IoT BASED GARBAGE COLLECTION AND VEHICLE TRACKING SYSTEM FOR SMART CITY

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Abstract: Collection of waste is an important activity in developing and developed countries. Waste collection is mainly depending on effectiveness of collection, transportation, and disposal. Improper waste collection causes environmental problems and health issues. Service of garbage vehicle is provided by municipal servant but the vehicle driver purposefully or by mistakenly covers some areas so the people of that area face the problem of garbage which is hazardous to health. Actually this problem is due to the garbage collection vehicle driver and civilians blame to the municipal servant. To overcome these problems, we developed RFID based garbage vehicle monitoring system and provide the route map to driver to reduce compliances. The transaction of vehicle path is controlled centrally at Municipal Corporation Office through IoT Techniques which assist the driver to collect the garbage effectively.

Index Terms **– Internet of Thing (IoT), Raspberry Pi, RFID Readers, RFID Tags, Vehicle Tracking System.**

I. INTRODUCTION

Generally, the solid waste is defined from Home, industrial, hospitals, market waste, yard waste and street sweepings. In olden days garbage was collected by horse and disposed outside of town. It is mostly hard to handle waste collection and transportation processes well as point to point locations of vehicles without high technology. Waste management is a most important activity in developing countries because of increase in urbanization and economic development. In India, as the population is increasing day by day waste generation is also increasing this leads to the problem of waste disposal. Due to increase in waste the Government is focusing on waste management. According to the survey waste generated in Mumbai was 16,200 tons per day in 2001 and increased up to 19,100 tons in 2005, to overcome this problem it needs proper waste collection in time [1]. The proposed system for the garbage vehicle tracking system would be in time, and collection will be effective as shown in Fig. 1.

Fig. 1 Garbage Collection and Vehicle Monitoring System [1]

Waste collection is an important activity and it is provided by municipal servant. They provide garbage vehicle for collection of waste but there are few problems due to driver so this system is developed, for effectiveness of this the managers need to monitor the vehicle and worker, tracking system is best solution. Implementation of garbage vehicle tracking system using Raspberry pi, RFID and Display assures Time to time and regular collection of waste in particular area in this system a particular area will be assigned with a particular nodes and the map of particular area along with the nodes will be given to the driver and on the display of vehicle the map will be display which will have the nodes of particular area from source to destination because of this system driver will be restricted to collect the from all nodes. If driver misses a particular node then through this system it will be indicated to him as well as to manager that particular node is missed. This system will contribute in "SWACHH BHARAT ABHIYAN".

The outline of the paper is as follows: The relevant work about smart garbage vehicle tracking system is discussed in Section II. The proposed system, hardware requirements and project dataflow is elaborated in Section III.

II. LITERATURE REVIEW

M. A. Hannan et.al. proposed system which deals with the solid waste monitoring and management system in [2]. This system consists of RFID, GIS, GSM and GPS for solid waste collection and monitoring. There were pick-up point locations from which waste is to be collected, through this pickup point map is prepared which is given to the waste collection vehicle driver. Pick-up point consist of container along with RFID tag this tag are read by the RFID reader, RFID reader are in the vehicle communication is based on client –server concept, where web browser is client. GSM and GIS used for communication in tracking system. Advantages of this system are low fuel cost, less labor requirement, proper waste collection monitoring and management and keeping recorded data.

Mohammad Salah Uddin introduced a Smart Anti-Theft Vehicle System in [3] based on Internet of Things (IoT) for monitoring the movement of any equipped vehicle from anywhere in real time. The implemented system consists of Global Positioning System (GPS), Global System for Mobile Communication (GSM)/General Packet Radio Service (GPRS) and Microcontrollers that provide access to check the vehicle tracking remotely using Smart Phone Application. Fuel line control and driver authorization is achieved using this technique.

Another method for smart garbage management in cities using IoT is introduced in [4] which deal with Microcontroller, GUI, Sensors, GSM, and IoT. Dustbin consists of circuitry in which Microcontroller, sensor plays main role. When threshold level is exceeds controller sends the message to waste collector through GSM, threshold level is activated by weight sensor. If the waste from dustbin are not collected in time then message is send to the higher authority through GUI, through this environmental and health issues are less, problems of dustbin overflow are solved.

