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Smart Garbage Monitoring System Using Node MCU

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***Abstract*— GARBAGE MONITORING is it a big problem? Yes if not disposed properly. With the increased concern about the garbage collection, segregation, effective re-utilization and pollution free environment there is a need for TECHNOLOGY to tackle the situation. What is to be done regarding the issue? Timely disposal and segregation of waste into dry and wet before dumping into bins is implemented using NodeMCU (MicroController Unit). As soon as the bin is filled, it should be brought to the notice of municipality department so that it can be taken to garbage monitoring plants before the bins are covered with flies, rodents, most importantly before it smells foul polluting the city environment. This can also save fuel of trucks.**

***Index Terms*— Keywords- IoT, NodeMCU, Sensors, Smart city, Garbage, Thinkspeak.**

I. INTRODUCTION

The internetworking of physical world and sensors are described as Internet of Things (IoT). These physical devices are connected to wireless or wired internet connections i.e., IoT is connection of embedded systems to internet. The basic Embedded system consists of sensors examples Temperature, Humidity, Light, Ultrasound, IR, RF, Metal sensor, Accelerometer, Gyroscope and other inputs like switches, Keypads, Timers to the microcontroller e.g., 8051, ATMEG 168, 68HC11 and output from these to Actuators, Relays, switches, PWM, notification as Buzzers, LEDs. Memory mapped IO devices like RFID, GSM. Display units like seven segment display, LCD, graphic display units etc.

The ideas of inter-connected devices or smart devices are designed to bridge the gap between the physical and digital world to improve the quality and productivity of life, society and industries. The most important application is the smart city next is the smart home and wearable on the internet, and these devices will use this data to interact with you on daily basis and complete tasks. Because of growing population of the world smart city application takes very important role. The smart city applications are smart surveillance, water distribution, smart security, environmental monitoring and smart waste management system. IoT will solve major problems faced by the people living in cities like pollution, traffic congestion and shortage of energy supplies, waste management system etc. We are interested in development of products like Smart Bin that will send alerts through cellular communication to municipal services when a bin needs to be emptied.

In recent times, garbage disposal has become a huge cause for concern in the world. A voluminous amount of waste that is generated is disposed by means which have an adverse effect on the environment. The common method of disposal of the waste is by unplanned and uncontrolled open dumping at the landfill sites. This method is injurious to human health, plant and animal life. The purpose of this project is the realization of a

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compact, low cost and user friendly segregation system for urban households to streamline the waste management process.

In this paper we introduce an IoT based Waste management system to achieve effective dynamic waste collection. This system consists of two Smart-Bins; one is for dry waste collection and second is for wet collection. We use Thingspeak for analysis data and user friendly GUI (Graphical User Interface) to send the information to the municipal office. The rest of this paper is organized as follows. Section 2 deals with related works on IoT based waste management system. Section 3 describes about the sensors used in the implementation of smart-bin. Section 4 describes about the block diagram of the smart-bin. Section 5 describes about the implementation of Smart-bin. Sections 6 gives the result of each sensor output and also results of data analysis using Thingspeak and also presents evaluation performance with the Android app, while Section 7 concludes the paper and discusses future work.

II. RELATED WORK

The architecture of Smart bin system [1] can be analyzed as three-tier architecture: outdoor nodes, analytics, and workstation. Through the test bed, collected data and applied algorithms, litter bin utilization and litter bin daily information was obtained. With such analytics, litter bin distributors and cleaning contractors are able to make better decision to increase productivity and efficiency. The disadvantage of this paper is the sensor node had limited memory size. This had an effect on the size of the program running on the sensor node.

IoT based architectural solution to tackle the problems faced by the present solid waste management system [2]. By providing a complete IoT based system, the process of tracking, collecting, and managing the solid waste can be easily automated and controlled effectively. The bins will be fitted with IR sensors to detect the level of Garbage collected. A gas sensor will be used to detect the presence of any harmful gases, a load cell is used to measure the weight of the bin, and indicators like LEDs and LCD will be used for notifications. The disadvantages of this paper are the protocol overhead is extremely small and is only of 2 bytes. It also requires very less bandwidth, making it the idle protocol for their system.

