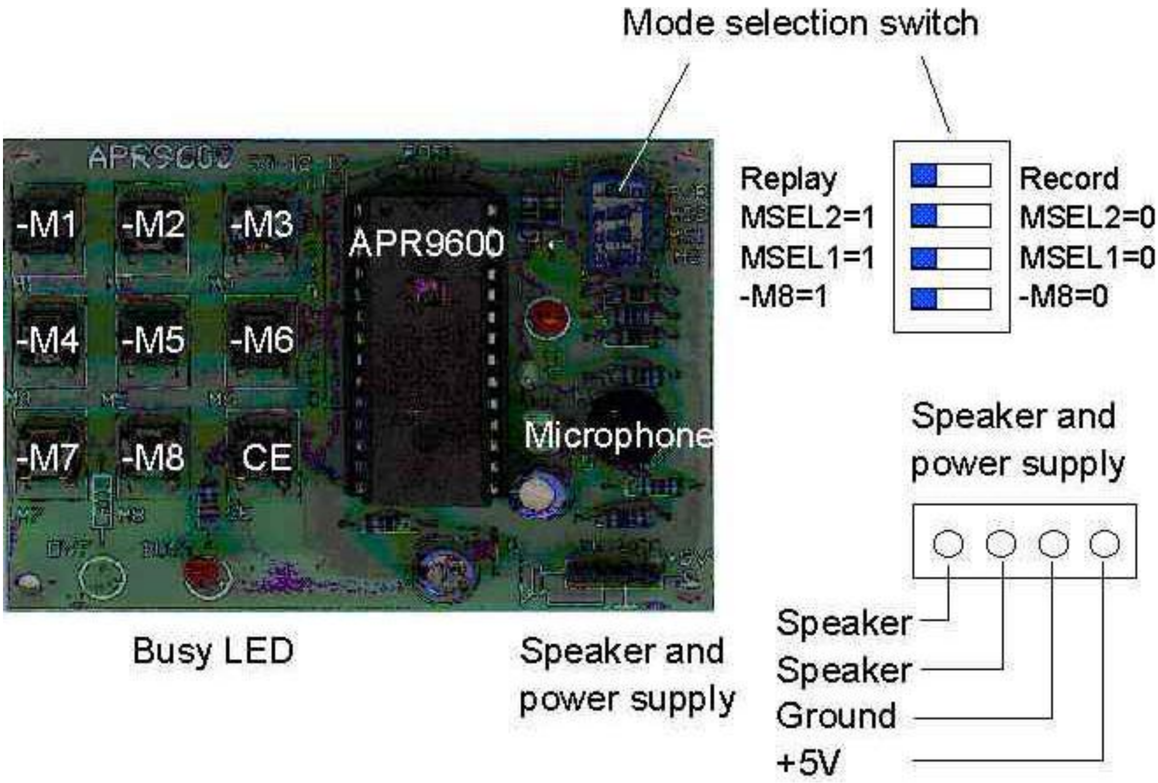

Fig 15: APR9600 module with connector details (to record in parallel mode, the switch setting should be same as displayed above. To record, the top switch should be on the right-hand side. To replay, the top switch should be on the left.

1. Use a good quality 8 Ohm speaker with a cavity such as speakers for computer sound systems. Do not use a bare speaker which gives you degraded sound.
2. For better sound replay quality, speak with a distance to the on-board microphone and speak clearly. Also keep the background noise as low as possible.
3. For even better sound replay quality, use microphone input or Audio Line In input. If Audio Line In is used, the amplitude of input signal should be < 100 mV p-p.

2.8 DC MOTOR

A DC motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback.A DC motor is closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analog or digital, representing the position commanded for the output shaft.

2.9 IR SENSOR

An infrared sensor is an electronic device, that emits 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. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor.

