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# Smart Medical Waste Management System

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***Abstract*— As technology grows, there are many technologies to prevent diseases. Nowadays, medical waste disposal is a major environmental problem. Medical waste contains harmful substances that can cause severe human health issues if it is not disposed of and treated properly. In this project, we propose an IoT-based smart medical waste management system, that relies on Arduino parts and ESP -8266. This allows the waste to be disposed of in respective allotted places. An IR sensor is used to track the path of the robot with dispose of the waste. In order to stop the spread of infections and to educate the community this project is done. In this project, Arduino-based line- following robots are used to automatically dispose of medical waste at appropriate locations without human aid. After the disposing process is completed, some wastes are used to recycling. By using IoT technology, In this way, the problem of medical waste disposal in medical centers may be reduced to the level of low-risk waste.**

***Keywords*— *Internet of Things (IoT), Smart medical waste management system (SMWMS), Arduino Integrated Development Environment (IDE).***

## I. INTRODUCTION

The project entitled Smart Medical Waste Management System deals with medical centers such as hospitals, clinics, and places where diagnosis and treatment are carried out generating extremely dangerous waste that threatens people with deadly diseases. Poorly managed medical waste can expose healthcare workers, waste collectors, patients, and more to infectious diseases, toxicity, and injury, leading to a risk of environmental pollution. Conventional medical waste treatment methods are often inefficient, expensive, and can pose a threat to humans. Since treating medical waste in a timely manner is pivotal to preventing disease and avoiding direct contact of waste handlers with the waste; we use this line follower which follows the black line using an IR sensor and disposes the waste in the main trash bin. A warning SMS is also automatically sent to the municipality informing them that the bin is full when the main trash bin is full and before exceeding the 24-hour time limit. This system enables real-time tracking and monitoring of waste, ensuring timely collection and preventing overflow of waste from the dustbin. It treats the medical waste in time to prevent diseases and inform the concerned supervisor to dispose of the waste. In this way, the problem of medical waste disposal is reduced in medical centers.

## II. EASE OF USE

### A. LITERATURE SURVEY

In this topic, works related to smart medical waste management systems are related. This smart medical waste management system has sensors, and IoT to interface the software and hardware to provide solutions to preventing diseases and deal with the handling and disposal methods used in the medical waste management process. It primarily classified the types of medical waste as hazardous (infectious) and non-hazardous (plastic). Further, it has segregated into sharps, radioactive waste, recyclable waste, pharmaceutical waste, anatomical waste, etc. The key is on sorting of medical wastes. It has sorted and dumped the medical waste into respective colored bins using image processing based on the standardized color code. This way it can treat those medical wastes appropriately and apply suitable disposal methods like incineration, sterilization, etc... This system continuously monitors the level of medical waste in the trash can, and when it is 90% filled, an alert message will be sent to the hospital housekeeping supervisor

stating that the dustbin is full. Along with that message, the location of the dustbin is also sent for easy access. This increases the efficiency of waste disposal by preventing the overflow of waste from the dustbin. It also prevents the spreading of infections in the hospital since we also dump pathological wastes in the dustbin. Direct and frequent contact of medical service providers with infected patients can cause health issues too. Hence the AGV used in this line follower robot to distribute medicines. AGV can be powered using a battery or using solar cells. Normally, it collects the medicines from the nurse (starting source point) follows the black line drawn on the hospital floor, and reaches the patient's room (final destination point). It also helps in real-time monitoring of patient parameters like blood pressure and temperature. It then sends the collected data to doctors via the Internet.

## III. THEORY OF PROBLEM

### A. PROBLEM DEFINITION

In medical centers diagnosis and treatment are carried out generating extremely dangerous waste that threatens people with deadly diseases. Poorly managed medical waste can expose healthcare workers, waste collectors, and patients to infectious diseases, toxicity, and injury, leading to the risk of environmental pollution. Pathological waste, such as human tissue, organs, body fluids, and body parts can even cause infections to waste handlers.

AIM OF THE PROJECT

In this smart medical waste management system, medical wastes are dumped in trash bins placed on each floor. Using the level monitoring system present in the trash bins, the level of waste in the dustbin is sensed, and when it reaches a particular threshold level the ultrasonic sensor signals the Arduino. The microcontroller further commands the line follower to follow the black line drawn at the floors of the hospital and deposit the waste at the main trash bin. An alert message is also sent to the concerned authorities informing them that “DUSTBIN IS FULL – XYZ HOSPITAL – LOCATION”.

### *B. HOW WASTE MANAGEMENT SYSTEM WORKS*

This project uses a line follower robot to dispose of the medical waste at appropriate locations. This system aids in treating medical waste in time to prevent diseases and inform the concerned supervisor to dispose of the waste and carry out proper treatment methods. Normally, line-follower robots are placed on each floor of the hospital. Upon this robot trash can is placed. The level monitoring system is installed in the trash can which monitors and sends a signal to Arduino when the trash can has reached a particular threshold value. Ultrasonic sensors are fixed both inside and outside the trash can and the main trash:

## IV. IMPLEMENTATION AND WORKS

### *A. ARDUINO:*

The Arduino UNO is an open-source programmable microcontroller board based on a microchip called ATmega328p microcontroller. The operating voltage of Arduino is 5 volts and the input voltage is 7 to 20 volts. There are 14 digital input and output pins of which 6 pins also an PWM pins (3, 5, 6,9,10,11) and 6 analog pins. The clock speed is about 16 MHz. The power source for Arduino is dc power jack or USB port. The programming can be done using C, C++ language with some specified header file and keywords in open-source platform Arduino IDE.

