# SMART TRASH CAN

PROJECT REPORT

Submitted in the partial fulfilment of the requirements

for the award of the degree of

**BACHELOR OF TECHNOLOGY**
**IN**
**COMPUTER ENGINEERING**


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# CERTIFICATE

This is to certify that the dissertation/project report entitled "**Smart Trash Can**" is an authentic work carried out by Mr. **Wajahat Ansari** and Mr. **Md. Mahtab Alam**.

The work is submitted in the partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Engineering under my guidance. The matter embodied in this project work has not been submitted earlier for the award of any degree or diploma to the best of my knowledge and belief.

**Date: 21/12/2016**

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# ABSTRACT

The concurrent effects of a fast national growth rate with large and dense residential areas and a pressing demand for urban environmental protection create a challenging framework for waste management. The complexity of context and procedures is indeed a primary concern of local municipal authorities due to problems related to the collection, transportation and processing of residential solid waste. In order to design and implement a suitable urban solid waste system, the first task is to forecast the quantity and variance of solid waste as it relates to residential population, consumer index, season, etc. We present a waste collection solution based on providing intelligence to trashcans, by using an IoT prototype embedded with sensors, which can read, collect, and transmit trash volume data over the network.

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CHAPTER 1

# INTRODUCTION

We are currently experiencing a fast development of smart cities where engineers, urban planners, architects and city managers are joining forces with the goal of boosting up the efficiency of municipal services and increasing benefits and convenience to their communities [1]. In this case, efficiency may be related to a wide spectrum of factors such as quality of life, economy, sustainability, or infrastructure management. Information and communications technology (ICT) has been highlighted as one of the key enablers for smart cities regardless of the context or specific goals of each individual service, application or action under this umbrella [2].

Smart cities have been identified as a promising potential application domain for the Internet of Things, with a wide range of possible services that can benefit city administration and citizens alike [3]. One service that can be provided in a smart city is smart waste management. Overflowing garbage bins have been another cause of concern for residents in developing countries. With increase in population, the scenario of cleanliness with respect to garbage management is degrading tremendously. With the already prevailing diseases, the open containers are proving to be a breeding place for germs. Traditionally, municipalities operate on weekly routes to pick up trash and recyclables on designated days, regardless of whether the containers are full or not.

Public trash cans detract from the surrounding environment when they are full for long periods of time. On the other hand, it can be an expensive operation to send garbage trucks to every trash can in the city; if cans are empty, the journey accomplishes nothing. Cities develop rough algorithms for minimizing cost of various municipal services such as collecting trash, but Internet of Things sensors can improve these services by notifying relevant public works officials when particular trash cans are full [4].

In this project, we describe how we tried and succeeded to build a system tackling the above problems and how will it help the community by keeping the trash cans from overflowing and reducing the overall garbage collection cost.