An embedded based intelligent alert system [3] is devised for the proper monitoring and maintenance of the garbage. This system averts the irregular cleaning of the dustbins by sending alerts to the concerned individual at regular intervals. Arduino UNO R3 is used as the microcontroller to read the data from the ultrasonic sensor. It is programmed to send an alert to the Thing Speak web server once the garbage reaches a certain distance. An RFID (Radio Frequency Identification) reader is interfaced with the Arduino for the verification process. The ultrasonic sensor checks the status of the dustbin and sends it to the web server. An android application is used to view the alerts and status at the Server end.

The waste management proposed [4] mainly consists of 8051 micro controller, IR Sensors, RF module, Processor Intel Galileo Gen2. The principle involved here is the IR sensors senses whether the bin is full or not, this data is sent to RF transmitter via 8051 micro controller .then RF receiver collects data from various transmitters and sends it to Galileo Gen2 micro controller , it process the data and send it to client, web server. Waste Level is detected inside the dustbin, transmit the information wirelessly to concerned people under in charge, the data can be accessed anytime and from anywhere. Major drawbacks are, it checks only for the level of garbage and no other aspect. This proposal does not deal in detail how the waste management is done once after sending message.

The solid waste management [5] mainly makes use of RFID, GPS, and Microcontroller, GSM, and Ultrasonic sensors. The main principle involved is the level of garbage is detected by ultrasonic sensors or load cells. The output of which is sent to municipal office through SMS using GSM modem, location of the dustbin is tracked through GPS module. This method provides a way to separate 5 types of plastic using NIR (near infrared reflectance spectroscopy); it also suggests a way of extracting biogas from organic waste. The drawbacks are the separation of different kinds of plastic is not included at the time of collection of waste, moreover it does not include organic waste collection, method to obtain biogas is suggested which is not required.

III. THE SENSORS

A. Ultrasonic Sensor

The device called ultra sonic sensor is used to detect the distance from which the object is separated from it. The principle behind this is it sends out the sound waves and it waits for reflection of sound wave from the object under consideration. By noting down the time lag between the sent and received wave, it is actually possible to measure the distance of object from the sonar sensor.

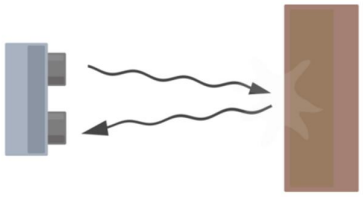

Figure.1 Basic Ultrasonic Sensor

Figure.2 Ultrasonic Sensor

As we know that sound wave travels through air at a speed of 344m/s, to find the round trip distance of sound wave, the return time is multiplied by 344. Round trip distance refers to the twice the distance of the object from the sensor. The actual distance is calculated by diving round trip distance by 2.

Distance= (speed of sound x time taken)/2

It should be noted that not all objects are detected by sensor due its shape wherein some waves get reflected back, size might be very small and the positioning angle also plays a role in detection of object. Some objects such as cloths, carpeting absorb the waves, where there is no way for detection of such objects. These are the factors to be noted.

B. Pir Sensor :

PIR sensor is an electronic sensor used to detect the motion of human being within a certain range of the sensor. Pyroelectric sensors that detect the levels of infrared radiation are used to make PIR sensors. Working: Whenever, human being moves in the field of view of PIR sensor, it detects the infrared radiation emitted by a hot body motion as shown in figure.3. Thus, the infrared radiation detected by the sensor generates an electrical signal that is used to activate an alert system or alarm sound.

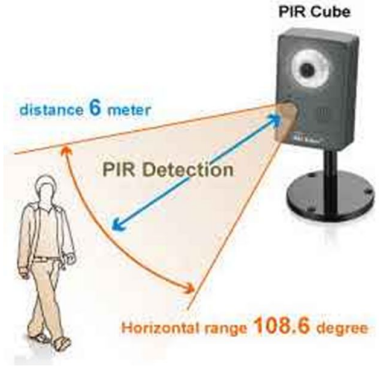

Figure.3 PIR Sensor working

Figure.4PIRSensor

The PIR sensor internally is divided into two halves, one half is positive and the other is negative. Thus, one half generates one signal by detecting the motion of a hot body and other half generates another signal. The difference between these two signals is generated as output signal. Primarily, this sensor consists of Fresnel lens which is bifurcated to detect the infrared radiation produced by the motion of hot body over a wide range or specific area as shown in fig.4. Once the motion is detected, the output goes high for a couple of seconds

and then returns to a normal state or low. This sensor requires settling time, which is in the range of 10 to 60 seconds.

