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# IoT Based Solid Waste Management System for Smart City

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**ABSTRACT:** Nowadays, waste management disposal is one of the important challenges for the municipal corporations in all over the world. Dust bins placed across cities set at open places are flooding because of increment in the waste each day and making unhygienic condition for the citizens. We develop IoT based robot which is in the bottom, and there is an ultrasonic sensor in the top of the garbage can. When the garbage is filled the sensor send signal to the robot and it start moving toward the yard. The fixed bin makes use of ultrasonic sensors for level of garbage detection and updates level of the bin to internet webpage, using Wi-Fi Module. This system, making small contribution towards the theme of Clean India Green India.

**KEYWORDS:** ATMEGA 328, MICROCONTROLLER, L93D MOTAR DRIVE, ESP8266 WIFI MODULE.

## I. INTRODUCTION

Waste management or Waste disposal is all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling etc.

The term normally relates to all kinds of waste, whether generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, or other human activities, including municipal (residential, institutional, commercial), agricultural, and social (health care, household hazardous waste, sewage sludge). Waste management is intended to reduce adverse effects of waste on health, the environment or aesthetics. Waste management practices are not uniform among countries (developed and developing nations); regions (urban and rural area), and sectors (residential and industrial).

In existing system of the automatic garbage level detecting system informing the concerned authorities timely. Whenever the garbage is full information can be send to the concerned authority to clean the bin. Here we use a low maintenance recent communication development like GPS. GPS is used in the project as a communication back bone for the whole system for various reasons likes easy to implement and less signal deterioration. Hence these networks can work even with very low power

This project proposes the method where a vehicle can be used to clean the polluted areas such as garbage around the dustbin. Solid waste management vehicle, the height of the trash filled in the fixed part bin is identified using an Ultrasonic sensor. Microcontroller is mainly used so as to interface the ultrasonic sensor with the Wi-Fi module. IR sensor is used to detect path lane of the garbage robot.

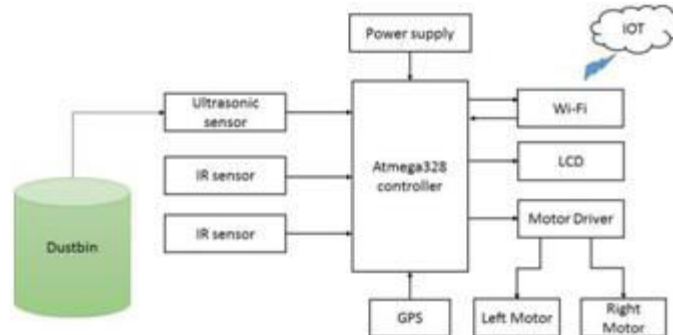
**II. BLOCK DIAGRAM**

Fig.1 Block diagram

In this project, control a garbage collection robot through android app. This system consists of ultrasonic sensor, IR sensor, Atmega328 controller, driver, relay, motor and Wi-Fi module. In this system used two IR sensor. These are placed in the robot left and right side. It is used to detect the path line. Ultrasonic sensor is used to detect the waste level in garbage tray. If the level of garbage is full this system automatically move and also update the information about the garbage level and share location in webpage through IOT server via Wi-Fi module.

GPS is used to track the location. Controller receive the input data and to control the robot through motor driver unit. Motor driver (L293D) is used to control the robot motor in forward and reverse/ left and right direction.

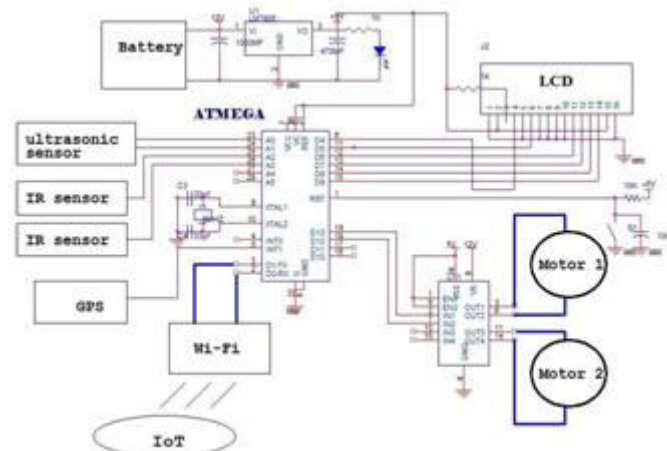
**III. CIRCUIT DIAGRAM**

Fig.2 Circuit diagram

**CIRCUIT DIAGRAM DESCRIPTION**

Battery used as supply. It is used to give supply to all units. LM 7805 regulator is used to maintain voltage as constant. Then signal will be given to next capacitor, which is used to filter unwanted DC component. Load will be LED and resistor. LED voltage is 1.75V. If voltage is above level beyond the limit, and then it will be dropped on resistor. In this project we used Atmega328 controller. Reset switch is connected to pin no 1. It is used to reset the program. To measure garbage tray level using Ultrasonic sensor. It is connected to controller port A0 (pin no 23). In this system used two IR sensor. These are placed in the robot left and right side. It is used to detect the path. These are connected to controller port A1 (pin no 24) and A2 (pin no 25). Controller receive the sensor signal, and to display status in LCD display. GPS is used to track the location and is connected to controller port 5. Controller receive the data and to update the information in IOT webpage through Wi-Fi module. Wi-Fi (ESP8266) is connected to controller port 2 & 3. Controller also to control the robot movement through driver unit. Robot movement like forward and reverse direction through motor driver L293D unit. It is connected to controller port D4 to D7.