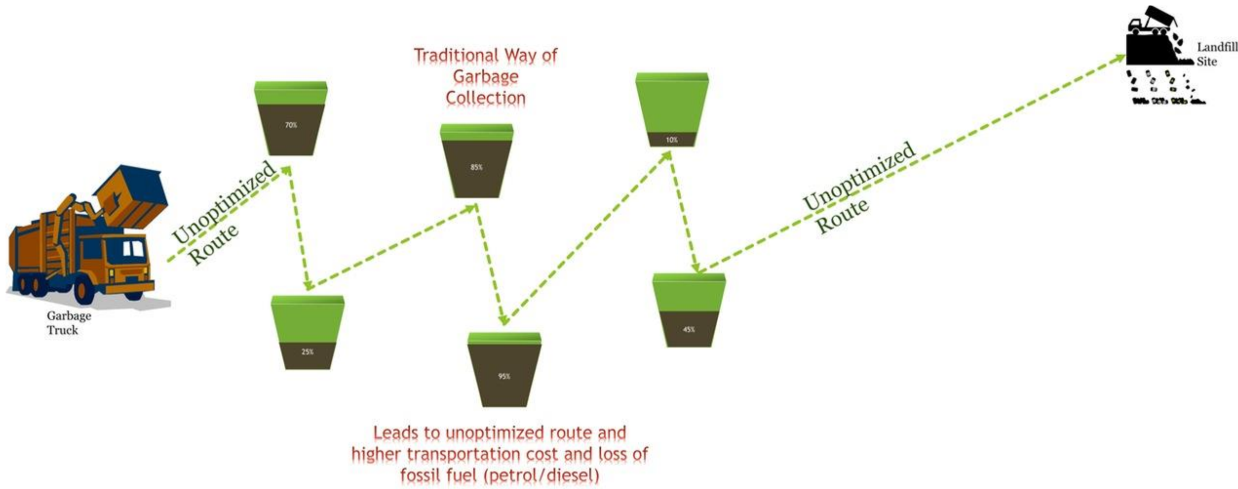


Fig. 1.1: Traditional way of garbage collection

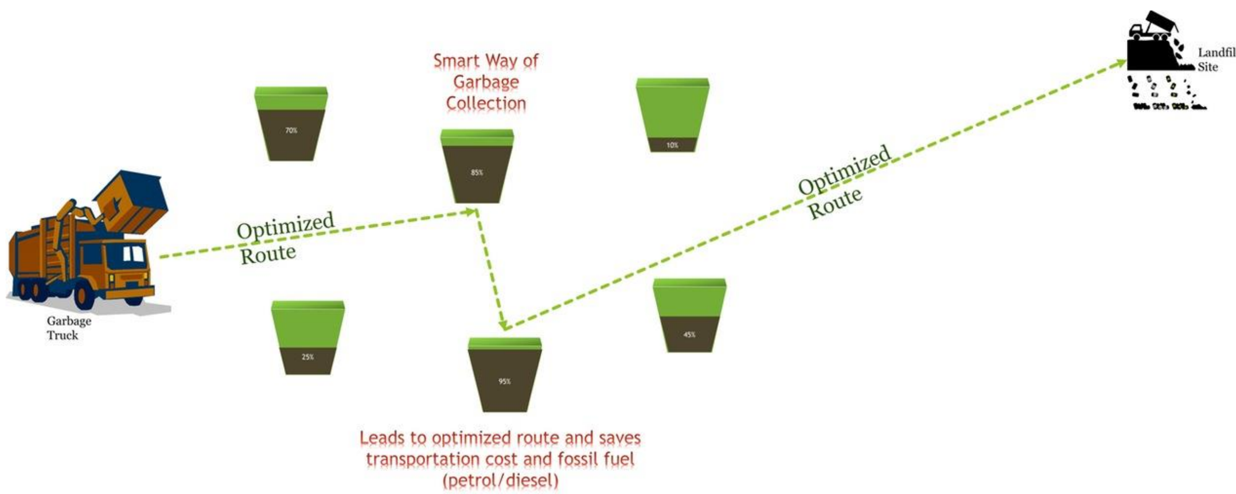


Fig. 1.2: Smarter way of garbage collection using sensor

CHAPTER 2

# INTERNET OF THINGS

The Internet of things (IoT) is the internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society." The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid, and expanding to the areas such as smart cities.

"Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring.

As well as the expansion of Internet-connected automation into a plethora of new application areas, IoT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems.

The concept of the Internet of Things was invented by and term coined by Peter T. Lewis in September 1985 in a speech he delivered at a U.S. Federal Communications Commission (FCC) supported session at the Congressional Black Caucus 15th Legislative Weekend Conference.

CHAPTER 3

# HARDWARE COMPONENTS

## 3.1 Arduino Uno Microcontroller Board

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

The project's board designs use a variety of microprocessors and controllers. These systems provide sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. The microcontrollers are mainly programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2005 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

An Arduino board consists of an Atmel 8-, 16- or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which let users connect the CPU board to a variety of interchangeable add-on modules termed shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an $I^2C$ serial bus—so many shields can be stacked and used in parallel. Before 2015, official Arduinos had used the Atmel megaAVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants). An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external chip programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, optiboot bootloader is the default bootloader installed on Arduino UNO.

