Design and Implementation of Smart Waste Management System using FOG computing

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Abstract - *Waste collection and to dispose is one of the biggest issue that world is facing. This requires huge expenditure and more costing includes manpower, collection bin vehicle cost, fuel cost, and proper ways to dispose it. This factor led the necessity of designing, implementing and executing an intelligent smart waste management system for proper dispose of waste. This paper concentrates on the implementation of Smart waste management using FOG computing. This system uses ultrasonic sensor for sensing the level of waste and using Arduino node MCU it will send the data to the server and from which it will analyze the filled level and according to which the collector truck will go for collection as per the optimized route generated. This system provides the efficient solution for the waste management system*

Key Words: Fog computing, Smart waste management system, Internet of Things, Optimized Algorithm

1. INTRODUCTION

The Cloud Computing model, "pay-as-you-go" is an effective approach for handling customer's data centers for several applications. There are several factors of data centers which frees and helps the cloud computing 's environment. This boon in turn arises a problem for bandwidth and latency sensitive applications which need their nodes to be in the same vicinity. Nowadays, Internet of Things (IoT) ratio have increased extensively. A new paradigm name "Fog Computing" is evolved for the support of demand in computing latency sensitive application of geo-distributed IoT devices/sensors. Fog computing inhabit nearer to IoT devices/sensors extending the Cloud computing rather it cannibalize to greater extent of computing, networking and storage facilities [2].

In this paper, we discuss a smart mechanism for improving the management of wastes in cities. The proposed system is based on the optimization algorithms. It consists of an IoT based prototype with sensors to measure the waste volume in containers or waste bins, with facility to transmit information over the Internet.

The rest of the paper is organized into the following sections. In section 2, related work is covered. System Implementations is shown in Section 3. Section 4 covers simulation and results of the proposed system. Finally, in Section 5, results and discussion and in section 6 concluding remarks are given.

2. RELATED WORK

In paper [1], for the intelligent garbage collection, a smart alert system has been propose wherein a alert signal, generated through an Ultrasonic sensor (interfaced with Arduino UNO), is provided to municipal web server. On receipt of such alert, the driver visits the particular location and performs the task of emptying the dustbin. In this process RFID is being used for auto-detection of status of dustbin i.e. empty or filled. Once the task of emptying is done, signals are sent back to server about the accomplishment of the task. An integrated module with RFID and IOT has been designed and proposed in this work.

In paper [2], the mechanism to priorities the collection based on the location e.g. schools or hospitals has been integrated together and, in that way, a dynamic waste management system has been proposed. Further, the similar priorities have been identified for the dangerous waste (i.e. causing the quick health impact to people living areas). The mentioned goal is achieved by means of novel algorithms which optimizes the priority and related cost. In current method data is evaluated with real time and synthetic data is retrieved by municipality of Saint Petersburg, Russia and for this they have designed and developed models like dedicated trucks model, detour model, minimum distance model, and reassignment model.

In paper [3] , the goal defined here is to reduce the power consumption and increase the operational time by designing a system which collects the data and deliver the data through wireless mesh network. The architecture considered for this expands over three tier namely, outdoor nodes (to sense the fullness of bin through sensor node), analytics (to analyses the data, process them, tag the metadata and then interface with the external system) and workstation (which works as the graphical interface for user). This system operates with the data delivery ratio of 99.25% and can be effectively used for litter bin daily seasonality information.

In paper [4], the present system is configured as 'pre-separated waste' for differentiating the database of waste collected obtained from the sensor with respect to its category i.e. organic, plastic, paper, bottle, metal etc. This enables to have an efficient waste management system and has been adopted in Korea. In the description of such a system, a generic work flow has been provided, wherein, on receipt of alert message, collection is to be arranged and once the task is done the status in the system is updated accordingly. While the types of smart bins and cloud

architecture is configured, the real implementation methodology which takes care of the different variables of the system has not been described.

In paper [5], with the additional incorporation of 'real-time' information on the status of the bin, expected fill-up time of the bins, and level of harmful gases, the IoT system proposed here can be employed by municipal administration for society level waste collection system. In the architecture, it comprises of devices embedded with microcontroller, sensors and communicator to the workstation (located at municipal office). However, the algorithm based shortest path determination and thereby saving on cost and time has not been exercised.