L293D is a ATMEGA 328 microcontroller, which acts as a processor for the arduino board. Nearly it consists of 28 pins. From these 28 pins, the inputs can be controlled by transmitting and receiving the inputs to the external device. It also consists of pulse width modulation (PWM). These PWM are used to transmit the entire signal in a

pulse modulation. Input power supply such as Vcc and Gnd are used. These IC mainly consists of analog and digital inputs. These analog and digital inputs are used for the process of certain applications.

Dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled.

#### IV. HARDWARE DETAILS AT MEGA 328

##### ANALOG INPUT

Arduino atmega-328 microcontroller board consists of 6 analog input pins. These analog inputs can be named from A0 to A5. From these 6 analog input pins, we can do the process by using analog inputs. Analog inputs can be used in the operating range of 0 to 5V. Analog signal is considered as the continuous time signal, from which these analog signal can be used for certain applications. These are also called as non discrete time signal. Inputs such as voltage, current, are considered to be either analog signal or digital signal only 14 by analysing the time signal properties. Various applications of arduino microcontroller can use only an analog input instead of digital inputs. For these applications, analog input ports or pins can be used.

##### DIGITAL INPUT

Digital inputs can be defined as the non continuous time signal with discrete input pulses. It can be represented as 0's and 1's. These digital inputs can be either on state or in off state. Arduino atmega328 microcontroller also consists of 12 digital input pins. It can be stated as D0 to D11. Nearly 12 inputs can be used for digital input/output applications. The working of the digital input ports is where the discrete input pulses can be triggered and supplied to the ports. These ports receive the input and therefore the port can be used for both input and output process. These digital pins can access only the digital inputs.

This ATMEGA-328 integrated chip consists of 28 pins. It consists of 6 analog inputs that are shown in the pin diagram. Analog inputs can be represented as PC0 to PC5. These analog input pins possess the continuous time signal which acts as an analog input for the system. Further it also consists of 12 digital inputs. It can be represented as PD1 to PD11 which act as a digital input ports based on pulse width modulation (PWM). These PWM, which transmits the signal in the form of discretized form. Both analog and digital input ports can be used for various applications for the input power supply, VCC and GND pins are used. Pins PB6 and PB7, which acts as a crystal to generate a clock signal. By using these crystal, we can generate the clock signals and by these clock signals, we can use this clock signals for input sources. PC6 pin are the one where it can be used for the reset option. Resetting the program can be done by using this PC6 pin.

##### ULTRASONIC TRANSMITTER / RECEIVER

The ultrasonic sensor is a hybrid circuit that allows to realize an ultrasonic detector adding few external components. Detection is based on amplitude variation of received ultrasonic signal (40 KHz) due to the movement of an object. It shows stable electric characteristics thanks to the "Thick film hybrid" technology.

Ultrasonic sensors have an acoustic transducer which is vibrating at ultrasonic frequencies. The pulses are emitted in a cone-shaped beam and aimed at a target object. Pulses reflected by the target to the sensor are detected as echoes. The device measures the time delay between each emitted and echo pulse to accurately determine the sensor-to-target distance.

##### ULTRASONIC SENSORS THEORY OF OPERATION:

The Ultrasonic sensor detects objects by emitting a short ultrasonic burst and then "listening" for the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air at about 1130 feet per second, hits an object and then bounces back to the sensor host that will terminate when the echo is detected, hence the width of this pulse corresponds to the distance to the target.

HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver.



## ULTRASONIC RECEIVER

To calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller.

## IR SENSOR

Infrared radiation is the portion of electromagnetic spectrum having wavelengths longer than visible light wavelengths, but smaller than microwaves, i.e., the region roughly from  $0.75\mu\text{m}$  to  $1000\mu\text{m}$  is the infrared region. Infrared waves are invisible to human eyes. The wavelength region of  $0.75\mu\text{m}$  to  $3\mu\text{m}$  is called near infrared, the region from  $3\mu\text{m}$  to  $6\mu\text{m}$  is called mid infrared and the region higher than  $6\mu\text{m}$  is called far infrared. (The demarcations are not rigid; regions are defined differently by many). This type of sensors consists of a pair of light emitting and light detecting elements. Infrared source transmits a beam of light towards a remote IR receiver creating an "electronic fence".

