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Smart Waste Management System using IoT

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Abstract: ***The Internet of Things or as we call it IoT is a system of interconnected computing devices, mechanical and digital machines with the ability to transfer data and communicate with each other over a network without requiring human-to-human or human-to-computer interaction once they are set up. In recent times the definition of the IoT has evolved due to the emergence and wide scale usage of multiple new technologies like real-time analytics, machine learning and commodity sensors. Along with them traditional fields like embedded systems, wireless sensor networks, control systems contribute to enabling the Internet of things. IoT technology is main component with products pertaining to the concept of the "smart systems". In the present day scenario, many times we see that the Garbage bins or Dust bins are placed at public places in the cities are overflowing due to increase in the waste every day. It creates unhygienic condition for the people and bad smell around the surroundings this leads in spreading some diseases and human illness, to avoid such situations we are planning to design a Smart Waste Management System using IoT.***

Keywords: IoT, RaspberryPi, SWMS, SPFS

I. INTRODUCTION

Waste management in the metropolitan areas is one of the challenging issues we are facing now a days. The need for an organized waste management system is mandatory to keep the environment and the surroundings clean. There are a lot of existing mechanisms available for handling the waste but to tackle the lack of gathering of the information is a challenging task. One major challenge in the waste management is to create a prototype because there is a lack of coordination between the government, people and local authority responsible for shipping and processing of the waste. Currently the waste gathering from public waste bin is conventional which requires a lot of labor and is an inefficient time consuming process. And so we need to implement a system to automate the process of waste management. The system proposed in this paper is based on Internet of Things (IoT) that can be easily implemented in a smart city infrastructure.

The idea is to automate to process of waste management and for that we suggest and implement garbage bins designed to help us with the process. These smart bins can be implemented on a large scale and the traditional dustbins may be removed so that it can avoid dumped wastes on the roads. The garbage level in the bins can be easily monitored and kept informed periodically. The idea behind smart waste management system (SWMS) is to avoid pollution and hazards caused due to the garbage. The system implements the smart technology with the help of ultrasonic sensors placed over the bins to continuously detect the waste level inside the bin. These bins will be connected to a network and when the waste level inside the bins reaches a preset threshold they will inform the responsible authorities via the network that they need to be emptied and the authorities can then act accordingly.

II. LITERATURE REVIEW

The problem of waste management has always been present in the modern cities and even in small towns and thus there is a lot of underlying work already being done in this field. Our Aim here is to take the best from those works and also add our contribution to create a more efficient system. Some of the Pre-existing works that were studied for this paper are:

A. In one of the research [1], an Ultrasonic sensor is placed under the dustbin. When the sensor signal reaches to the threshold value, a notification will be sent to the respective Municipal / Government authority person. Density of the Dustbin also checked through a GUI (Graphical User Interface) so any of the authenticated people can check the present condition of the dustbin. This would enable the personnel to send the collection vehicle to collect the full garbage bin or dustbin.

B. In [2], it describes the application of our model of “Smart Bin” in managing the waste collection system of an entire city. The network of sensors enabled smart bins connected through the cellular network generates a large amount of data, which is further analysed and visualized at real time to gain insights about the status of waste around the city.

C. In [3], we see that the workers of Municipal Corporation tend to leave some of the waste bins unattended as it requires a lot of manual labour. . Hence to reduce their manual effort technology of IoT based embedded devices is used to introduce the smart garbage collection systems is that majorly have two units one is master unit to undertake allocation of work to available truck drivers for respective area and slave unit that keep record of all the garbage collection in different areas.

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D. In [4], Advanced Decision Support System (DSS) is used for efficient waste collection in smart cities. This model consists of data sharing between truck drivers on real time to perform swift waste collection with the help of dynamic route optimization technique. This system handles situation of ineffective waste collection where areas are inaccessible. City is incorporated with surveillance cameras to capture and produce the proof of problematic areas to authorities. The waste collection system is to provide high (QoS) quality of service to the citizens of a city.

III.INFERENCE FROM LITERATURE

By studying the above mentioned works we reached to a conclusion that even though the basic ideas were same there was a concept of synchronisation missing from these systems.

A. Lack of a Proper Infrastructure or a Control System

The above mentioned systems all lacked a central control which will monitor all the activities of the underlying units i.e. to assign a specific set of waste collection trucks to a specific area, the maintenance of the smart waste bins and their sensors as well as the security of the bins.

B. ID System for the Bins

The whole plan will be implemented city wide and thus there must be a system that gives all the bins that are placed a unique id on the basis of their placements and size which helps in their collection and maintenance.

C. Optimization of Path for Waste Collection

Once the system receives a notification that a waste bin is on its threshold the collection trucks must be dispatches to collect the bins. But in case there are multiple bins which need to be collected then there must be a system that generates an optimal path for the trucks on the basis of bin id so that they can collect the bins in the minimum time.

