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IoT Based Automated Smart Waste Management System

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ABSTRACT

With increase in population we have an increase in the garbage around urban areas. Here we propose a smart dustbin that operates automatically to help solve this issue using IOT and sensor based circuitry. Usual dustbins require to be opened by pressing foot against its lever and then throwing garbage. Also a person needs to keep track when it is full so that it can be emptied and does not overflow. Here we propose a smart dustbin that does all this by itself. Our system consists of a sensor in order to detect human clap signal and on a clap of foot tap it opens automatically without anyone needing to press its lever. The dustbin opens automatically when it receives the signal and closes its hatch. Also the dustbin consists of a level sensing ultrasonic sensor that constantly measures the level of garbage in the bin and automatically detects if it is about to fill up. The dustbin now consists of a smart circuitry that transmits this information over the web to signal the main garbage collector of the facility to empty the particular garbage bin. We use IOT to develop the online web part for the IOT system. This bin is of a vast usage in offices, homes and even in public places for garbage management. Thus, we get a fully automated smart dustbin that allows for automated garbage cleaning. This makes them well aware of the existing garbage level and instigate them whenever the bins reach the threshold level. They are sent with alert messages so that they can collect the garbage on time without littering the surrounding area. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field. Thus, smart waste management provides us with the most optimal way of managing the waste in an efficient manner using technology.

Keywords : IoT, Arduino Uno Board, GSM Modem, Ultrasonic Sensor.

I. INTRODUCTION

In the recent decades, Urbanization has increased tremendously. At the same phase there is an increase in waste production. Waste management has been a crucial issue to be considered. The main part in cleanliness is the garbage collection system that has to be smarter. In addition to this the people need easy accessibility to the garbage disposing points and garbage collection process has to be efficient in terms of time and cost in terms of fuel. In the present situation, the Garbage collection in the Indian cities is mostly manual where all the workers need to go to location where garbage list dropped by the citizens, and they need to collect it with some equipment. This system is automated now. The smart cities in India are developing with the fast rate in many respects such as smart homes, connectivity with world by roads, rails and airways, use of information technology etc. However, there is need to improve the garbage collection and disposal in smart cities. The present paper discusses the various issues with existing garbage collection systems and the novel approach to improve the garbage collection using Automated Robotic Dustbin

This project is a way to achieve this good cause. In this paper, smart bin is built on a microcontroller based platform Arduino Uno board which is interfaced with GSM modem and Ultrasonic sensor. Ultrasonic sensor is placed at the top of the dustbin which will measure the stature of the dustbin. The threshold stature is set as 10cm. Arduino will be programmed in such a way that when the dustbin is being filled, the remaining height from the threshold height will be displayed. Once the garbage reaches the threshold level ultrasonic sensor will trigger the GSM modem which will continuously alert the required authority until the garbage in the dustbin is squashed. Once the dustbin is squashed, people can reuse the dustbin. At regular intervals dustbin will be squashed. Once these smart bins are implemented on a large scale, by replacing our traditional bins present today, waste can be managed efficiently as it avoids unnecessary lumping of wastes on roadside. Foul smell from these rotten wastes that remain untreated for a long time, due to negligence of authorities and carelessness of public may lead to long term problems. Breeding of insects and mosquitoes can create nuisance around promoting unclean environment. This may even cause dreadful diseases.

II. RELATED WORK

F. Annie Lincy,T. Sasikala, Smart Dustbin Management Using IOT and Blynk

At present, population rate in the main cities has increased tremendously. This has increased the production of waste. The management of huge volume of waste has become more difficult and challenging. The public dustbins are overflowing and have become nobody's concern. Due to the lack of responsibility of the corporation people, the overflowing garbage wastes have created unhygienic surroundings and foul smell. So, to overcome this issue, smart dustbin is designed. This smart dbuilt on Arduino Uno board and is interfaced with GSM, GPRS and sensors. The sensors are used to check the threshold level of the dustbin. The threshold levels are already set. If the garbage hits the mentioned threshold level, continuous alert is sent to the respective authority until the garbage is recovered and the externally fixed LED is changed into red color. Once, the garbage from the bin cleared the LED changes to green color. This alert system is triggered by the sensors to the GSM modem. A time limit (say 24 hours) is given to respective authority, where if he/she fails the duty, the alert to the higher authority is sent. By this facility, the higher authority will be able to take action on the irresponsible workers. Features like maps are used to locate the dustbins which make the authority to reach the location easily. Connectivity among the dustbins is given to establish communication among the bins and provides smart system. Thus, the implementation of smart dustbins

will create a hygienic society and will make the management of waste easy. The negligence of authorities and the public may be reduced. A clean and disease free environment can be created.