## TYPES OF INFRARED SENSORS 1) ACTIVE INFRARED SENSORS

Once a beam is broken / interrupted due to some opaque object, output of detector changes and associated electronic circuitry takes appropriate actions. Active infrared sensors employ both infrared source and infrared detectors. They operate by transmitting energy from either a light emitting diode (LED) or a laser diode. A LED is used for a nonimaging active IR detector, and a laser diode is used for an imaging active IR detector. In these types of IR sensors, the LED or laser diode illuminates the target, and the reflected energy is focused onto a detector. Photoelectric cells, Photodiode or phototransistors are generally used as detectors. The measured data is then processed using various signal-processing algorithms to extract the desired information.

Active IR detectors provide count, presence, speed, and occupancy data in both night and day operation. The laser diode type can also be used for target classification because it provides target profile and shape data. These sensors are used as reflective opto-sensors. Reflective opto-sensors are either intensity based or use modulated IR. Intensity based sensors are affected by ambient light. Modulated Infrared sensors wherein emitter is turned ON and OFF rapidly, are less susceptible to ambient light. Reflective opto-sensors are used in two configurations.

## BEAM SENSOR

This type of sensors consists of a pair of light emitting and light detecting elements. Infrared source transmits a beam of light towards a remote IR receiver creating an "electronic fence". Once a beam is broken / interrupted due to some opaque object, output of detector changes and associated electronic.

## REFLECTANCE SENSORS

This type of sensors house both an IR source and an IR detector in a single housing in such a way that light from emitter LED bounces off an external object and is reflected into a detector. Amount of light reflected into the detector depends upon the reflectivity of the surface.

This principle is used in intrusion detection, object detection (measure the presence of an object in the sensor's FOV), barcode decoding, and surface feature detection (detecting features painted, taped, or otherwise marked onto the floor), wall tracking (detecting distance from the wall)

## WI-FI MODULE (ESP8266):

The ESP-01 ESP8266 Serial WIFI Wireless Transceiver Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield. The ESP8266 module is an extremely cost-effective board with a huge, and ever-growing, community.

## L293D MOTOR DRIVER:

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be



driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

#### DC MOTOR:

The direct current motor or the DC motor has a lot of application in today's field of engineering and technology. Starting from an electric shaver to parts of automobiles, in all small or medium sized motoring applications DC motors come handy. And because of its wide range of application different functional types of dc motor are available in the market for specific requirements.

#### LCD – LIQUID CRYSTAL DISPLAY:

Liquid Crystal Displays (LCDs) have materials, which combine the properties of both liquid and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarizer is pasted outside the two glass panels. This polarizer would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizer and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarizer, which would result in activating / highlighting the desired characters. The LCDs are lightweight with only a few millimeters thickness. Since the LCD's consume power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD does not generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size of the layout size is relatively simple which makes the LCD's more customer friendly. The LCD's used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications. LCD display use of our project title message and information message. Our project connects to a microcontroller unit data line connected to a 'PORT 2' and control lines connected to a P3.5, P3.6, P3.

#### BATTERY:

Lead-acid batteries are the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use to provide the high current.

#### ARDUINO SOFTWARE IDE:

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross platform application written in Java. It originated from the IDE for the Processing programming language project and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism for compiling and loading programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch". The Arduino IDE supports the C and C++ programming languages using special rules of code organization. The Arduino IDE supplies a software library called "Wiring" from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consists of two functions that are compiled and linked with a program stub: `main()` into an executable cyclic executive program: `Setup()`; a function that runs once at the start of a program and that can initialize settings.

A low self-discharge rate, up to approximately 3% per month, may allow storage of fully charged batteries for up to a year, depending on storage temperatures, before charging becomes critical. However, we strongly recommend



that all batteries should be recharged within Six months of receipt as it will enhance their long term life. Please refer to this Technical Manual and individual battery specification sheets for more details.

Power-Sonic batteries may be discharged over a temperature range of -40°C to +60°C (-40°F to +140°F) and charged at temperatures ranging from -20°C to +50°C (-4°F to +122°F).

### RUGGED CONSTRUCTION

The high impact resistant battery case is made of nonconductive ABS plastic. The case materials impart great resistance to shock, vibration, chemicals and heat. Flame Retardant (FR) battery cases and lids are available where the end application dictates.

### LONG SERVICE LIFE

PS/PSH and PSG Series: Have a design life of up to five years in standby applications. In cyclical applications up to 1,000 charge/discharge cycles can be expected depending on average depth of discharge. PG Series: Have a design life of up to 10 years in float applications. Please consult this Technical Manual and product specifications to become aware of the many factors that affect product life.

### V. CONCLUSION & FUTURE SCOPE

This project is devised to render the task of muck collection from differing places and then dump it at a particular location from where the muck is conveniently taken for the action of reusing and recycling. By intimating the notification of level of garbage filled in the fixed dustbin to the garbage robot, we can decrease the number of trips of the garbage collecting vehicle, thus saving power and money. Also by introducing the Wi-Fi Module for updating the information through internet. Thus, by implementing this project in real time scenarios we can make a contribution towards the enhancement of Smart City Project, thereby making the dream of CLEAN INDIA GREEN INDIA come true.

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