Smart Waste Disposal System in Hospitals using Robot

Stephina R[1], Sushmitha S[2], Thanmaya H K[3], Thejaswini Y N[4], Smt. Asha M[5]

[1-4]Students, Dept. of ECE, GSSSIETW, Mysuru, India
[5]Assistant Professor, Dept. of ECE, GSSSIETW, Mysuru, India

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***Abstract*—** This project is based on autonomous hospital logistics systems. We present mobile robot that need to navigate and safely move in a human populated environment. The smart truck garbage collector robot inculcates some sensors and move in a predesigned path. These robots are specially designed to carry various goods that need to be transported. The fixed bin makes use of Infrared sensors for level of garbage detection and updates the coeval level of the bin to the garbage truck using RF Module. This is thereby a fully automated system, making small contribution towards the theme of Clean India Green India.

Keywords **–** *Truck Robot, Smart Bin, IR Sensor, Arduino, RF module*

I. INTRODUCTION

Hospital waste transport and waste handling is a time-consuming, hazardous and infectious process as the staff is exposed to be in contact with medical and bio-hazardous waste. The biomedical waste collected from hospital should not be stored for 24 hours. In order to avoid this we need to ensure regular and safe disposal of waste to help the hospital maintain a clean environment for the patients, staff and visitors. This is done by robotic transport of trash from the smart bins in which RTOS methodology is implemented. The trash collected from smart bins consists of arduino based microcontroller with sensors. Mobile robots need to navigate and move safely in a human populated environment. These robots are specially designed to carry various goods that need to be transported. This project consists of smart bin for the collection of trash and an arduino based robot for the disposal of trash. The bin describes the usage of Infrared Sensors fitted on the upper edge of a dustbin and are interfaced with an arduino microcontroller. The IR sensors are used for waste level detection in bin. At the point when the dustbin fills up, it sends the message through CC2500 RF module to the arduino based robot to collect the trash. It is utilized for everyday determination of waste containers, in view of which the courses to pick a few of the waste receptacles from various areas are chosen.

This concept is being realized by using Real time systems and Arduino embedded with microcontroller. Along with significant safety benefits, a cleaner, safer and more efficient environment is provided for all. The installation of robot unit reduces the annual cost and improves turn-around time and also less contact of staff to the biomedical waste.

II. LITERATURE SURVEY

Navale Pallavi, Gosavi Kriti [1] had proposed a smart garbage bin based on universal hardware kit which would be mounted over the lid of the garbage bin's lid. The rest segment consists of bins with sensory node installed in it, second segment contains the router and the third segment is android application and the base station. The proposed system is capable to response and updates the specific bin status in real time which in turn can help to minimize collection route and fuel cost to make the environment clean and healthy.

Ali Gurcan Ozkil, Steen Dawids, Zhun Fan [2] had presented a system, consisting of a fleet of robot vehicles, automatic stations and smart containers for automation of transportation of goods in hospitals. Design of semi-autonomous robot vehicles, containers and stations are presented and the overall system architecture is described. Implementing such a system in an existing hospital showed the need of necessary modifications to the hospital infrastructure. HelpMate robot is one of the earliest service robots that are commercially available.

Gayani Karunasena, Dilathi Amaratunga [3] had aimed to provide a critical review on automation and robotics applications at a post disaster scenario. Comprehensive literature review, documentary survey and field survey are adopted as methods of data collection. Survey revealed capacity constraints of expertise, funds and cultural issues as main challenges. Finally, the paper provided new avenues for effective utilization of automation and robotics through mapping of best practices.

Fernando Carreira [4] had developed a dedicated mobile robot, the i-MERC, to perform the service with the aim of increasing the quality of the meals transportation service inside hospitals and health care centers (HHCC). This robot is equipped with a heating system in the meals compartment which guarantees the meals temperature and prevents bacteriologic proliferation. The i-MERC also integrates a personalized diets information system where information about patients' diets can be introduced and accessed by the service personnel.

Agha Muhammad Furqan Durrani [5] had proposed an Automated Waste Control Management System which includes an electronic waste detection device and a central control unit. An infrared sensor for sensing waste levels, GPS for location identification, Arduino Board having a microcontroller and GSM Module for sending

the message containing the information regarding waste bin being is full or empty. All the components in this overall system, work in an intelligent manner to make automated waste management possible so that the waste is collected and disposed to the dumping sites only when it is necessary at a proper time. This work mainly focuses on timely and automatic waste collection and transportation mechanism.

Gopal Krishna Shyam, Sunil Kumar S Manvi [6] had proposed a Smart Waste Collection System on the basis of level of waste present in the waste bins. The data obtained through sensors is transmitted over the internet to a server for storage and processing mechanisms. It is used for monitoring the daily selection of waste bins.