S. Karthikeyan et. al. in [5] used ZigBee network and MQTT (Message Queue Telemetry Transport) protocol to determine status of garbage container. The paper discussed calibration of sensor, ZigBee range test, validation of protocol, database model and notification of optimal path using IoT Technology. Finally the communication between server and truck driver is achieved through Telegram messaging application.

Authors in [6] deal with the garbage bins or dustbins placed at public places are overloaded, then Wi-Fi module, Microcontroller, IR sensor is used that indicates overloaded dustbins. In bin when waste reaches to its defined level, it is sensed by IR sensor. Controller sends the signal to Wi-Fi module it transmit to Wi-Fi router and further this signal is send to the mobile. In mobile HTML page is used for processing by Wi-Fi module. Status of bins is updated on HTML page. This system reduces human efforts.

Authors in [7] used RFID technique using Near Field Communication (NFC) Tags in real time scenario for automatic literature searching system in college library. This system uses PIC microcontroller which interfaced with GLCD display. The main contribution of this work is that the GLCD can display multi locations of the user i.e. one person can change their location from one point to other point and even then the shortest path to switch to other place will be displayed on the GLCD. Also, the system is handy, portable, reasonably priced and require less time for searching any literature.

Another researcher introduced IoT Based Waste Management System in [8]. Additional sensors are used microcontroller, RFID, sensors, IoT, GSM. PIR and ultrasonic sensors are used. Sensors are used for sensing the required –parameters. As soon as parameter are sensed output signal is generated, forwarded to GSM transmitter later this signal is received by GSM receiver Record of data is kept in monitor section.

III. PROPOSED SYSTEM

A. The Proposed Work:

The block diagram of proposed work is shown in Fig. 2. Raspberry pi acts as a main controller. The display device will be placed in vehicle. Route map is shown on display along with particular nodes. Driver has to follow the route as per nodes, if a node is miss then it is indicated to driver by buzzer and display. LED glows when node is completed. RFID tag and reader are used for node detection. Wireless communication is done through Raspberry pi, because of wireless communication data is transmitted and stored in data base which is useful for future use.

B. Working Principle of RFID

Faraday's principle of magnetic induction is the basis of near-field coupling between a reader and tag Reader will pass A.C. signal through coil, which results formation of magnetic field in nearby region. As shown in Fig.3, if tag with small coil is brought in this region, A.C. voltage will form across it. This voltage is converted to DC voltage and then connected with capacitor. Capacitor will charge and this will acts as power source to tag chip. Tags draw current that give its own small magnetic field that opposes reader's field. This small incremental current will be detected by coil which is similar to load applied to tag's coil [9].

This is load modulation. Due to load modulation, tag sends data back to the reader. This signal can be recovered by the reader by controlling change in current flows through the reader coil. The number of modulation encoding methods are used that depends on number of ID bits needed, data transfer rate, and additional redundancy bits placed in the code to remove errors resulting from noise in the communication channel. Near-field coupling is the most straightforward approach for implementing a passive RFID system [9].