C. Moisture Sensor:

The volumetric water content of soil is measured by using moisture sensor, making it ideal for performing experiments in courses such as soil science, Agricultural science, environmental science, horticulture, botany, and biology. The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. The sensor creates a voltage which is proportional to the dielectric permittivity of the water content of the soil. The sensor averages the water content over its entire length. There is a 2 cm zone of influence with respect to the flat surface of the sensor. The figure above shows the electromagnetic field lines along a cross section of the sensor, illustrating the 2 cm zone of influence.

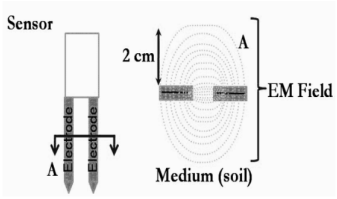

Figure.4 Internal structure of Moisture Sensor

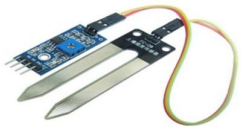

Figure.5 Moisture Sensor

IV. PROPOSED SMART-BIN

A. System Architecture:

Waste management can be broadly categorized as: segregation, collection, and transportation. Segregation of the solid waste can be done at the root level where the citizens segregate the waste according to wet, dry and medical waste and dump the garbage to the respective garbage bins placed at their homes. The bins will be fitted with ultrasonic sensors to detect the level of garbage collected. A moisture sensor will be used to detect the presence of moisture, PIR sensor is used to detect the movements of any rodents in the vicinity of the garbage bins and indicators like LEDs and LCD will be used for notifications. The sensors will be interfaced to NodeMCU that will collect the sensor data and send it to ThingSpeak cloud where the data will be collected. Based on the data collected, the maintenance person of that apartment gets a message. The message displays the levels of bins of all houses, so that he can be alerted to collect the garbage. Bio-degradable waste will be used as manure for gardens in the apartment.

B. Block Diagram

The smartest, easiest, cleanest and simplest home segregation method can be achieved through smart bin concept. Intelligent Monitoring is the IoT solution that is revolutionizing how Smart Cities and private companies service their container assets. Presence of Optimistic logistic resources which reduces collection and delivery costs by up to 50%.This self responsible work of environment concerned citizens makes life easier for rack pickers, workers of municipal corporation. This method also avoids spreading of diseases, breading of mosquito and other rodent's .The outlook of the city also improves with this approach, builds healthier environment, healthier citizen's, beautiful surroundings

Our bin is designed for each apartment's use, the compounder gets alerts from different apartment to collect the waste regularly so that it doesn't stink and the garbage is disposed properly even if the apartment owner is busy or out at work etc. Our module consists of 3 ultrasonic sensors, 1 pir sensor, 1moisture sensor fitted on to the inner side of bin cap, protected from waste. These sensors can actually sense the waste that in the bin, each sensor delivers message regarding different aspect of sensor. Ultrasonic sensor notifies the level of bin, i.e. whether the bin is filled or not depending on which the compounder decides to empty it. The pir sensor detects for any rodents in the bin as it can detect motion of objects, moisture sensor differentiate between wet and dry waste and sends data appropriately. These sensors data is then sent to thing speak, data analytics will be accessible to compounder, the data is sent to his mobile phone via virtuino (associated with thing speak) app where there is different alarm sounds for different apartment, indicates him to empty that particular bin.