Vikrant Bhor & Dishant Pandya [7] had proposed a system in which the level of garbage in the dustbins is detected with the help of Sensor systems, and communicated to the authorized control room through GSM system. Microcontroller is used to interface the sensor system with GSM system. A GUI is also developed to monitor the desired information related to the garbage for different selected locations. This will help to manage the garbage collection efficiently.

Balaji Masanamuthu Chinnathurai, Ramkrishna Sivakumar [8] had an objective to design a robot (Recyclebot) that automatically segregates recyclable and non-recyclable waste and to create awareness among people about the benefits of recycling. The Recyclebot system comprises of different modules for navigation, image acquisition, image processing and humanmachine interface. It uses image processing to analyze the object against its database and direct it towards the corresponding waste-bin using linear actuators.

Nimisha S Gupta, Deepthi V [9] had proposed a spot automatic waste segregation unit that effectively gives a solution to the problem of segregating metal, dry and wet wastes. In order to separate the metallic waste a parallel resonance impedance system is used, and for the separation of wet and dry capacitive sensors are used. The benefits of this work are, the waste has a higher potential for recovery and the occupational hazards of waste separating workers is also reduced.

III. SYSTEM METHODOLOGY

Figure 1 represents the block diagram of smart bin. It consists of Limit switches, Motor, Motor Driver, Arduino Nano, IR sensor, CC2500 wireless.

• A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection.

• The board is fitted with the CC2500 wireless that is linked to the Internet. At the point when the dustbin fills up, the board informs the framework.

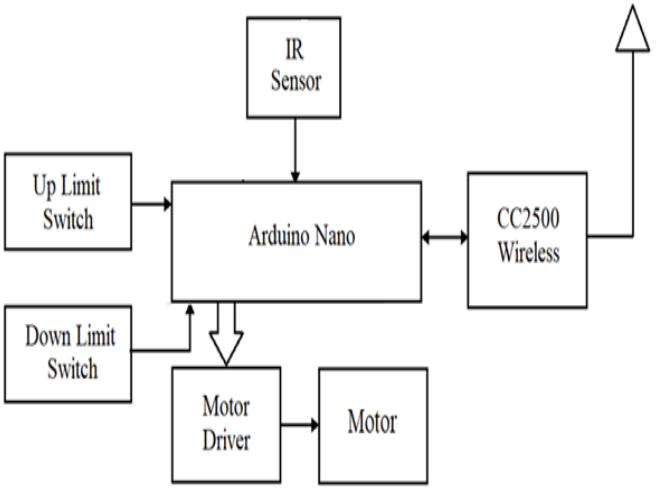

Fig.1.Block diagram of Smart Bin

Figure 2 represents the block diagram of Robot. It consists of Limit switches, Motor, Motor Driver, Arduino Mega 2560, IR sensor, CC2500 wireless, Color sensor.

• The board is fitted with the CC2500 wireless that is linked to the Internet. The color sensor is used for the path detection, to go from start to destination path.

• Up limit switch and down limit switch are used to provide capability to limit action in programmed behaviors.

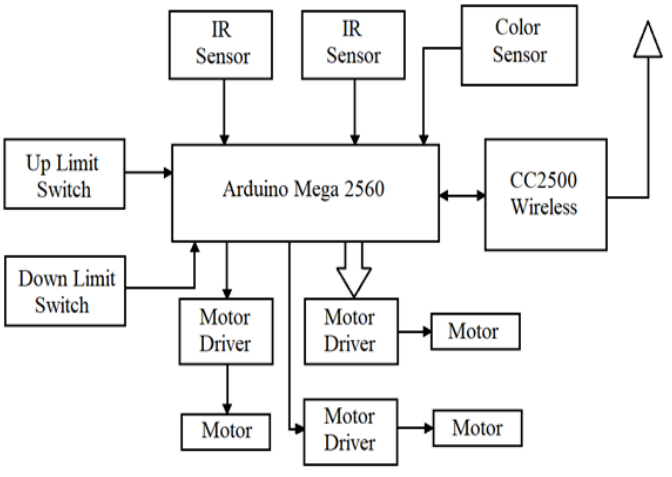

Fig.2.Block diagram of Robot

IV. WORKING PRINCIPLE

- In the present paper the fixed smart bin and truck robot is used. In the smart waste management system using a robot the trash is dumped and the

level of the trash filled in the fixed bin is identified using IR sensor.