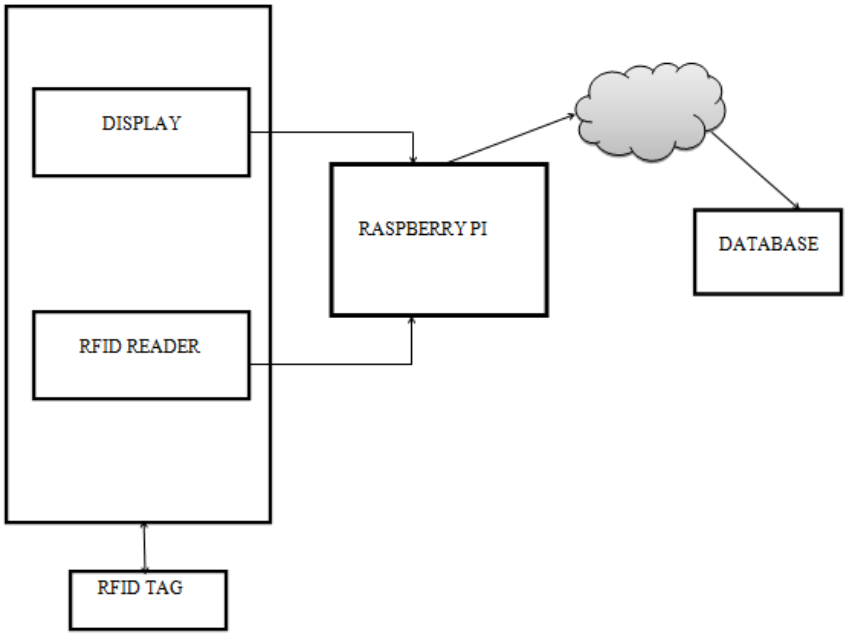


Fig. 2: Block Diagram of Proposed Work

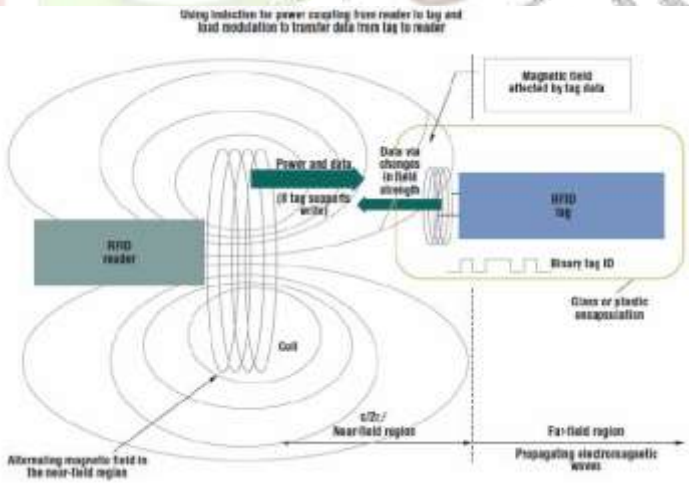


Fig. 3: Working Principle of RFID [9]

C. Hardware Description:

1. MFRC522 RFID Reader

It is a contactless reader module based on the MFRC522 from NXP B.V. Communication via Serial which makes it simple and easy-using. It is compatible with ISO/IEC 14443 A/MIFARE cards. It supports all variants of the MIFARE Mini, MIFARE 1K, MIFARE 4K, MIFARE Ultra light, MIFARE DESFire EV1 and MIFARE plus RF identification protocols, and the operating distance in Read/Write mode is up to 40 mm. The basic features are: Power supply 3.3 V/5V, FIFO buffer handles 64 byte send and receive, SPI interface, Working current 13~26mA, Idle current 10—13mA, Working temperature -25 ~ 85℃ and Size of 1.00mm×40.90mm.

This module could be used in a variety of applications: Access management, Tracking of goods, Tracking of persons and animals, Toll collection and contactless payment, Machine readable travel documents, Smart dust (for massively distributed sensor networks), Tracking sports memorabilia to verify authenticity, Airport baggage tracking logistics and etc.

2. Raspberry Pi Zero W

The Raspberry Pi Zero W extends the Pi Zero family. This Pi Zero W has all the functionality of the original Pi Zero, but comes with added connectivity, consisting of 802.11 b/g/n wireless LAN, Bluetooth 4.1 Bluetooth Low Energy (BLE). Like the Pi Zero, it also has: 1GHz, single-core CPU, 512MB RAM, Mini HDMI and USB On-The-Go ports, Micro USB power, HAT-compatible 40-pin header, Composite video and reset headers and CSI camera connector.

