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GARBAGE E-MONITORING SYSTEM

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Abstract— **Many-a-times the garbage bins located at some significant position get filled up completely, and yet concerned authorities aren't aware of the event. Additionally, the garbage collector has to make unnecessary trips to collect garbage from the bins which aren't completely filled. This isn't a cost effective method of garbage collection. To avoid this situation, we came up with an idea of an E-Monitoring System for smart garbage collection. The garbage bins are facilitated with ultrasonic sensors, attached to a NodeMCU Unit. The unit has an inbuilt Wi-Fi module, which regularly sends the garbage level status from the associated bins over the web browser. Additionally, an email notification is also sent as soon as the garbage level cross a threshold value, say 90% of the total depth of the bins. The project aims to reduce the human effort for garbage collection, whilst the statistical representation of data collection provides a prototype for future research and learning.**

Keywords— **Garbage Collection, IoT, Smart City**

I. INTRODUCTION

The Internet and its applications have become an integral part of today's human lifestyle. It has become an essential tool in every aspect. Due to tremendous demand and necessity, researchers went beyond connecting just computers into the web. These researchers led to the birth of a sensational gizmo, Internet of Things (IoT). Communication over the Internet has grown from user – user interaction to device-device interaction these days. The IoT concepts were proposed years back but it's in the initial stage of commercial deployment.

Since most of the process is done through the internet, we must at least have an active internet connection throughout the integration process. The technology can be simply explained as a connection between human-computer-things.

Garbage Monitoring is deeply centered on basic human interaction. Today, despite living in the era of internet and intelligence, the majority of the people have not utilized hands-on benefits from it. There are a huge number of employees deployed across different parts of the city for garbage collection and monitoring, and yet in a lot of occasions, the management fails to deliver the best service. In past years waste collection was treated in a rather static approach, nowadays with the proliferation of sensors and actuators, IoT enable dynamic solutions as well[1]. Specifically, only in [2] and [3], it is addressed the waste collection as a problem which can be solved with IoT infrastructures; incorporated with Smart Cities.

Garbage E-Monitoring is helpful to as many people using the service, from a local consumer to the Municipal Office responsible for garbage collection of the entire city. Currently, existing methods produce results that are robotic, the output which is beyond knowledge to a consumer with no prior knowledge in related fields.

A Smart City is a city well performing in a forward-looking way in the following fundamental components (i.e. Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance), built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens. Our research into existing methods in garbage monitoring system has led to providing a prototype for future research and enhancements. Whilst, there is still room for improvement in efficiency, we set ourselves the following objectives: Smart garbage collection

The system discusses the technical solutions and best practice to embark the deployment of an electronically insulated Smart City. Smart Cities is the future of civil habitation since by

2050 the vast amount of earth population (i.e. 70 percent) will move to urban areas thus forming vast cities [4]. These cities will incorporate smart infrastructure in order to manage their need for fundamental and advanced services [5].
In the era of big data and artificial intelligence, this project upon completion thereby provides a prototype for future research and practice in environmental management and monitoring with the usage of cost efficient, easily controlled and expandable devices.

II. PROPOSED ALGORITHM

A. Related Work –

On an abstract level, several components of our system can be viewed as:

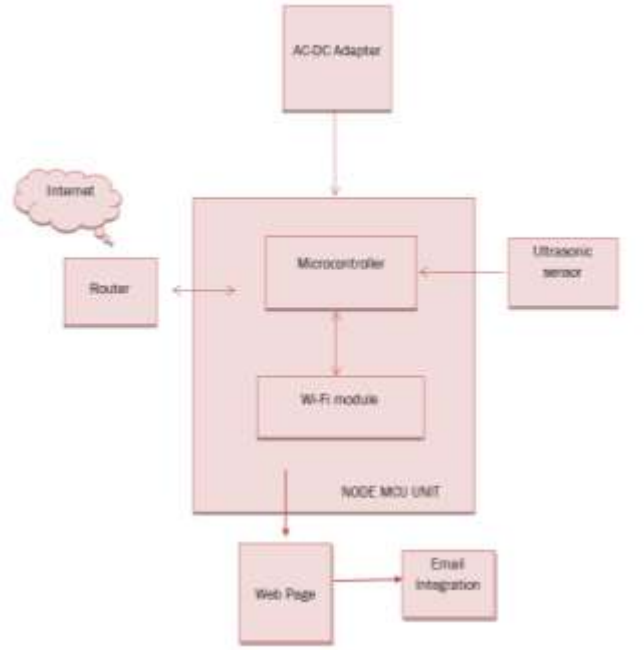

Fig. 1. System Architecture

Our first task is to blend the ultrasonic sensors with the garbage bins and enable the Wi-Fi Module to communicate with the underlying system.