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available.

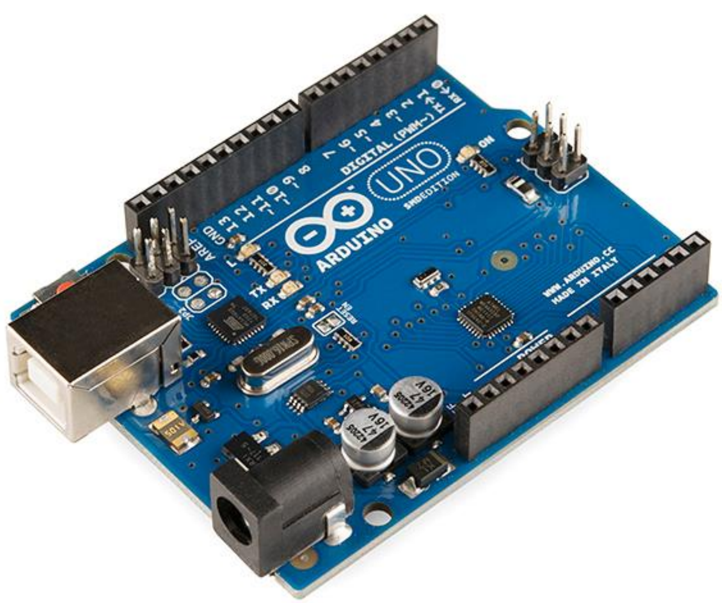


Fig. 3.1: Arduino Uno Board

## 3.2 Ultrasonic Sensor (HC-SR04)

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:
(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz signals and detect whether there is a pulse signal back,
(3) If the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = High level time × velocity of sound (340 m/s) / 2.

The pins on the sensor are:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- Ground


Fig. 3.2: Ultrasonic Sensor (HC-SR04)

## 3.3 U-blox Neo-6M GPS Module

U-blox is a Swiss company that creates wireless semiconductors and modules for consumer, automotive and industrial markets. They operate as a fabless IC and design house. Using their portfolio of chips, modules or software solutions it's possible to create subsystems and products to fulfill needs for the Internet of Things (IoT), M2M or Car2Car (or Vehicle to Vehicle) solutions quick and cost-effectively.

U-blox develops and sells chips and modules that support global satellite navigation systems (GNSS), including receivers for GPS, GLONASS, Galileo_(satellite_navigation), BeiDou and QZSS. The wireless range consists of GSM-, UMTS- and CDMA2000 and LTE modules, as well as Bluetooth- and WiFi-modules. All these products enable the delivery of complete systems for location-based services and M2M applications (machine-to-machine communication) in the Internet of Things, that rely on the convergence of 2G/3G/4G, Bluetooth, Wi-Fi technology and satellite navigation.

The U-blox Neo-6M collects the location, date, time and motion information from the multiple satellites. The data received by the module is transferred to the Arduino board through serial communication.

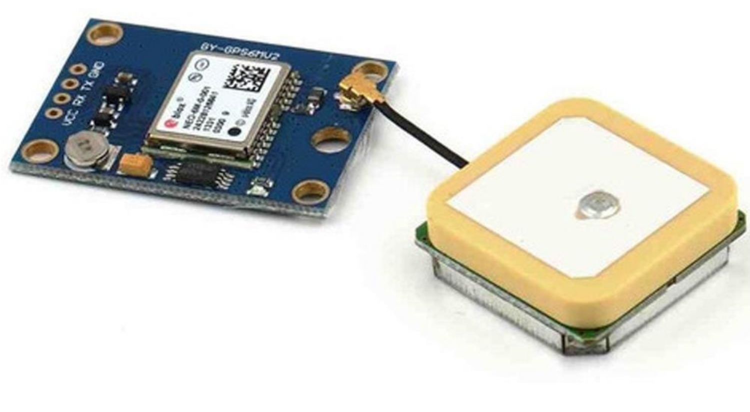

Fig. 3.3: U-blox Neo-6M GPS Module

## 3.4 SIM900A GSM Module

The SIM900A is a complete Dual-band GSM/GPRS module in a SMT type which is designed especially for Chinese market, allowing you to benefit from small dimensions and cost-effective solutions.

Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900A can fit almost all the space requirements in your applications, especially for slim and compact demand of design.

The SIM900A uses a GSM micro SIM card for network connectivity. It can operate on power input of 9 - 12 V. The module also has a microSD card slot to store the data received. It is compatible with the AT cellular command interface.

Fig. 3.4: SIM900A GSM Module

CHAPTER 4

# LITERATURE REVIEW

Kunzmann K.R., [1] "Smart Cities: A New Paradigm of Urban Development". The paper discusses the concept of Smart City as a still fuzzy one. Smart City is in the making by those who promote it as a chance to improve the quality of life, or use it to demonstrate their commitment to a better life in modern cities, and to sell their products and services. As a slogan, it has become the new paradigm for those who wish to use or sell new information and communication technologies for better, more livable cities. There is, however, also a slightly darker side of the Smart City concept, that is not much the access to this technology, but rather the extreme dependency on technology, and on corporations dominating technology and related services.

Komninos, N., [2] "Intelligent Cities: Innovation, Knowledge Systems, and Digital Spaces". The book discusses about the environment of innovation, and the major models for creating an environment supporting technology, innovation, learning, and knowledge based development. The book mainly focuses on the Western Coast of USA, Japan and Europe.

A. Zanella et al., [3] "Internet of Things for smart cities". The paper describes an IoT system architecture for Smart Cities, and analyzes solutions available for the implementation of urban IoTs. It also tells how the Internet of Things (IoT) shall be able to incorporate transparently and seamlessly a large number of different and heterogeneous end systems, while providing open access to selected subsets of data for the development of a plethora of digital services. In this paper, they focused specifically to an urban IoT system that, while still being quite a broad category, are characterized by their specific application domain.

Jose M. Gutierrezet al., [4] “Smart Waste Collection System Based On Location Intelligence”. In this project, they designed a waste collection solution based on providing intelligence to trashcans, by using an IoT prototype embedded with sensors, which could read, collect, and transmit trash volume data over the Internet. They installed and deployed their system in the city of Copenhagen, Denmark. The results indicate that under the same conditions, basing the waste collection strategies on real time trashcan filling status improves the waste collection efficiency by guaranteeing that when trashcans become full, they are collected the same day, and by reducing by a factor of 4 the waste overflow that cannot be accommodated when trashcans are full. However, the distance required to drive is tripled, implying an increment on the daily collection cost between 13 - 25%.

CHAPTER 5

# OBJECTIVE & METHODOLOGY

## 5.1 OBJECIVE

To digitize a trash can by designing an Internet of Things system comprising of sensor, modules and microcontroller such that when the trash can is filled to its highest limit it sends out an alert to the user, which would help in preventing overflow of trash can and providing a better and healthy environment in the planned smart cities.

## 5.2 CIRCUIT CONNECTION

To design the abovementioned system, the following hardware components were required:

- Arduino Uno board
- Ultrasonic sensor
- GPS module
- GSM module

All of the components have been described in detail before.

We first take a trash can which has a lid because the ultrasonic sensor is to be attached at the bottom face of the lid of the trash can. Along with the ultrasonic sensor, a small GPS module is also attached with the trash can. The GPS is used to detect the location of the trash can such that when it is filled, the pickup man has the exact location of the trash can and no time is wasted in looking for it.

We also use a GSM module, which is used to send out the SMS notifications when the trash can is filled completely alerting the user to empty the trash can as soon as possible. The GSM uses GSM SIM card which is inserted in the slot given and receives network through an antenna attached to the module.