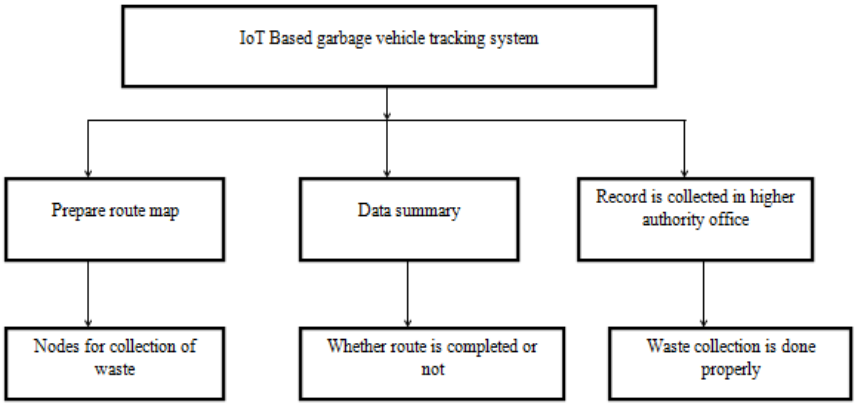
3. OLED

Two separate colors make this 128*64 SPI graphic OLED module unique. The two areas give convenient way to show lots of information in an easy-to –read display. It has less than an inch diagonal, thin lightweight display that uses super low power, making it great for handheld devices powered by batteries.

D. Dataflow of Proposed System:

Figure 4 shows the dataflow of system which is divided into three parts. First part is for driver, second part is for both driver as well as higher authority and third part is only for higher authority. First part consists of route map from which waste is to be collected, collection points are shown by nodes. Second part gives information to both driver and higher authority about waste collections. Third part completely deals with higher authority. All information about waste collection is stored which can also be useful in future.

Fig.4: Dataflow of Garbage Collection & Vehicle Tracking System



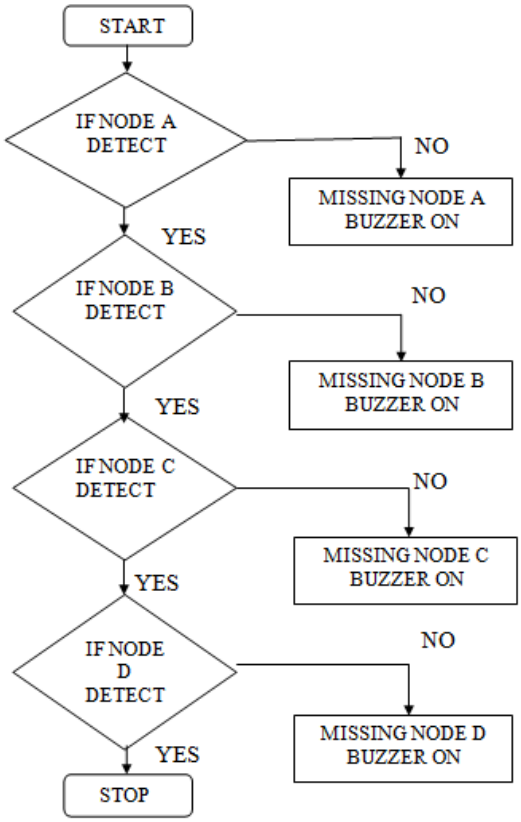


Fig. 5 Flowchart of Proposed System

Figure 5 shows the flowchart of proposed system. Initially the route map will be display on LCD. When vehicle reaches to node A, then RFID reader reads the tag information of node A. The Raspberry Pi sends this information to the server via the Wi-Fi module. The server stores the information in the database. If vehicle does not complete the route of node A, then it will display on LCD as well as BUZZER is also ON (for driver) and it will be indicated to main center through Raspberry-pi. After node A, vehicle will reach to next destination and the process repeats until it will cover entire desired area.

IV. SYSTEM DEVELOPMENT

The interfacing circuit diagram is shown in Fig. 6. The Raspberry pi controls the complete process like reading data coming from the reader, comparing data with pre-defined data, driving buzzer, driving status, LED and sending status to display. RFID reader is used to read RFID tags. Buzzer is used for indication and driven by inbuilt n-p-n transistor. LCD is connected with Raspberry pi in 4 bit mode. RS, RW, EN of LCD is directly connected at wiring Raspberry pi GPIO 11, ground and GPIO 10 respectively. The data pin are connected at wiring Raspberry pi GPIO 6, 5, 4 and 1. The push button is also connected at wiring pi GPIO pin to display the attend count. RFID reader is connected at UART pin.