- USB- Universal serial bus
- PWM pins – Pulse width modulation pins.
- IDE- Integrated development environment.

### *B. CONNECTION OF ARDUINO, SERVO MOTOR AND ULTRASONIC SENSOR:*

The rotary actuator or linear actuator known as a servomotor (or servo motor) enables precise control of angular or linear position, velocity, and acceleration.It has three wires coming out of the servo motor , They are PWM(signal) ,Vcc , GND.

Ultrasonic distance uses SONAR to determine the distance of the object. Here in this system, ultrasonic sensor is used to the presence and absence of a vehicle in the parking slot. It has high accuracy of about 2cm to 400cm and stability. Black material or sunlight don’t affect the operation of the system, The Echo and Trig pins are connected to Arduino digital pins , Vcc is connected to 5V and ground the pins are grounded.

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Arduino is connected with servo motor and ultrasonic sensor which is settled to detect the waste and servo motor is used to open the dustbin cap.

- PWM - Pulse width modulation pins.
- Vcc - power supply.
- GND- ground.

*C. CONNECTION OF ARDUINO WITH L298N IC AND DC GEAR MOTOR :*

The Arduino is connected with a L298N IC and a dc gear motor to run the motors to manage the waste. L298N IC , a jumper controls the module's 78M05 5V regulator, which is also present. The 5V regulator is enabled if the jumper is left in place. We will power the module using the voltage regulator if the motor power source is less than 12V. Here, the micro controller is powered by an output from a 5V pin. Make sure the jumper is not intact and supply 5V electricity through the pin independently if the power source is higher than 12V.

*D. CONNECTION OF ARDUINO WITH IR SENSOR:*

An electrical device known as an infrared proximity sensor, sometimes known as an IR sensor, emits infrared light to sense some feature of its surroundings and can be used to detect an object's movements. This passive sensor can only measure infrared radiation because it is passive. This IR sensor guides the robot, (which is , Arduino connected with an L298N IC and a dc gear motor ) to the basement to dump the waste.

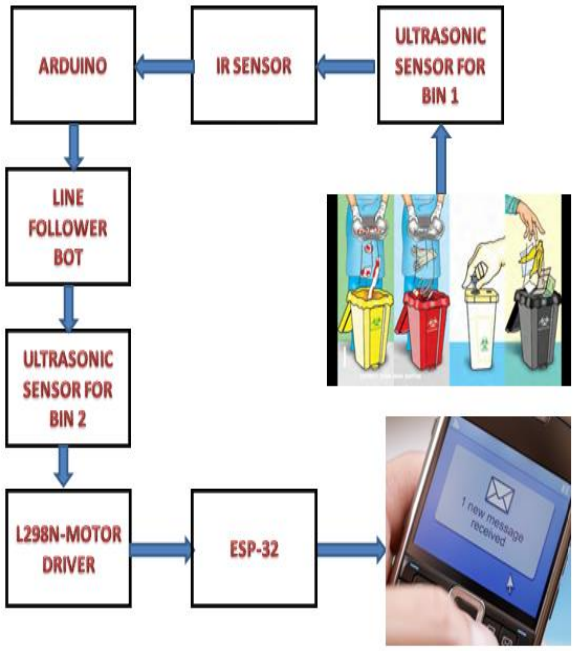
*A. CONNECTION OF ESP-32 AND GPS :*

The Tensilica Xtensa LX6 dual-core or single-core microprocessor, Tensilica Xtensa LX7 dual-core, or a single-core RISC-V microprocessor are used in the ESP32 series, which also has integrated antenna switches, RF bulbs, power amplifiers, low-noise receive amplifiers, filters, and power-management modules.

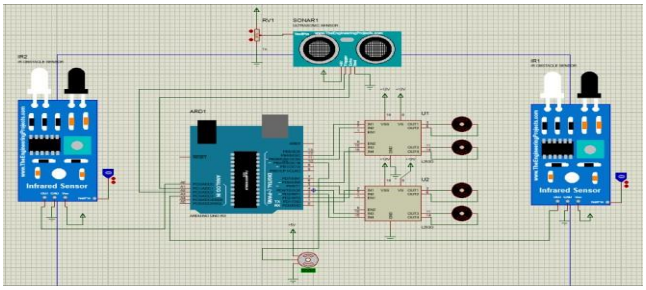
Our ESP32 development board will be programmed using the Arduino IDE. Consequently, you need to have the most recent Arduino IDE version. The ESP32 plugin must also be installed, in addition. This design is to send an alert message (as “the garbage is full”) with a location which assists us to disposing of the waste within a 24 hr time limit.

## IV. RESULT AND DISCUSSION

### A. BLOCK DIAGRAM:




## V. CONCLUSION



CIRCUIT DIAGRAM


ALERT MESSAGE TO MUNICIPALITY

This study has proposed a smart medical waste management system that improves waste management by reducing the number of users that manage medical waste effectively and disposing of it by sending a message and location to the municipality within 24 hours. Our proposed architecture and system has been successfully stimulated and verified. In our future studies, we will improve our design by adding a segregation system (separation of hazardous and non-hazardous waste).For example, segregation of organic ,metal and plastic, and, in addition to our plan, we are designed to recycle the waste in order to reuse it efficiently.

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