Mohammad Abbas Hussain,Kvs Nikhil, Koppuravuri Yaswanth Pavan Kalyan, IoT Based Smart Dustbin Monitoring With Tracking System Using ATMega 2560 Microcontroller

India is rapidly developing country in the world. As a growing economy it is important to manage its waste. In India on an average 64 million tons of detritus is produced which ranks 5th in global scenario. Now a days in many localities garbage is thrown arbitrary and roads are seen with full of litter. These unplanned things causes many problems sometimes it may cause hazardous diseases. It necessitates a management system that will curb this issue and has a complete observation on the detritus. The intention towards this paper mainly focused on the monitoring and tracking of garbage present in our ambience. In addition to that the data is sent into IOT based cloud platform for real time monitoring. After reaching the end value of garbage in the dustbin the alerts are sent directly to the municipal corporation through GSM module. If any fire occurs in the dustbin, it will get alert through buzzer.

Nowadays, waste management is one of the problems on which millions of dollars are spent worldwide. the key issue in waste management is waste collection and sorting. Also, one of the issues in the waste management is that the garbage bin at public places gets overflowed in advance before the commencement of the next cleaning process. This, in turn, leads to various hazards such as bad odor & ugliness to that place which may be the root cause for the spread of various diseases. To tackle this problem, we propose the IOT enabled dustbins in this paper. these bins, use RFID tags for tracking of the wastes linked with a web-based online system and according to the weight of waste added, host server calculates the points and updates in the database of virtual wallet. Also, it measures the fullness of the dustbins and updates the status of each dustbin on the municipal server. It notifies them when the dustbin is full and provides the shortest route to empty all the dustbins based on the capacity of the municipal waste loading vehicles. The Capacity of trucks is calculated and updated each time according to the number of dustbins serviced by the trucks, as soon as it completes a route assigned to it. Furthermore, the user is assisted in material waste classification through our application and also the smart bin knows its content and can report back to the rest of the recycling chain about its contents. Our system, target two crucial problems, cost efficiency in waste sorting and waste collection processes.

Description:

In recent times, waste management problem has become a crucial challenge for Bangladesh, which is having a detrimental impact on the environment. This paper presents the proposition of designing a smart dustbin similar to an Automated Teller Machine (ATM) along with an intelligent embedded system, which has been dubbed as Automated Teller Dustbin (ATD). An efficient convolutional neural network (CNN) based image classifier is developed, which is able to detect and recognize any object regarded as garbage by analyzing training features. Additionally, it can also count the number of labeled objects and assign a price value to each object. The waste brought by any individual to the ATD will readily be recognized by the image classifier and the recycle value, which has been assigned for that object can be withdrawn by that individual. Therefore, a direct exchange of waste and its equivalent price is possible, which will incentivize people to use our proposed smart dustbin. After the installation cost, the operation and maintenance cost can be gained by recycling the garbage in it. A pre-trained CNN-based model ALexNet has been utilized to train and test the model with a dataset of 20 images for each of the 10 categorized objects collected from different waste management shops in Dhaka,

Bangladesh. The model that has been trained for object recognition has attained an accuracy of 96%, which bears testimony to the feasibility of our proposal.

Description:

Internet or net of effects is concerned in every one parts of human life, work, health and social zones, which will importantly affect the prospect development of the worldwide financial society. Internet of Things (IoT) permits association among gadgets utilizing web with the capacity to accumulate and trade data. The net of objects refers to a kind of n/w to link everything with the net based on specific protocols during info sensing tools to perform info substitute & communications in order to complete smart recognitions, positioning, tracing, monitoring, and administration. Recent scientific advance have led to an increase in the carbon footprint. Energy efficiency in the IoT has been magnetize a lot of thought as of researchers & designers above the last pair of years, concrete the way for an emerging area called green IoT.

III. Existing System

The existing waste management systems rely on traditional methods of waste collection, transportation, and disposal. These systems often lack real-time monitoring and data analysis capabilities, leading to inefficient resource allocation and missed opportunities to optimize the waste management process. In contrast, the smart waste management system using IOT leverages the power of technology to provide a more efficient and sustainable waste management solution.