3. SYSTEM IMPLEMENTATION

Fig- 1 : Layout for smart waste management

Above Fig. 1. shows the layout for smart waste management system. It shows that garbage bin which when get filled gradually it will send data to the fog server and from fog server it will send data to the cloud and from the cloud it send alert sms to the garbage collector driver who will receive shortest path for the collection of garbage. Fig 5. shows flow of the system that how it executes. If the garbage bin is filled upto 75% it sends alert message to collector else it will wait until upto reaches upto 75%.

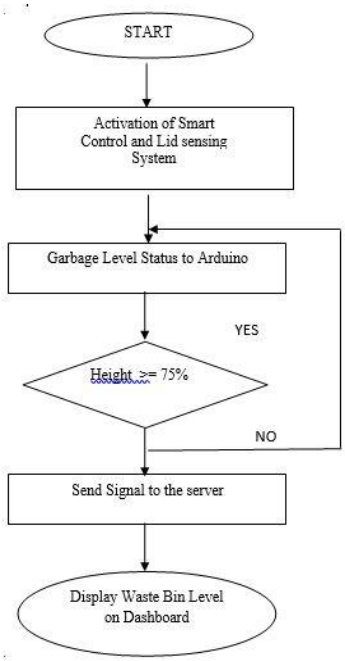

Fig -2 : Flowchart for smart waste management

3.1 Methodology

A computer scientist Edger Dijkstra proposed Dijkstra's algorithm, [8] in 1956 and published in 1959. Dijkstra algorithm solves the single-source shortest path problem for a graph with non-negative edge path costs results in a shortest path tree. This algorithm is often used in routing and as a subroutine in other graph algorithms. For a given source vertex (node) in the graph, the algorithm finds the path with lowest cost (i.e. the shortest path) between that vertex and every other vertex [8].

4. SYSTEM CONFIGURATION

4.1 Hardware specifications

4.1.1 Node MCU

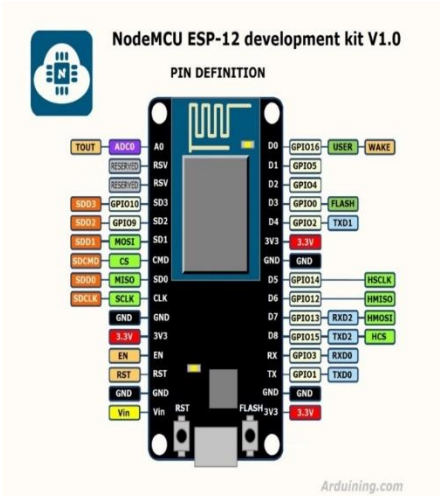

Fig- 3 :Pin diagram of NodeMcu[9]

The Node MCU is open source IoT platform device consisting of the ESP8266 module having a 32-bit ARM microprocessor with support of WIFI network and built-in 128 K Bytes flash memory, USB Port to power (5 volts) and programming having 10 digital GPIOs pins at 3.3V and input pins having 1.8V and its based-on Lua scripting language. There are 6 extra GPIOs [9]. Advantages are low cost, reduced size of the board, integrated support for WIFI network and low energy consumption.

4.1.2 Ultrasonic sensor

Fig - 4 :Ultrasonic sensor Pin diagram [9]

The ultrasonic sensor (HC-SR04) is economical sensor provides 2cm to 400cm with a ranging accuracy that can reach up to 3mm of non-contact measurement functionality. It includes an ultrasonic transmitter, a receiver and a control circuit. There are four pins Trig (Trigger), Echo (Receive), VCC (Power), and GND (Ground). The HC-SR04 emits high frequency sound wave at regular interval which propagates in air at the velocity of sound. When sound strike the object, the waves are reflected aback as echo signals to the sensor which themselves calculates distance to the destination [9].

4.2 Software specifications

4.2.1 Arduino IDE

The Arduino integrated development environment (IDE), provided by the Arduino project which is a cross-platform application coded in the Java. It originated from the IDE for the languages Processing and Wiring. It is open source platform which is easy to use on hardware and software side. It includes a code editor with various features and simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch". The Arduino IDE supports the languages C and C++ using special rules to organize code [9].