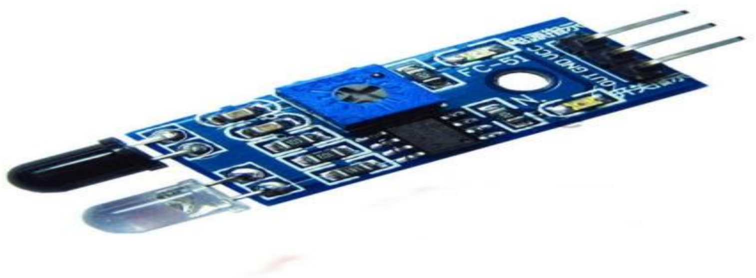

Fig 16: IR Sensor

III.DESIGN AND MODELLING

3.1BLOCK DIAGRAM

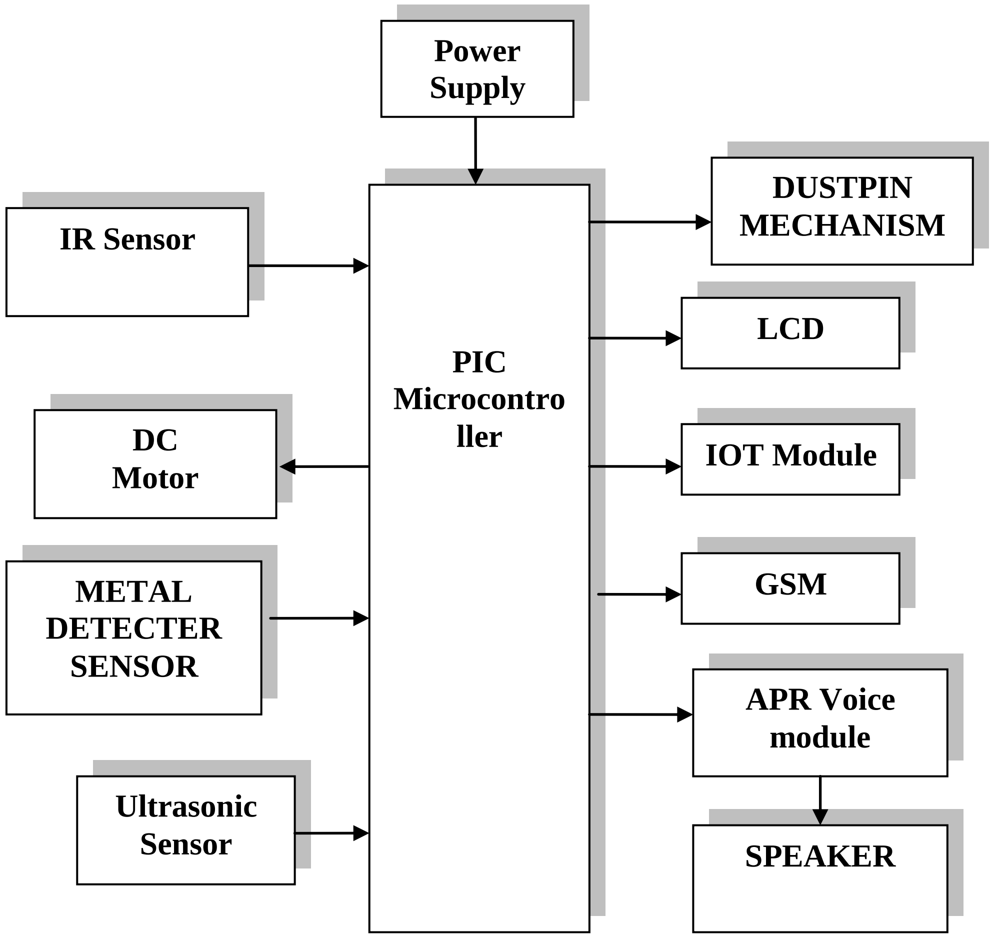

Fig 17 :block diagram of proposed system

3.2 WORKING

In proposed system, ultra sonic sensor is used to monitor the level of garbage level. IR sensor is used to monitor the nearby persons and automatically drivers the DC motor to open the lid of the dustbin. The dustbin data are uploaded to the cloud using IOT. These helps for clearing the wastage from dustbin and IR sensor for detecting the any human's presenting in front of dustbin. If it detects then door will open automatically. Then the metal detecting sensor is placed inside the dustbin for finding the wastage material either metals or non-metals and automatically separate those wastage

EXISTING SYSTEM	PROPOSED SYSTEM
➢ In existing method, the dustbin is not monitored continuously ➢ There is no wireless technology is available for monitoring. **Drawbacks of existing system** ➢ Difficult to find the dustbin is full or not remotely.	➢ In our proposed system we are going to monitor the dustbin in real time and update the status of the dustbin **Advantages of proposed system** ➢ Fast response ➢ Person nearby is detected. ➢ One time installation

IV. IMPLEMENTATION

Connection of ultrasonic sensor with PIC microcontroller is very easy.connect the vcc and ground of ultrasonic sensor to the 5 volt and ground of PIC.Then connect TRIG and echo pin of ultrasonic sensor to RB0 AND RB4 of PIC. Connect RX pin of PIC to TX pin of GSM.Similarly TX of PIC with RX of GSM .GSM needs 12V supply.

