

IOT BASED GARBAGE MANAGEMENT SYSTEM FOR SMART CITY USING RASPBERRY PI

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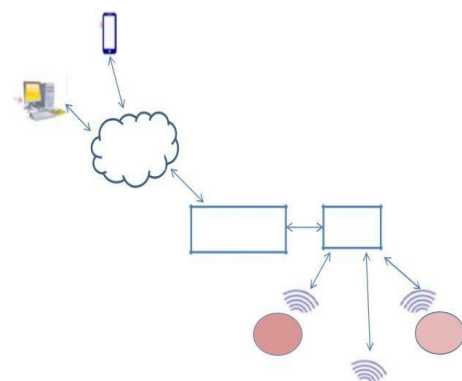
Abstract— In many places, we can see that the municipal waste bins are overflowing because of it is not collected and cleaned before it fill and overflow. The consequences for this overflowing waste bin is very severe. It can lead to land pollution, air pollution, which will lead to spread of diseases to humans and animals around it. Thus there should be a alert system that can monitor the bin and can give the condition or level of filling of the waste bin to the municipality using wireless sensor network. So that the bin can be cleaned on time and the environment can be kept safe.

This paper presents the smart waste management system of the garbage system that identifies fullness and level of the waste bin using the wireless sensor network(WSN). which is embedded to the Linux board to inform the information to the authorized person for the cleaning of the waste bin in time. Here we use Raspberry Pi as the embedded Linux board. The board architecture is designed based on the arm 11 microcontroller architecture. The ZigBee protocol is used for communicate with all the sensor nodes placed in the tested areas with the embedded Linux. Also the embedded Linux will act as a coordinated node in the wireless sensor network. The aim of the coordinator node is to collect the parameters like level of waste bin and odor it wirelessly. Each sensor node will have a level sensor and a gas sensors and one ZigBee RF antenna device for communicate with the coordinator node. The Raspberry Pi store will collect the data in the database and then analyze

the data it has stored. The board has an Ethernet interface and it run as the simple data web server. The coordinator will collect the data from ZigBee wireless communication protocol and allows the user to monitor the whole data from the web browser. Thus the cleaning authority can collect the garbage on time.

Keywords—Wireless sensor network, Embedded linux board, Raspberry Pi (Rpi), Zigbee , Level sensor.

1.INTRODUCTION



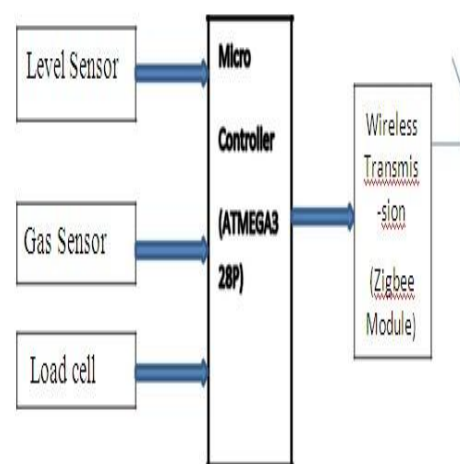
In the whole world the waste management in the metropolitan areas is one of the challenging issues we are facing now a day. The need for an organized waste management system is mandatory to keep the environment green. There is a lot of existing mechanisms are available for handling the waste management. The lack of gathering of the information is the major challenging task.

This miscommunication will surely affect the national growth rate in dense suburban area and also the demand for urban ecological protection is increasing day by day. This is one major challenge in the waste management to create a prototype because of the lack of coordination between the government, people and local authority for shipping and processing of the waste. Currently the waste gathering from public waste bin is conventional which acquire a lot of labors and is time overwhelming process. Internet of Things (IoT) is the control of the system using the internet. The 'thing' in IoT can mean to be a physical device with sensor which is capable to send information through IP address and also it have the ability to communicate information to the base station automatically. This technology is very useful to saving of the time. Internet of Things can be able to interact in various systems over the internet. The objects we can embody digitally also we can be operate or monitor it from anywhere in the world. This will help the people to gather more information without going to the location. In this project we bring a new direction for integrating the IOT for the green environment by cleaning the waste automatically.