IV. PROPOSED ARCHITECTURE OF THE SYSTEM

The system will be based on a Raspberry Pi board computer system on the field implementation side. A sensor kit with an ultrasonic sensor will be installed on the top lid of the waste bin. This sensor will keep a check on the waste level in the bin. There will be a pre-set threshold level set and once the sensor senses that the waste is above that level the sensor will then send a notification to the main control room via the network over Wi-Fi with the help of a Wi-Fi module also installed in the sensor kit. Once the control room receives the notification then control room will then dispatch the nearest truck to collect garbage from that bin.

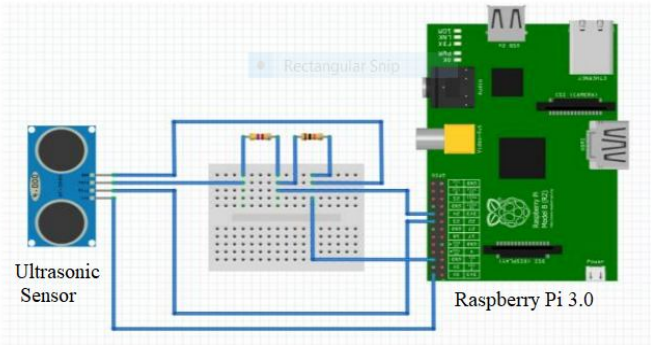

Fig. 1 A basic Sample Circuit

The whole System Will Consist of Three Major Modules:

A. The Admin Module

This module will serve as the central module and all the tasks will be organized and managed here. The database of all the bins will be stored here. The monitoring of garbage level, the dispatch of collection trucks, in case of multiple collections the generation of a shortest path etc. will be some of the major functions of this module.

B. The web module

The whole system will be on a network and to access it there will be a web module through which the collection truck drivers can see which bins are to be collected and also the path they have to follow. In addition to it this will also serve as an graphical interface to the system which will show stats like the sensor state and waste level in nearby bins.

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C. The Field Module

This module can be called as the field agent of the system as it will be the system installed on the bins that will enable the monitoring and management on the bins.

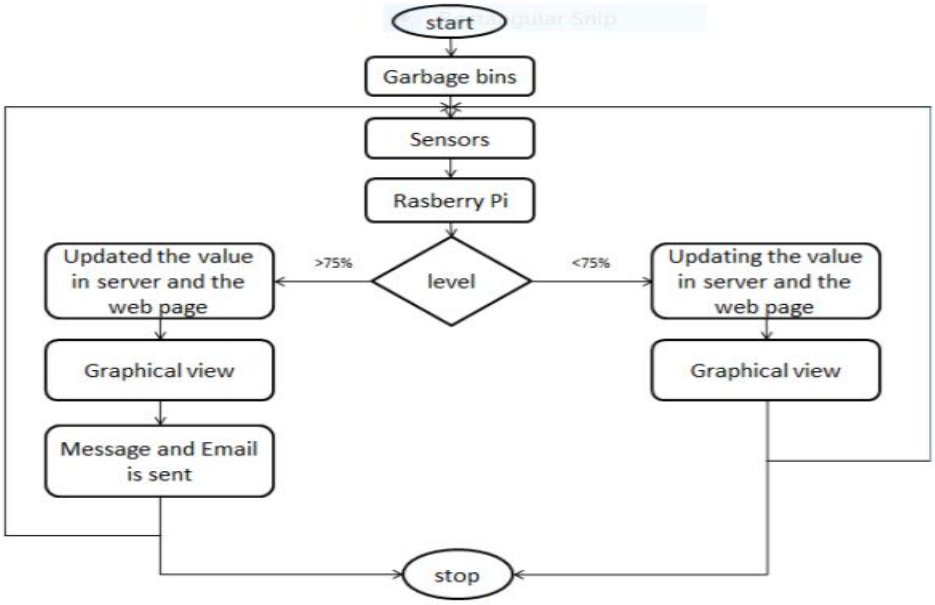

Fig 2. Flow Chart of the functioning of the field module

Another key component of the system is the shortest path finding system (SPFS) which will make it very effective in case of multiple collections in the area. Its functionality includes the bin id, maps api and a shortest path finding algorithm. Once the system is made aware that there is a set of bins from a specific area which need collection, the system will check their bin id and with the help of map api which will have the placements of all the bins marked, it will generate the shortest path connecting them and will provide that to the driver responsible for collection of the bins.

Fig 3. Demo view of map with bin placement and path marked

V. ADVANTAGES OF THE SWMS

When the proposed system will be fully implemented and begin functioning this will serve in the optimum management and maintenance of the waste management system since it will be fully atomized we can be sure that it will function to the closest accuracy possible.

A. The monitoring system will allow the municipal corporation to collect the garbage bins in time such that there is no spillage of waste around and also to ensure that the bins are being collected in a regular manner.

B. The SPFS will also ensure that there is no extra wastage of fuel and time while collecting the waste.

C. As it will have a central control system in case of any failure the system will know and that failure can be resolved easily and quickly in an efficient manner.