- Thus the level is remitted to the garbage truck robot collector part with the help of CC2500 RF module.
- Arduino Nano is used to interface IR sensor with the RF module, motor, motor driver, and limit switches in the smart bin.
- As soon as the trash gets filled, the robot comes near bin in a predefined path by identifying the color of the bin using color sensor.
- Arduino Atmega 2560 is mainly used to interface the IR sensor with the RF module in the robot. This is a fully automated system in which the robot moves automatically when it gets a signal via RF Module from the Smart Bin, when it is completely filled.
- The IR sensor is also used in robot which acts as level detector and controlling truck robot in the path movement. The program is burned in the microcontroller Arduino 2560 and 328 using the Arduino (IDE) and RTOS software.
- The data or information of the garbage level of corresponding filled bins is sent to robot to empty the bin as fast as it can. Then the robot moves toward the bin for collecting the trash in the predefined path and after dumping the trash in at the destination point, it will be moving back to the start point.

V. SYSTEM ARCHITECTURE

1. ATMega-2560 Microcontroller

ATmega2560 is an 8-bit CMOS low-power microcontroller; it mainly works on Advanced Virtual RISC (AVR) enhanced RISC architecture. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

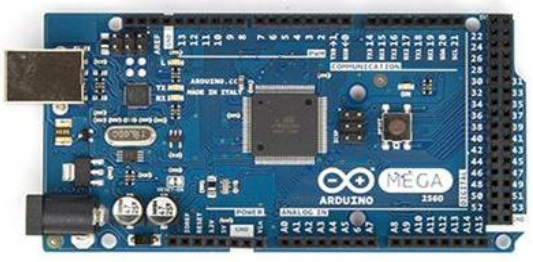

Fig.3. ATmega2560 Microcontroller

2. Arduino Nano

The Arduino Nano is a microcontroller board based on the ATmega328. It has 14 digital Input /Output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz ceramic resonator, USB connection, a power jack, an ICSP header and a reset button.

Fig.4. Arduino Nano Board

3. DC Motor

The DC motor is an electrical device which converts from dc electrical energy into mechanical energy.

Features of DC Motor:

- Low cost for control achieved.
- Low torque at startup and high speeds.
- Rugged design.
- Simplicity of construction.
- Can operate in an open loop control system.

Fig.5. DC Motor

4. L293D Dual H-Bridge Motor Driver

L293D is mostly used H-Bridge Driver IC.H-Bridge can also be made with the help of transistors and MOSFETs etc. L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and anti-clockwise direction.

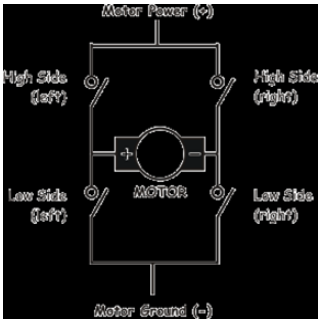

Fig.6. H-Bridge Motor

5. Dc-Dc Converter

DC-DC converter is widely used for the purpose of converting unregulated DC input into a regulated DC output.

Fig.7. DC-DC Converter

6. CC2500 RF Module

CC2500 RF Module is a trans-receiver module which provides easy to use RF communication at 2.4 GHz. It can be used to transmit and receive data at 9600 baud rates.

It requires no extra hardware and no extra coding to It works in Half Duplex mode i.e. it provides communication in both directions, but only one direction at same time.

Fig.8. CC2500 RF Module

7. IR Sensor

The sensor consists of an IR detector. Picks up the incoming IR rays and signals the presence of the object. It consists of an IR LED connected through a 320 ohms resistor. The IR photodiode is connected in reverse bias and forms a voltage divider with the 10K resistor. The red led is used to indicate the presence of an object.

Fig.9. IR Sensor

8. Color Sensor

The TCS3200 is a programmable color light-to-frequency converter that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. Digital inputs and digital output allow direct interface to a microcontroller.

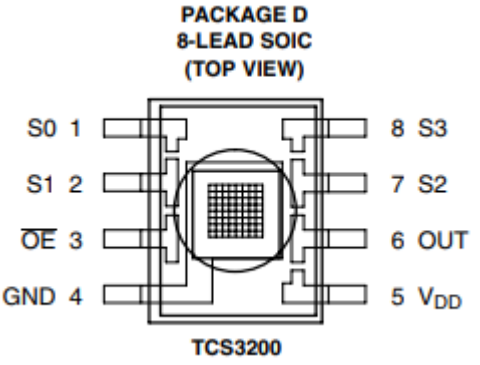

Fig.10. TCS3200 Converter

9. LIMIT SWITCH

Limit Switches are electromechanical device and offer high reliability and security. A variety of models are available with an operating force ranging from low to high.

Fig.11. Limit switch

10. Software Requirements

- RTOS
- Arduino

VI. ADVANTAGES

- It saves time and money by using smart waste collection bins and systems equipped with level sensors.
- It keeps our surroundings clean and emphasizes on healthy environment.
- It further reduces manpower requirements to handle the garbage collection process.
- Smart bin sensors will constantly update in real time to fill the levels and efficiency of the unit.
- Installation of robot unit reduces the annual cost and improves turn-around time.