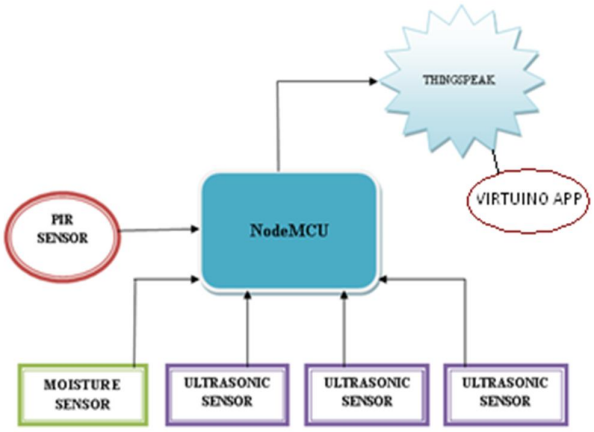

Figure.7.Block Diagram of working module in bin

V. FLOW CHART

Sensors values are loaded depending on height, moisture and motion of a person. The PIR sensor and Moisture sensor checks whether it is greater than or equal to its maximum value if so there is buzzer. All the 3 sensors values are sent to thingspeak via wifi module and the values can be visualized through graph. The values in thingspeak are sent Android app where if the ultrasonic value is greater than maximum value then there is alarm. If the sensors don't exceed their maximum value then it will check for sensor values again.

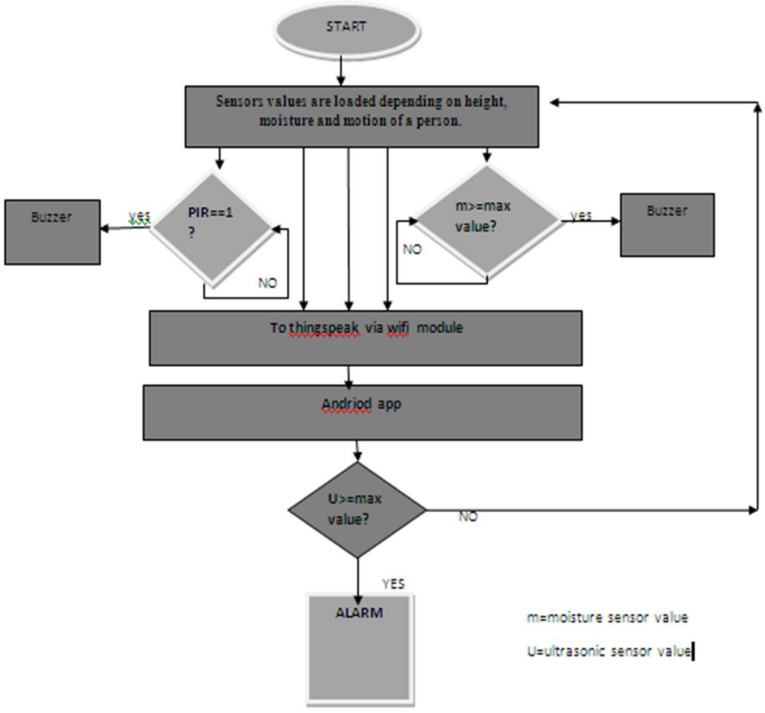

Figure.8 Implemented flow chart

A. NodeMCU:

NodeMCU is an open source IoT platform. It uses the Lua(it is a lightweight multi-paradigm programming language designed primarily for embedded systems and clients.) scripting language.NodeMCU is built on the ESP8266 SDK 1.4 and based on eLua(Extraterritorial Land Use Authority) project. The firmware on which NodeMCU works is ESP8266 Wi-Fi SoC(System On Chip)and the hardware is based on the ESP-12 module NODEMCU can be programmed using Arduino IDE

Figure.9 Nodemcu

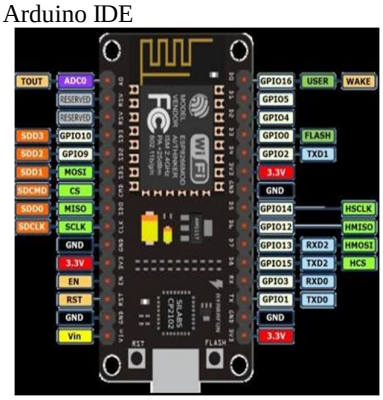

Figure.10 Pin configuration

TABLE I. DETAIL OF NODEMCU

Developer	ESP8266 Open source community
Type	Single-board microcontroller
Operating system	XTOS
CPU	ESP8266
Memory	128kBytes
Storage	4MBytes
Power	USB

NodeMCU is developed by ESP8266 open source community. It is a single board microcontroller with operating system XTOS, CPU version ESP8266.It consists of 128Kbytes of memory with storage of 4Mbytes.It is powered by USB.