All the components, namely, ultrasonic sensor, GPS module and GSM module, are connected to the Arduino Uno board. The sensor and modules are connected through jump wires (males and females) into their corresponding pins. The microcontroller provides power to the ultrasonic sensor and the GPS module but the GSM module runs on external power source because it requires higher power than the microcontroller can provide. The microcontroller itself derives its power from either the computer to which it is connected through the USB cable or from a DC power source. The complete circuit is shown below.

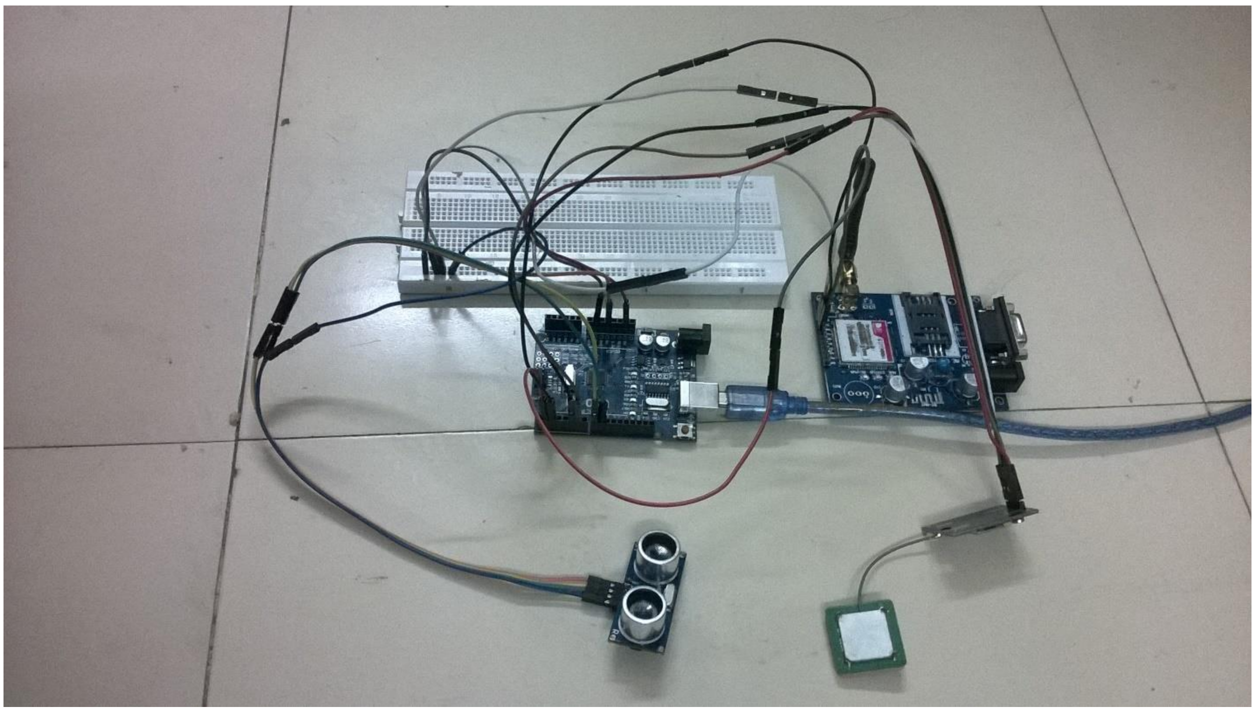

Fig. 5.1: Complete system

## 5.3 PROGRAMMING

We need to program the Arduino accordingly to perform the desired function. The Arduino uses its own programming environment known as Arduino IDE (Integrated Development Environment). It also uses its own programming language which is similar to C and Java. The programs in Arduino are also known as sketch.

The sketch has two major functions, first is **setup()** and second is **loop()**. The program can also have functions additional to these two. The setup() function is used to establish serial connection between the Arduino board and the computer and also between the Arduino board and the modules connected to it; and also for defining functions of the pin connected to external modules. The serial communication is generally done at a baud rate of 9600 bps. The setup() function is run only once at the start of the system.

The loop() function runs infinitely, if not interrupted. It contains most of the portion of the sketch which needs to be run always. In our case, the code to calculate the space left in trash can and the code to receive location of the trash can is embodied in the loop() function. Also, the code to send out SMS notification is in the loop ().