The input to the sensor module would come from the waste bins which are places at different localities in the public area. The sensor is placed in a garbage bin at a maximum level. If the level is crossed by the garbage in the garbage bin, then the sensor will sense that and will communicate to the ARM 7vcontroller. When, if suppose garbage 1 is full the ultrasonic sensor attached to its lid will detect the level and send a command, the received command will show the condition of the garbage box over the computer.

The message would be that the garbage 1 in particular area is filled completely, please collect it. At the same time, an email will be sent to drivers; saying that the particular garbage bin is completely full. The same thing will happen when the garbage box 2 becomes full; the ultrasonic sensor will detect the level and send a command, the receiver attached will receive that command and will display that on computer stating the garbage bin 2 in another area is filled completely, please collect it. At the same time, a similar email will be sent to a driver's side to collect the garbage bins.

B. Hardware Architecture –

NodeMCU Unit:
ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

Fig. 2. A sample model of NodeMCU Unit

When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements:

1. 802.11 b/g/n protocol
2. Wi-Fi Direct (P2P), soft-AP
3. Integrated TCP/IP protocol stack
4. Integrated TR switch, balun, LNA, power amplifier and matching network
5. Integrated PLL, regulators, and power management units
6. +19.5dBm output power in 802.11b mode
7. Supports antenna diversity

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8. Power down leakage current < 10uA
9. Integrated low power 32-bit CPU could be used as application processor
10. SDIO 2.0, SPI, UART
11. STBC, 1×1 MIMO, 2×1 MIMO
12. A-MPDU & A-MSDU aggregation & 0.4□s guard interval
13. Wake up and transmit packets in < 2ms
14. Standby power consumption of < 1.0mW (DTIM3)

CPU:
This chip embeds an ultra-low power Micro 32-bit CPU, with 16-bit thumb mode. This CPU can be interfaced using:

- Code RAM/ROM interface (iBus) that goes to the memory controller, that can also be used to access external flash memory,
- Data RAM interface (dBus), that also goes to the memory controller
- AHB interface, for register access, and JTAG interface for debugging

General Purpose I/O:
There are up to 16 GPIO pins. They can be assigned to various functions by the firmware. Each GPIO can be configured with internal pull-up/down, input available for sampling by a software register, input triggering an edge or level CPU interrupt, input triggering a level wake-up interrupt, open-drain or push-pull output driver, or output source from a software register, or a sigma-delta PWM DAC.

These pins are multiplexed with other functions such as host interface, UART, SI, Bluetooth coexistence, etc.

Power Consumption:
ESP8266 has been designed for mobile, wearable electronics and Internet of Things applications with the aim of achieving the lowest power consumption with a combination of several proprietary techniques. The power saving architecture operates in 3 modes: active mode, sleep mode, and deep sleep mode.

By using advanced power management techniques and logic to power down functions not required and to control switching between sleep and active modes, ESP8266 consumes less than 12uA in sleep mode and less than 1.0mW (DTIM=3) or less than 0.5mW (DTIM=10) to stay connected to the access point.

Other Components Description:
ESP8266 onboard processing and storage capabilities allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, which includes the power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

Sophisticated system-level features include fast sleep/wake context switching for energy efficient VoIP, adaptive radio biasing for low-power operation, advanced signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

III. Experiment and Result

After appropriate blending of ultrasonic sensors with the garbage bins and the NodeMCU Unit, the performance of the system was analyzed. The level of garbage in the bins can be viewed as:

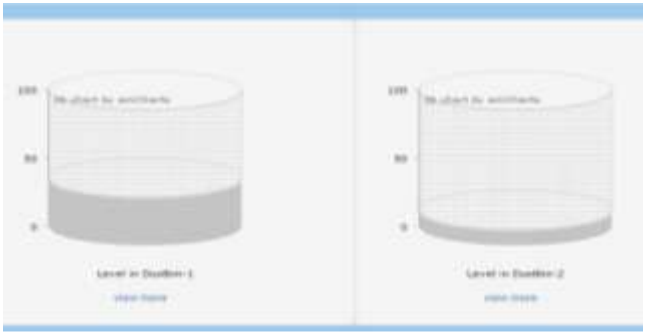

Fig. 3. Garbage Bins Status

With an aim for future research work and learning, every individual bin were facilitated with their own recordings, as mentioned below:

Fig. 4. Individual Bin Status

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To facilitate the system with a user-friendly interface, a graphical representation of the garbage collection statistics is also made available using best-fit JavaScript Library.
The statistical representation can be viewed as:

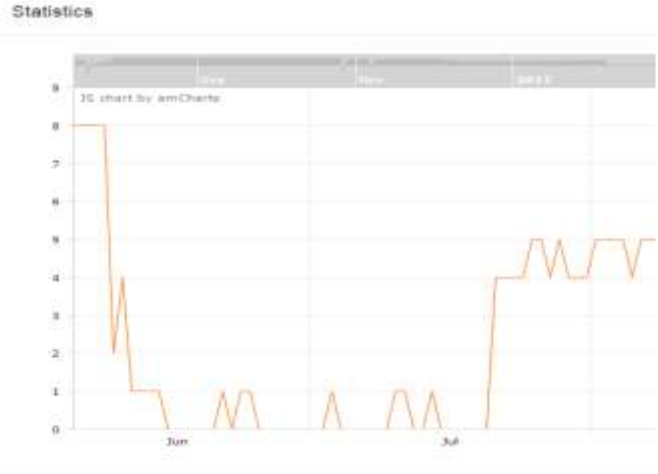

Fig. 5. Graphical record to bin level

On the back end, a timer of 8 seconds was pre-setup which keeps on refreshing after the given interval to facilitate a new level of the garbage bins. At any point in time, the level in the bins was found to be:

		record_no	bin1	bin2
Copy	Delete	2803	5	10
Copy	Delete	2804	5	10
Copy	Delete	2805	7	10
Copy	Delete	2806	6	10
Copy	Delete	2807	7	10
Copy	Delete	2808	22	10
Copy	Delete	2809	5	10
Copy	Delete	2810	14	10
Copy	Delete	2811	8	10
Copy	Delete	2812	8	10

Fig. 6. Back-end record for garbage level in each bin

A separate email notification was also delivered as soon as the garbage bin reach cross a given threshold:

From: **E-garbage Monitoring System** <E_Garbage_Monitoring_System@mail.com>
Date: Monday, December 5, 2016
Subject: Alert..!Bin is Full
To: hegdevasanth1995@gmail.com

Hello, Alert..The bin is running out of space. Hurry to clear them. Happy cleaning. :)

Fig. 7. Email notification regarding bin status

IV.CONCLUSION

This project is the implementation of smart garbage management system using IR sensor, microcontroller, and Wi-Fi module. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduces the total number of trips of garbage collection vehicle and hence reduces the overall expenditure associated with the garbage collection. It ultimately helps to keep cleanliness in the society. Therefore, the smart garbage management system makes the garbage collection more efficient. Such systems are vulnerable to the plundering of components in the system in different ways which need to be worked on.

Difficulties Encountered:

- We initially started with the Arduino and ESP8266 module, but the module was very unstable, and thus we faced a lot of difficulties in sending the sensor data to the web page.
- A lot of settings were enabled and the code snippets were regularly modified so as to enable accepting data from external hardware.

Future Work:
Smart dustbin helps us to reduce the pollution. Many times garbage dustbin is overflow and many animals like dog or rat enter inside or near the dustbin. This creates a bad scene. Also, some birds are also trying to take out garbage from the dustbin. This project can avoid such situations by collecting garbage from the bins before they are completely filled. And the message can be sent directly to the cleaning vehicle instead of the contractor's office. Furthermore, the project also facilitates the usage of Statistical representation of data, which

provides a prototype for future research and practice in waste management.

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