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VI. ENHANCEMENTS POSSIBLE IN FUTURE

The system designed above is as per the latest norms but there are still some advancements that can be made:

A. To integrate it with an intelligent traffic management system to ensure that the path followed under SPFS is traffic free so that the driver can reach there inn time.
B. To analyse the trend followed in waste collection in a specific area so as to maintain cleanliness there and to check if more bins need to be placed.
C. The field system here is powered by the city electrical line but they can be converted to solar powered to reduce energy consumption. This will make it a self-dependent system.
D. Initially the cost of each setup will be more but if the sensors and the raspberry pi computer board are bought in bulk or made in bulk for this type of a system then it will reduce the cost drastically and will be an even more economically better solution.

VII. CONCLUSION

Here we have proposed an architecture of a smart waste management system (SWMS) that works in IoT. It monitors the waste level in the bin by using ultrasonic sensors and when the bin is full informs the responsible authority about it so that it can be collected. The shortest path finding system (SPFS) enables the collector trucks top follow the shortest path while collecting the bins saving both time and fuel. The above mentioned system automates the process of waste management and reduces any chance of human error. The Advantages of the SWMS completely overshadow its only disadvantage in the current time which is its high cost and also vouches for a completely reliable system for waste management. This system can be implemented in smart cu=cities under the Swatch Bharat Abhiyaan, an Initiative by the Indian Government and can facilitate it in many ways.

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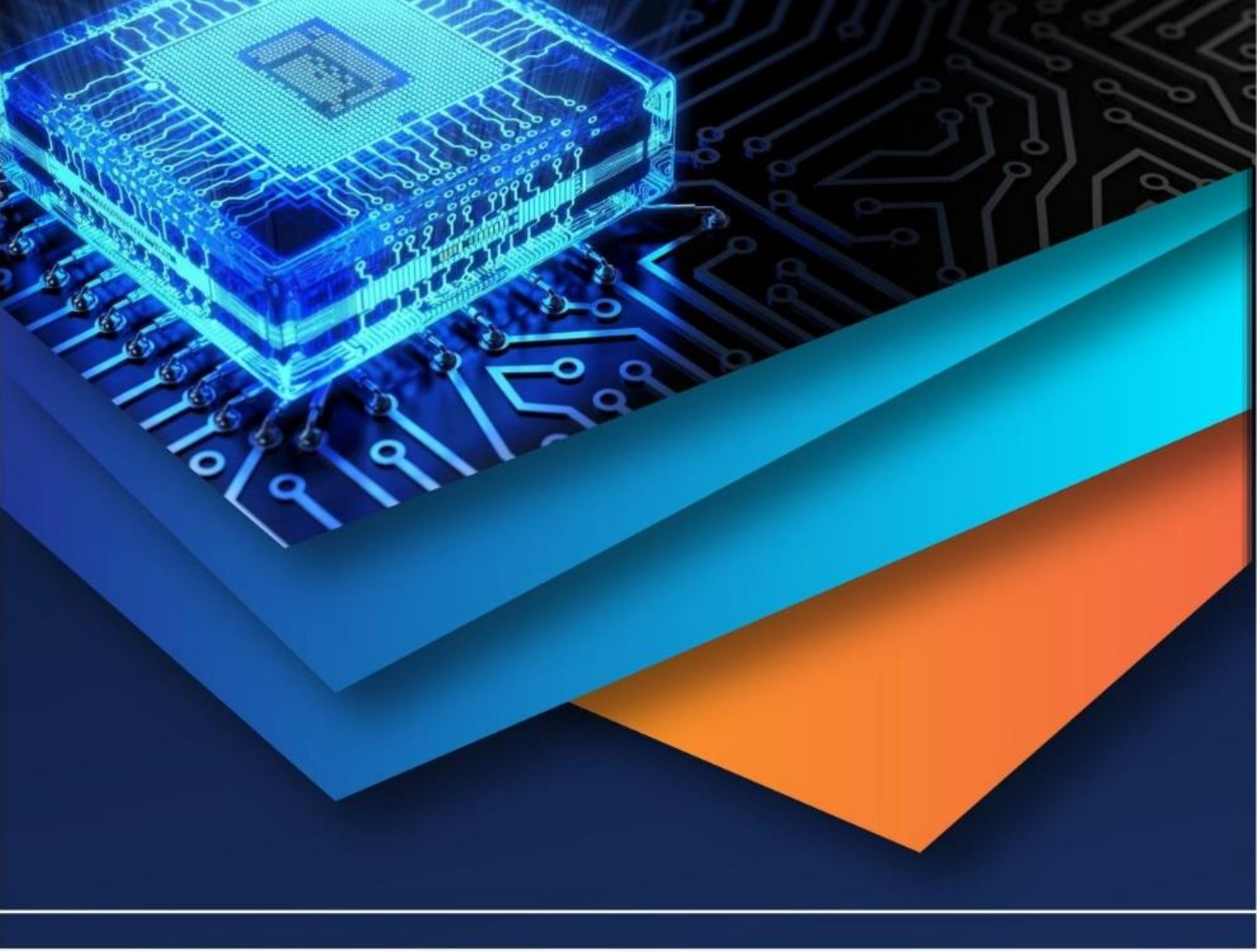

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