# RESULT

COM4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 30 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 1 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 2 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 2 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 2 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 27 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 26 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 26 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 24 cm |
| 6 | 28.560659 | 77.279029 | 25-11-2016 | 6:20:40 | 0.69 | 670.93 | 24 cm |

Fig. 6.1: Values of latitude, longitude and space left in trash can showing at Serial Monitor

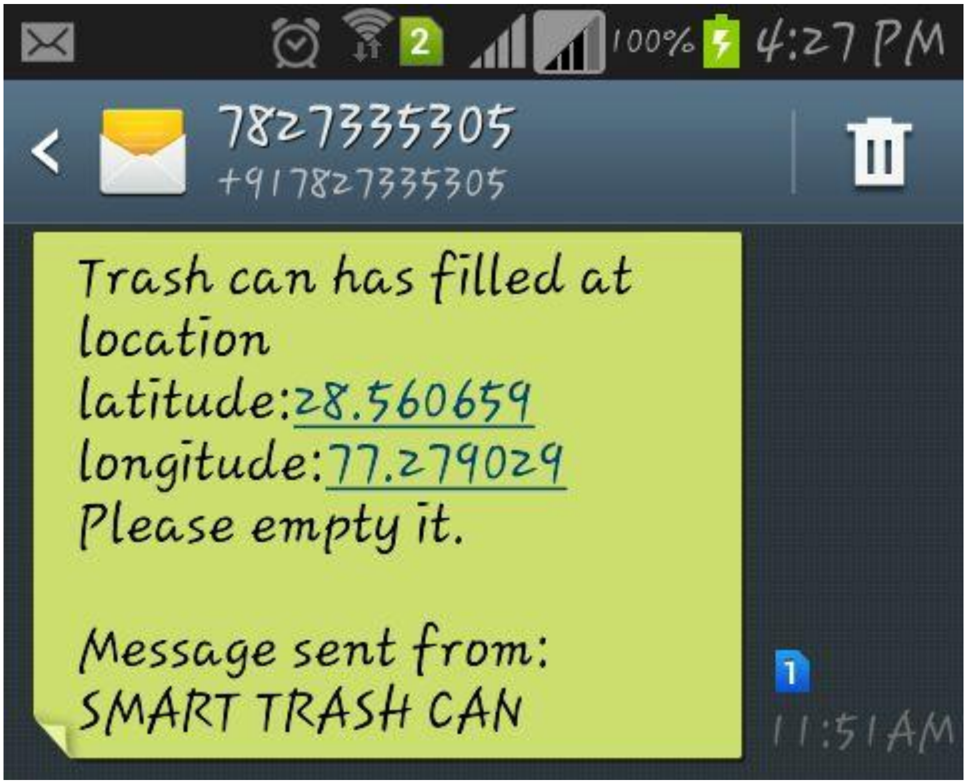


Fig. 6.2: SMS received as notification

# REFERENCES


[1] Kunzmann K.R., Smart Cities: A New Paradigm of Urban Development. Crios, 1/2014, pp. 9-20, doi: 10.7373/77140

[2] Komninos, N., Intelligent Cities: Innovation, Knowledge Systems, and Digital Spaces, 2002, Spon Press

[3] A. Zanella, N. Bui, A. Castellani, L. Vangelista, and M. Zorzi, “Internet of Things for smart cities,” IEEE Internet of Things Journal, vol. 1, no.1, pp. 22–32, Feb. 2014

[4] Jose M. Gutierrez, Michael Jensen, Morten Henius And Tahir Riaz, Smart Waste Collection System Based On Location Intelligence, Procedia Computer Science 61 (2015) 120 – 127

[5] Vicentini F., Giusti A., Rovetta A., Fan X., He Q., Zhu M., Liu B., Sensorized Waste Collection Container For Content Estimation And Collection Optimization, Waste Management, Volume 29, Issue 5, May 2009, Pages 1467-1472, ISSN 0956-053X