4.2.2 ifogSim

iFogSim,is tool for modelling IoT and Fog environments and measures the impact of resource management techniques in cost, network congestion, latency and energy consumption. iFogSim is consist of multiple layers, where each layer has some specific tasks to perform operation of higher layers[10].

5. RESULTS AND DISCUSSION

The circuit diagram for the smart waste management is shown in figure,

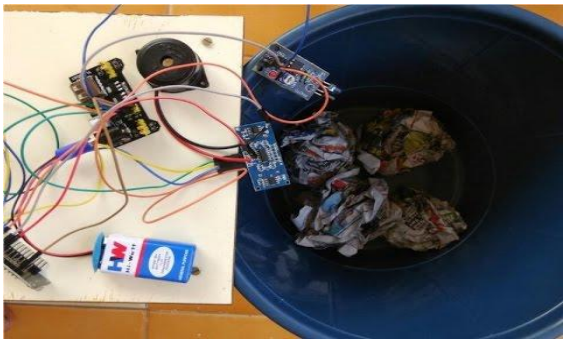

Fig- 5 : Experimental Setup

The below chart shows the level of bin get filled on the Thing speak server and also, we can get the current location of the same. We plot graph for the other predefine nodes and from these nodes we can implement the Dijkstra's shortest path finding algorithm using MATLAB. Thing Speak allows users to visualize and analyze uploaded data using Matlab and does not requires the purchasing of a Matlab license from Math works. In fact, all of the Thing Speak documentation is incorporated into the Math works' Matlab documentation site and even enabling registered Math works user accounts as valid login credentials on the Thing Speak website. These data will set to FOG server and from them it is sent to Cloud.

Fig- 6 : Level of bin filled

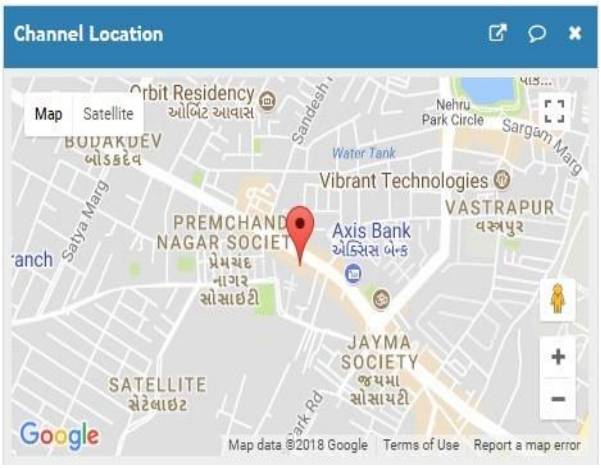

Fig- 7: Current location of bin

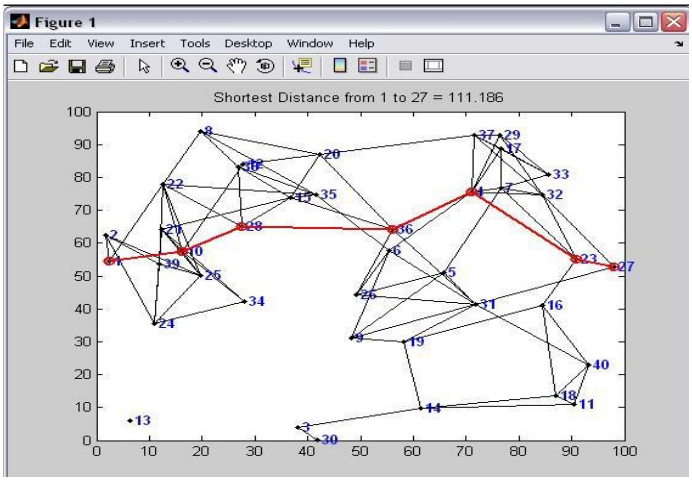

Fig- 7: Dijstra's Algorithm

6. CONCLUSIONS

This paper shows the smart waste management system by using smart bins giving its filling level to the server. By implementing this system it reduces time , cost and optimizes routes . Our system informs the status of bins to the garbage collector and which will collect garbage as per shortest path generated on the level of filled bins. Optimized routed is obtained using the MATLAB.

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