2. PROPOSED ARCHITECTURE USED FOR SMART WASTE MANAGEMENT SYSTEM

Design of smart waste management system is as shown in Fig.1,

The coordinator node manages multiple Routers and the End device nodes. The whole system consist of three parts, they are the Coordinator node, the Router or End device sensor node and the web server design. The radio transceiver is linked to



both the Coordinator node and End device sensor node. It will transmit the garbage bin data from coordinator node to End device sensor node. The wireless communication here we use is based on the ZigBee protocol which uses 2.4 GHz wireless link. The web server is designed on Raspberry Pi for monitoring the status of the waste bin. We use any devices which have the capability to access the web service. Here for monitoring the data we use PC, laptop, smartphone etc. It also sends the complete contact information for all the authorities, which Includes the full mailing address, the telephone numbers, fax numbers, and e-mail addresses.

a) Raspberry Pi

In this paper we use as the controller for the coordinator node. Raspberry Pi is the small, inexpensive minicomputer that enables people of all ages to explore computing, and to learn how to program in languages. It's job in this paper is it continuously collects the informations send by the sensor nodes via ZigBee, and it will process the large

quantities of data timely and is available for users to view at the instant. It is the core of the whole system.

b) End device sensor node

Sensor node we use here is to sense the level and odor of the waste bin. It finds both the processes of the whole system. It is designed using Arduino UNO board based on microcontroller Atmega 328. It consists power supply unit, ZigBee protocol based radio transceiver, level sensor (ultrasonic) and gas sensors (CO₂, H₂S, NH₃, Methane etc). Also there is data logger used for the temporary storage attached to it. It will sense the garbage bin parameters typically each time one-minute intervals and send back the acknowledgement to the coordinator node via the ZigBee wireless communication protocol.

c) ZigBee

The ZigBee is the wireless transmission of data which uses low amount of data for the transmission. It defines the layers of network layer, physical layer, and controlling layer are used for the media access, while ZigBee protocol is used to work on the network layer and the application layer.

d) Database and web server

In our proposed system we designed the database based on MySQL which is installed on Raspberry Pi. MySQL is one good choice of database in the web applications. MySQL which uses Oracle is the Relational DataBase Management System (RDBMS). It is also an open source software. Database stores the parameters and informations send by a sensor node in it with time. It also sends the information to the web page also for monitoring the system

e) Ultrasonic

The Ultrasonic sensors here we use are to detect the level of the waste bin. There is three ultrasonic sensors will be placed at each angle of 120 degrees from each other so that the whole area of the waste bin can be covered. The waste bin have a protecting box at the top center where the ultrasonic sensors

will be placed. According to the size of the waste bin the range of the Ultrasonic sensor will change. Considering all the parameters, including size, things on it, the specifications of the ultrasonic sensors can be implemented.

f) Load cell

The Load cells are placed at the 4 corners of the waste bin in the bottom. The load cell can be used as a secondary sensor. If there is any problem in the ultrasonic sensor, it will not send the output to the municipality. In this situation we can use this as a backup plan. The load cells are good for the keeping of the sensor which we can use it as the secondary storage.

g) Gas sensors

The Gas sensors here is used to detect the odor of the garbage bin. Sometimes even before filling of the garbage in the bad smell from the garbage bin will get ruin the place. To avoid this situation we fix the gas sensor. The gas sensor detect the level of gas in the garbage box, and then it will compare the odor of the gas with the threshold value feed on the system. If there is any deviation as the value is more than the threshold value, then that message will be sent to the municipality through the communication sensor. Thus the municipality can rush to the place and clean up the garbage bin and save the place from the bad smell that may ruin the place.

3. WASTE MANAGEMENT SYSTEM OPERATION

We use the public waste bin for the system to apply. Here we are using alert system to aware the municipal corporation to remove the waste from the waste bin because of two reasons. One is the waste bin is full and the other one is the odor from the bin is too much. By this alert the municipal cooperation

can take quick action and remove the waste from the waste bin.

The waste bin we use is fixed with three types of sensors. They are Ultrasonic sensor which is used as level sensor, another one is load sensor and the last is ZigBee Transceiver. The ultrasonic sensor is fixed on the top of the waste bin and four load sensors also kept near to that. The signal from the load sensor is converted by the analog to digital converter. The analogue to digital converter will convert the analogue signal it received to the digital signal. The converted digital signal is then transmitted to the node sensors. The node sensors send the digital data to the communication protocol. From the communication protocol it is sent to the ZigBee wireless communication protocol. These all are inside the arduino microcontroller.