Fig 18: Implementation

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V. SYSTEM TESTING

5.1 TEST APPROACH

We will test the project in IOT BASED GARBAGE MONITORING SYSTEM USING PIC

5.2 TEST CASES

In this section we discuss about the inputs, expected output, testing procedure.

5.2.1 INPUTS

This project requires three inputs: 1. Power supply: Power supply is the basic need of any electronic circuit. Here we use 5v dc battery to give power and sometimes we can give power directly from the computer. We also need a 12V power supply for the GSM module. 2. We can also power these circuits via two 9v batteries using a circuit divider. Distance, The distance will be the input of the circuit and will be gotten from the ultrasonic sensor.

5.2.2 EXPECTED OUTPUT

The expected output of this project should be a text message showing the distance to full. Also, it will also send the humidity and the temperature of the area. The output should also be seen on the serial monitor of the PIC. Also, the output should also be seen on the serial monitor and also on the mobile

5.2.3 TESTING PROCEDURE

For testing first connect the circuit to the power supply is given to the PIC using computer and it can be done by using battery. In this way the whole testing circuit is built. Now we give input to the HC-SR04 by changing the level of solid garbage.. Change in garbage levels should be messaged using GSM Module. Summary of testing procedure:- 1) Connect the circuit according to the diagram 2) Give power to the system. 3) Vary garbage level for the ultrasonic sensor to give output. 4) Get the output from the DHT11 sensor. 5) Send message via the GSM module.

VI. FUTURE DEVELOPMENTS

With the use of GPRS ,the exact location of the garbage can be found, hence it reduces traffic and credits can be given to individual .Metal detection sensors can be used to detect explosive in airports, railway station ,malls and hospitals.

VII. EXPERIMENTAL RESULTS

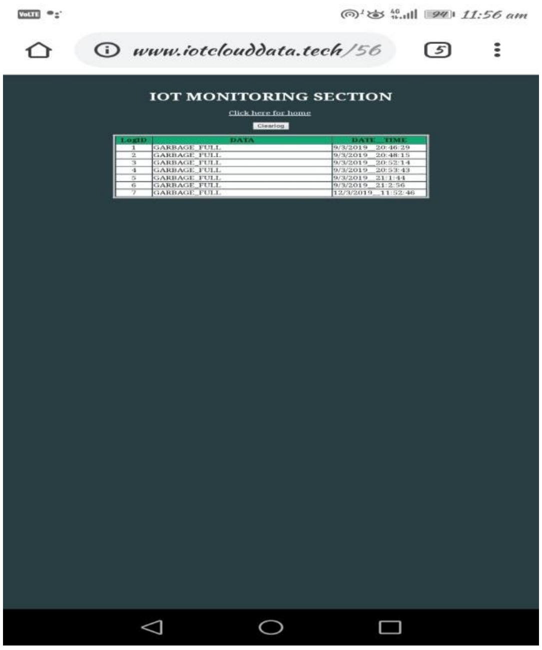

Fig 19:Experimental result of GSM

Fig 20:Experimental result of IOT

VIII. CONCLUSION

We built an efficient garbage monitoring system which can be used to monitor the level of garbage in the dump. This data can be further used to plan garbage collection trips more efficiently, ultimately reducing overflowing bins and helping have better public sanitation.

8.1ADVANTAGES

- Very simple circuit.
- The HCSR04 sensor is very rugged.
- Helps monitor garbage levels.
- Uses very small amount of electricity.
- Ultimately helps in better planning of garbage pickups.
- Can help in reducing overflowing bins.
- Reduces trips to areas where the bins still have a lot of capacity.

8.2 DISADVANTAGES

- Cannot detect liquid waste.
- Only detects the top of the garbage level. It wouldn't realize if there is space left.

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