Drawbacks

- Controlling drivers and tracking the fleet is an important issue.
- Network issues.
- Need an admin to be monitored often.
- There would be a chance that the sensors would be broken.
- As with any technology, automated smart waste system can experience technical issue.

IV. Proposed System

- Smart Bins: The system could use smart bins equipped with sensors that can detect when the bin is full and needs to be emptied.
- Real-time monitoring: The system could use real time monitoring to keep track of waste levels, pickup times and other important data. This information can be used to optimize waste collection schedules and routes, reduce costs, and improve efficiency.
- Data analytics: The system could use data analytics to identify patterns and Collection. This information can be used to optimize waste collection routes, identify areas for improvement and reduce waste generation.

Merits

- Less Human Effort.
- It enhances the city vision.
- Helps to reduce pollution.
- Proper monitoring.
- Municipalities can also deploy and maintain smart city infrastructure.
- Low Production cost.

Module Description

A module is a Hardware and software component or part of a program that contain one or more routines.

ARDUINO (ATMEGA 328P)

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The ATmega328/P provides the following features: 32Kbytes of In-System Programmable Flash with

Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6-channel 10- bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and six software selectable power saving modes.

NODEMCU (ESP8266)

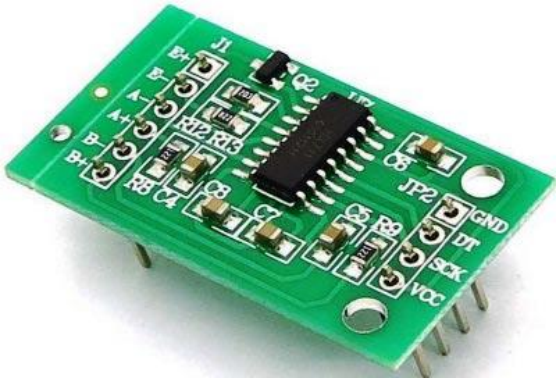
This allows very fast start-up combined with low power consumption. In Extended Standby mode, both the main oscillator and the asynchronous timer continue to run. Atmel offers the QTouch® library for embedding capacitive touch buttons, sliders and wheels functionality into AVR microcontrollers. The patented charge-transfer signal acquisition offers robust sensing and includes fully debounced reporting of touch keys and includes Adjacent Key Suppression® (AKS™) technology for unambiguous detection of key events. The easy-to-use Q Touch Suite toolchain allows you to explore, develop and debug your own touch applications. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core.

SENSORS

A sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes depends upon transducer in its environment and send the information to other electronics, frequently a microcontroller. A sensor is always used with other electronics.

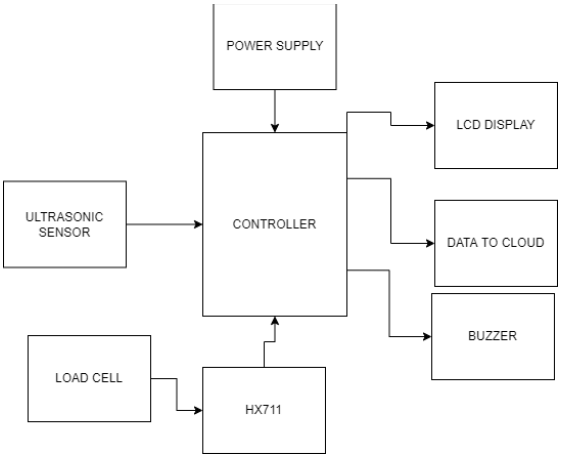
ULTRASONIC SENSOR:

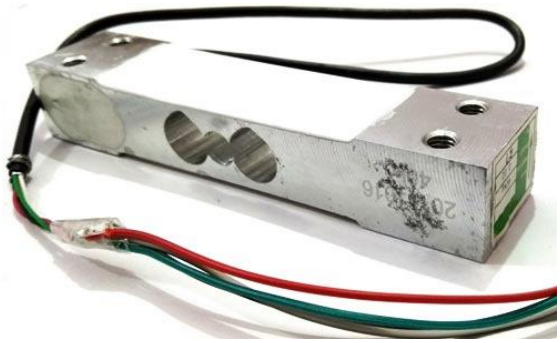
The HC-SR04 Ultrasonic Sensor is marketed as a Ranging Module as it can be accurately used for measuring distances in the range of 2cm to 400cm with an accuracy of 3mm. In order to send the 40 KHz Ultrasound, the TRIG Pin of the Ultrasonic Sensor must be held HIGH for a minimum duration of 10μS.After this, the Ultrasonic Transmitter, will transmits a burst of 8-pulses of ultrasound at 40 KHz. Immediately, the control circuit in the sensor will change the state of the ECHO pin to HIGH. This bin stays HIGH until the ultrasound hits an object and returns to the Ultrasonic Receiver. Based on the Time for which the Echo Pin stays HIGH, you can calculate the distance between the sensor and the object.