VII. DISADVANTAGES

- It requires a well-structured hardware.
- The one-time cost of installation will be higher than the present technique.
- It reduces man power requirements which results into increase in unemployment for unskilled people.

VIII. RESULTS

- This project is utilized for everyday determination of waste containers and to pick the waste receptacles from various areas using the robot.
- The huge element of this framework is that it is intended to refresh from the past experience and choose on the day by day squander level status as well as anticipate future state.
- In view of this chronicled information, the rate at which squander canisters gets filled is effortlessly determined. Therefore, it can be anticipated before the flood of squander happens in the particular area where the waste canisters are set.

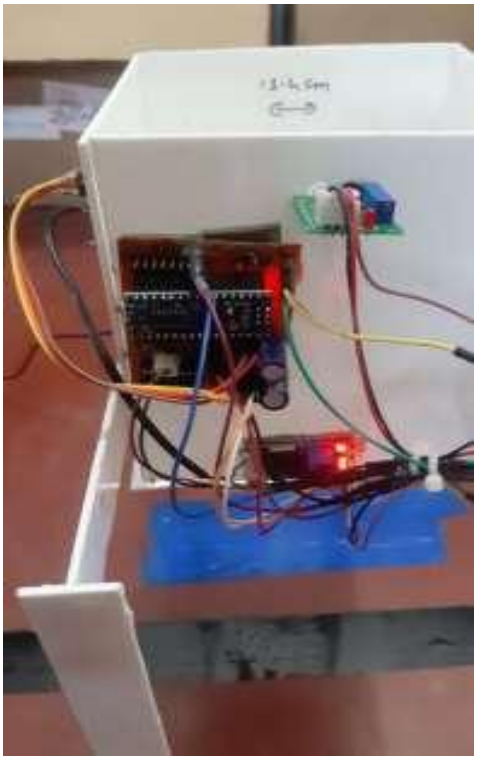

Fig.12. Implementation of Bin module

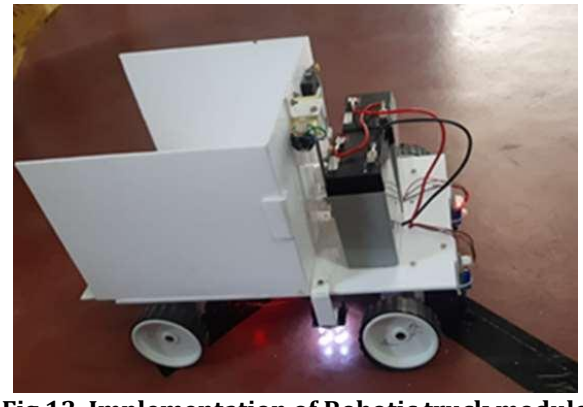

Fig.13. Implementation of Robotic truck module

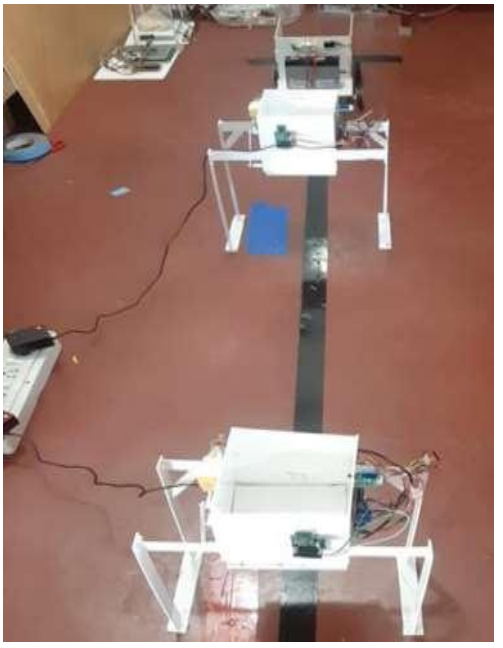

Fig.14. Setup of Robotic truck in a pre-defined path.

Fig.15. Collection of trash by Robotic truck

Fig.16. Dumping of trash by Robot

IX. CONCLUSION

This project is devised to render the task of trash collection from different wards of the hospital and dump it in a particular destination by the robot. By intimating the notification of level of garbage filled in the smart bin to the truck robot, we can decrease the number of trips of the garbage collecting vehicle, thus saving power and money. Also by introducing the RF wireless module on the fixed bin part, we are making the system fully automated. Thus, by implementing this project in real time scenarios we can make a contribution towards the enhancement of Smart City Project.

X. FUTURE ENHANCEMENT

After this stage of enhancement, we can moreover take this project to a higher level. We can accomplish to make use of a navigation system that is GPS based instead of using black line that the robot follows. This project is limited to just a single platform or single storied building and in future this can be made to work in multi storied buildings. For this there will be a requirement of a robot that can climb on different floors. This technique would be a very effective implementation for this project.

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