When the waste bin is full the sensors will get sensed and a message will be sent to the municipality. Otherwise there is another thing that continuously happens is for every one minute the sensors will send the status of the waste bin. Thus the municipal people can be know the level of the waste bin for every one minute interval. We can reduce or increase the interval time period. There is another one sensor which is used to know the level of the odor of the waste bin. This sensor will send the information of the level of the odor in the waste bin. When the odor of the waste bin become too much because of the degrade of the degradable wastes inside the waste bin, then the message will be sent to the municipality by the sensors in it automatically.

Here the two sensors will not send the same data simultaneously because the ZigBee sensors we use consist of the collision detection. Thus the ZigBee will prevent the simultaneous same messages. Thus this avoidance of the simultaneous messages will help to avoid the annoying the municipal office by getting repeated messages

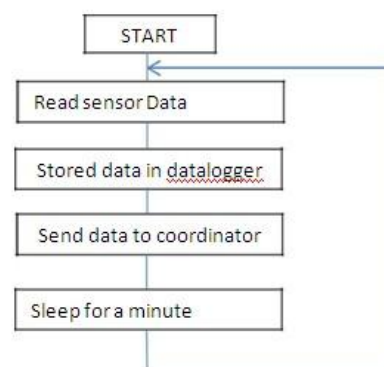


Fig.3. End device sensor node flowchart

4. EMBEDDED SYSTEMS

The Embedded system is the combination of the software components and the hardware components. The embedded system consists of the microprocessor to the microcontroller. The microprocessor is used to feed a program for some multipurpose while the microcontroller consists of an inbuilt microprocessor which can be used for a single purpose only. The embedded system is most important now a days, because the most common usage things now we use are all embedded systems. For example, from the watches to the traffic signal light and heavy weight machineries in the manufacturing sectors is used by the embedded system.

In the embedded system there should be a microcontroller or a microprocessor. Both are needed to be programmed by the programmers. The microprocessor we program can be reused as for the another one purpose too. Because what we need is the erasing of the old program and rewrite another program for the microprocessor. The microcontroller can be used for a single purpose for what we decide for. If we want to change, we need to change the whole components inside the microcontroller. The embedded system can be a whole system or the small

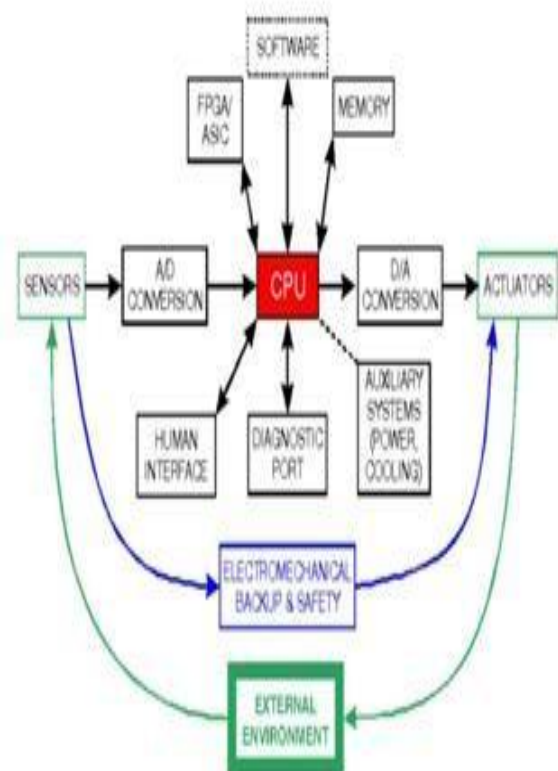
part of a whole instrument. The embedded system consist of the internal storage memory and RAM inbuilt into it. Also the embedded system is the user interfaced system used to interface with the human interaction. Here we have the part to debug the system. The real time computer is used to feed the program and debug the program inside to, also it can monitor the whole processes inside the embedded system. The Internet of things can be used to link with the embedded system very easily.

a) Embedded systems functions

- Embedded systems takes the data from the input sensors and process, it will make the user-friendly the result.
- The Embedded systems generate the comments feed inside it and transmit the commands to the users
- The Embedded system is used to work on the real time system without any delay on it.