Load Cell and HX711 Weight Sensor Module:

The load cell is a transducer that transforms force or pressure into electrical output. The magnitude of this electrical output is directly proportional to the force being applied. Load cells have a strain gauge, which deforms when pressure is applied to it. And then strain gauge generates an electrical signal on deformation as its effective resistance changes on deformation. A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. Load cell comes in various ranges like 5kg, 10kg, 100kg and more, here we have used Load cell, which can weigh up to 40kg.





Now the electrical signals generated by the Load cell are in few millivolts, so they need to be further amplified by some amplifier and hence HX711 Weighing Sensor comes into the picture. HX711 Weighing Sensor Module has HX711 chip, which is a 24 high precision A/D converter (Analog to digital converter). HX711 has two analog input channels and we can get gain up to128 by programming these channels. So HX711 module amplifies the low electric output of Load cells and then this amplified & digitally converted signal is fed into the Arduino to derive the weight.

H-BRIDGE:

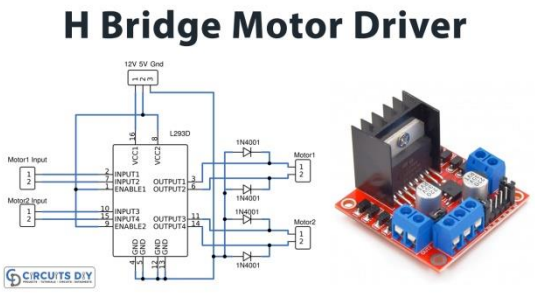
The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoides, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16 lead plastic packaage which has 4 center pins connected together and used for heatsinking The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heatsinking

The L293 and L293D are quadruple high-current half-H drivers. These devices are designed to drive a wide array of inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-

current and high-voltage loads. All inputs are TTL compatible and tolerant up to 7 V. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. On the L293D, these diodes are integrated to reduce system complexity and overall system size. A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0°C to 70°C.

A typical application for the L293 device is driving a two-phase motor. Below is an example schematic displaying how to properly connect a two-phase motor to the L293 device. Provide a 5-V supply to VCC1 and valid logic input levels to data and enable inputs. VCC2 must be connected to a power supply capable of supplying the needed current and voltage demand for the loads connected to the outputs

VCC1 is 5 V ± 0.5 V and VCC2 can be same supply as VCC1 or a higher voltage supply with peak voltage up to 36 V. Bypass capacitors of 0.1 uF or greater should be used at VCC1 and VCC2 pins. There are no power up or power down supply sequence order requirements. Properly heatsinking the L293 when driving high-current is critical to design. The Rthj-amp of the L293 can be reduced by soldering the GND pins to a suitable copper area of the printed circuit board or to an external heat sink.

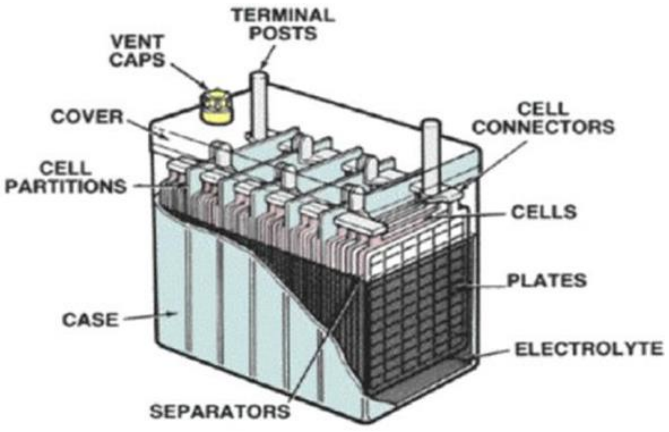


LEAD ACID BATTERY:

Lead acid batteries are the most common large-capacity rechargeable batteries. They are very popular because they are dependable and inexpensive on a cost-per-watt base. There are few other batteries that deliver bulk power as cheaply as lead acid, and this makes the battery cost-effective for automobiles, electrical vehicles, forklifts, marine and uninterruptible power supplies (UPS).