B. Arduino Uno:

The open source called Arduino providing interface between computer hardware and software companies and project oriented for community of users working with microcontroller kits , IoT related works wherein involving interaction and information collection from objects in the physical world. The products of the project are distributed as open-source hardware and software, which are licensed under the GNU(is an operating system and an extensive collection of computer software), Lesser General Public License (LGPL) or the GNU General Public License (GPL), manufacturing of which is permitted by Arduino boards and software distribution to any licensed person.

VI. RESULT ANALYSIS

The circuit diagram and graphical analysis obtained from thingspeak and virtuino regarding different sensors are shown as follows. As per the predefined threshold values we get the alarm beep along with door number,

considering the range of the sensor (ultrasonic-value depends upon the height of the bin, pir-1 for motion detected, 0 for motion not detected, moisture – 1024 for dry waste, the value decreases for wet waste).

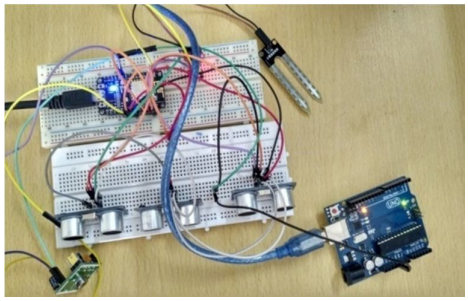

Figure.10 circuit connection

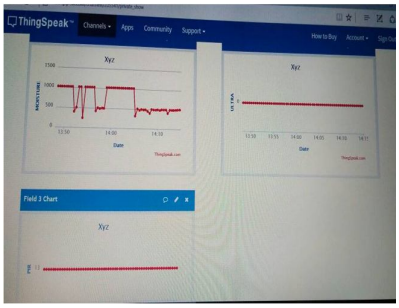

Figure.11 Output on Thingspeak

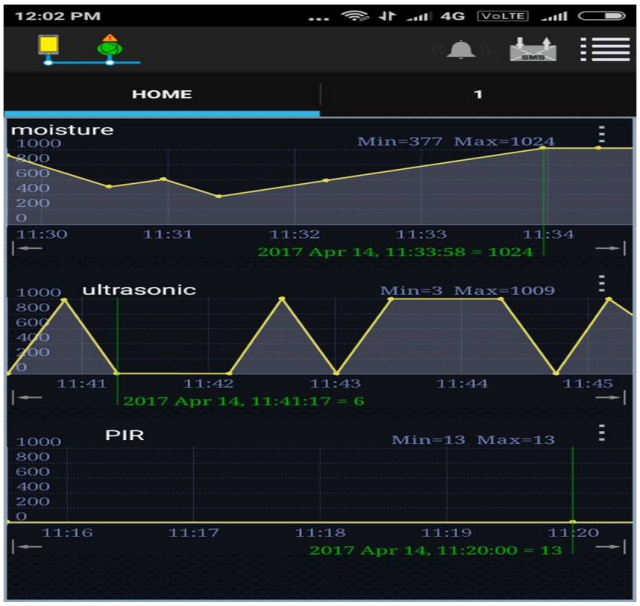

Figure.12 Output from Virtuino App

VII. Conclusion

The multispecialty smart bin designed above can lead to an Eco-friendly, clean and healthy surrounding. This implementation can efficiently deal the problem of waste disposal which has been proved to be great threat to any developing country. The top 4 developed countries spent most of their economy on effective waste management, recycling and disposal. Proper integrated work force can work collectively with distributed networks located all over the city for timely and fast decision making based on analytical data collected from sensors alarm alerts from virtuino, bins shall also be provided with GPS connectivity for tracking the exact location . Further we continue the work to provide message interfacing to know the condition of the bin. In addition to this we are trying a method to detect sanitary and medical related wastes in order to segregate it separately.

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BIOGRAPHIES

Mamatha Dhananjaya has completed B.E from Bangalore University, Karnataka. She also received M.Tech in Digital communication and networking from VTU , Belagavi, Karnataka and pursuing PhD in area of IoT from VTU, Belagavi, Karnataka. Her area of interest is Internet of Things, Could computing and Signal Processing. She is currently working as Asst. Prof. at Global Academy of Technology, Bengaluru, Karnataka,

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