Figure 7 is the hardware design in which Part 1 indicates Raspberry pi zero W that powered with 5V DC adapter. Raspberry pi zero W is main controller of circuit. OLED display 128*64 pixel is indicated in as Part 2 in below Fig. 4. OLED has 4 pin IC which is connected to SDA and SCL pins of Raspberry Part 3 indicates MFRC522 RFID reader that is connected to Raspberry pi using SPI bus.

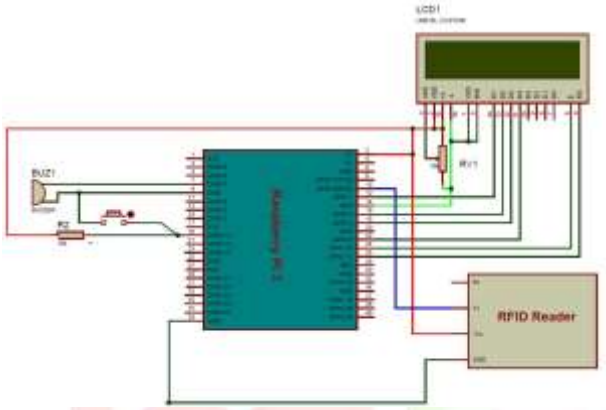


Fig. 6 Interfacing Circuit Diagram of System

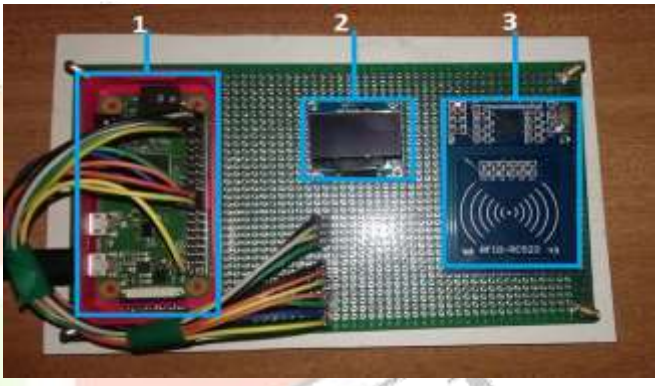


Fig. 7: Hardware Design of Proposed Work

This hardware setup is kept in driver cabin of garbage collection vehicle. It uses vehicle battery for power supply of just + 5 V DC. The system is ON when the vehicle is in field, whereas in other situation system can be turned OFF. For development of the system, prototype implementation is preferred. Different vehicle tracking maps is defined to cover selected area by garbage vehicle. There are at least 4 nodes are assigned in between these routes with RFID tags at each node. The graphical path is also designed on OLED at driver end. The sequence of each node is also defined and driver has to cover such nodes sequentially without missing it (knowingly or unknowingly). If driver tries to avoid any nodes in particular route, then alert is given to driver either through warning bell or continuous blinking on display. The database of each vehicle is logged at centralized command control center through use of IoT. Even pathetic situation like breakdown of vehicle, late arrival or late departure at particular nodes will be monitored at control center.

Table 1 gives comparative approach between existing technique and proposed technique. The proposed system is our ongoing project. From Table 1, it is clear that our proposed system perform exceptionally well as compared with existing technique.

TABLE 1 COMPARISON WITH EXISTING TECHNIQUE

Sr. No.	Performance Parameters	Existing Technique	Proposed System
1.	Computation Time	More	Less
2.	Cost Effectiveness	High	Low
3.	Computational Complexities	High	Low
4.	Track Area Covered	High	Low

V. CONCLUSION

The developed system works for garbage vehicle tracking, collection, processing and management with integration of raspberry pi and RFID. The main aim of this system is to complete overall route of garbage collection through this system data is also updated automatically and timely. This system ensures that route is completed or not within stipulated time. With the implementation of this system many manual interventions will be stopped. In future, the system is developed on real time application platform to improve and smooth the ground level mechanism for waste collection. The public grievances related to irregularities of garbage collection vehicle will be automatically solved. The municipal corporation gets ease access for daily garbage vehicle inward and outward database with capacity of garbage collected. Finally this work will definitely contribute The Smart City Mission launched by Ministry of Urban Development with the help of implementation of IoT effectively.

VI. ACKNOWLEDGMENT

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