Vented Lead Acid Batteries:

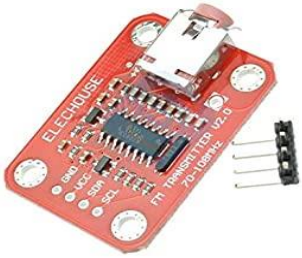
Vented lead acid batteries are commonly called “flooded”, “spillable” or “wet cell” batteries because of their conspicuous use of liquid electrolyte (Figure 2). These batteries have a negative and a positive terminal on their top or sides along with vent caps on their top. The purpose of the vent caps is to allow for the escape of gases formed, hydrogen and oxygen, when the battery is charging. During normal operation, water is lost due to evaporation. In addition, the vent caps allow water and acid levels of the battery to be checked during maintenance.



RF 433MHz Transmitter/Receiver

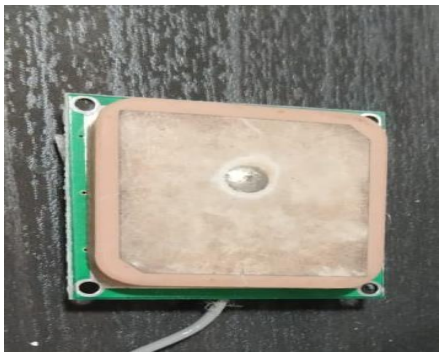
Throughout this tutorial we'll be using the FS1000A transmitter and corresponding receiver, but the instructions provided also work with other 433MHz transmitter/receiver modules that work in a similar fashion. These RF modules are very popular among the Arduino tinkerers and are used on a wide variety of applications that require wireless control.

These modules are very cheap and you can use them with any microcontroller (MCU), whether it's an Arduino, ESP8266, or ESP32.



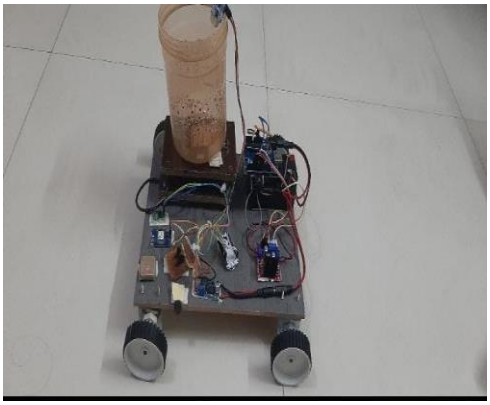
GPS LOCATOR:

GPS tracking is useful for all types of waste management system. GPS devices are often used to monitor trash trucks, street sweeping vehicles, and other city maintenance vehicles. Additionally, waste management fleet managers use GPS tracking to locate other available vehicles in the event that a truck breaks down.

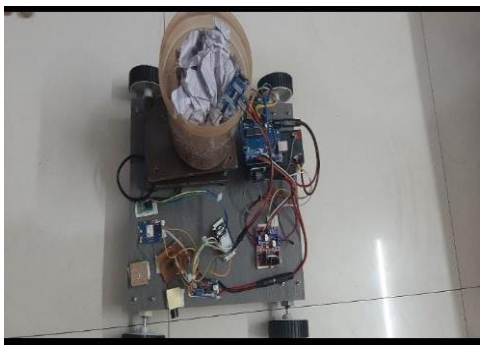


V. Results and Discussion

Empty status



Filled status



Smart waste management systems can use sensors and image recognition technology to identify and segregate metal and non-metal waste. This can be done at the source of the waste generation, such as in homes, offices, or industrial facilities, or at the collection point.

VI. CONCLUSION AND FUTURE WORK

It thus emphasizes on the feasibility of the prototype to be put into mass production pertaining to its simplicity in design and low production cost. The Smart Dustbin aims to improve the garbage collection system and its disposal at appropriate time across the country.

The features of VCAD include, garbage level sensing, and dynamic mobility will mreduce the human efforts required to collect the garbage in comparison to the conventional methods. There are still some shortcomings such as the problem of foul odour, manual control which restricts the mobility of the dustbin which can be addressed into the future versions of the dustbin.

VII. FUTURE WORK

Metal and Non metal

The use of smart waste management systems for metal and non-metal waste can help reduce the amount of waste sent to landfills, conserve resources, and promote sustainable waste management.

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