b) Block diagram of an embedded system:

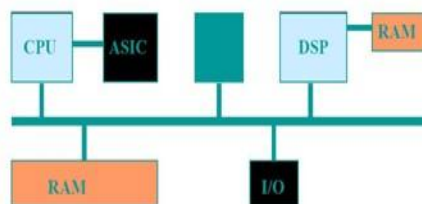
An Embedded system consist of the software part and the hardware part. The main part of the embedded system is the CPU in it. The embedded system here consist of digital interface microwaves, VCRs utilize embedded systems. Thus it will get the software and the hardware system in the



The combination of the software system and the hardware system should match each other otherwise the command we given to the system will not work in the system. The characteristics of the embedded system are the single functioned system, tightly constrained, reactive and real time.

Heterogeneous Architectures

The Embedded system usually have the Heterogeneous Architecture. It is the combination of certain components. The software and the hardware are combined to form the embedded system. The figure given below shows the block diagramed representation for the heterogeneous architecture of the embedded system.



Control of physical systems

hardware components, sensor, input and output components. In the electronics we use either a microprocessor or a microcontroller, we don't use

The embedded system is used to control the system because it is used to monitor the environment directly. The embedded system is very useful for the development and study of the environment around it. Thus the embedded computer is used to take the control of the system. The embedded system designers must be so careful while selecting the components, power, mechanical, network, and digital hardware with corresponding software.

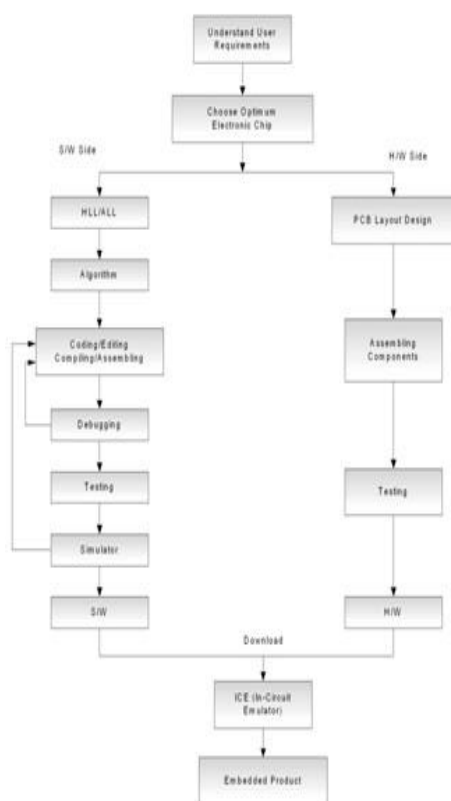
5. DESIGN OF EMBEDDED SYSTEM

The Embedded system have the design cycle. The flow diagram of the system is given below in the block diagram. From starting of the project to the ending of the fabrication design, we should consider about the software consideration and the

a) CLASSIFICATION

- The Real Time Systems.
- RTS will respond to the events within the specified deadline.

both the microprocessor and microcontroller in the same kit.



- The right answers which are produced after the dead line should be considered as a wrong answer
- There is also the Real Time System classification
- The Hardware Real Time Systems

The Software Real Time System

Thus the kit for the IoT based garbage management system using the arduino UNO is implemented and taken out the output. The system works in the real time and the output is taken out by the message received from it. The pictorial representation of the kit used for the alert system is given above. The arduino is fixed in the bottom right corner. The alarm message is sent by the ZigBee in the kit.

6. CONCLUSION

Thus the embedded based smart garbage system by the intelligence alert system is devised for proper monitoring and maintenance of the garbage. The new system will avert the irregular cleaning of the municipal waste bin by sending alert to the concerned individuals at regular intervals.

7. FUTURE SCOPE

As the internet is spreading faster in every small part of the world, internet of things can make the things digitized, the scope from the project is that by providing knowledge of internet and its uses for rural people we can make village smart by providing these features like smart garbage management, digital water supply, and intensity controlled street light, etc. In our paper we are using raspberry pi which is a small computer, it can provide many functions the project as it will be upgraded in the future and which is low cost and powerful devices. Displaying the agriculture related things helps to uneducated people to get know about facilities given by the government to them. E-learning improves and provides standard

education to village student and it will bring them from imaginary to real environment.

8. REFERENCES

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