

A Review Paper on Air Quality Monitoring using Android Controlled Robot in a Garbage Landfill

*Mrs. Jyoti Wadmare,
Assistant Professor
Department of Computer
Engineering,
K.J Somaiya Institute of
Engineering and IT, Mumbai-22
Email:jyoti@somaiya.edu*

*Ms. Shruti Nair,
Student, Final Year
Department of Computer
Engineering,
K.J Somaiya Institute of
Engineering and IT, Mumbai-22
Email:ssn@somaiya.edu*

*Ms. Siddhi Pota,
Student, Final Year
Department of Computer
Engineering,
K.J Somaiya Institute of
Engineering and IT, Mumbai-22
Email:siddhi.pota@somaiya.edu*

Abstract: This paper, proposes an android based system which will help to identify excess gaseous effluents from the landfill site where domestic as well as chemical waste is dumped without much treatment. The traditional automated monitoring systems which exist are deployed in large setup and are wired and non portable. The proposed system describes an intelligent gas tracking System which is based on android operated system, gives facility to access a larger area quickly on mobile handsets. This system will sense the gaseous effluents from the landfill and if found to be dangerously high, then will raise an alarm and alert the master using android application. This whole system will be controlled by an android environment which will include navigation of vehicle, providing locations of gaseous effluents and alerting the master. Hence this system will prove to be an alternative to human and animal teams engaged in landfill monitoring.

Keywords: Arduino, mobile vehicle, sensor, methane etc.

I. INTRODUCTION

Environmental monitoring is important to protect the public and the environment from toxic Contaminants or dangerous airborne chemicals. Environmental monitoring is often a highly labor-intensive activity and puts the human and animal monitoring teams at a high risk while in a hazardous environment. Therefore, it is important to identify complementary cost effective measures that can help to reduce the impacts of pollution gases. When a potentially dangerous airborne chemical is detected, whether its origin is from an industrial accidental leak or from a landfill, it is necessary to take containment measures to avoid harm to the surrounding environment. However, locating the source of the chemical agent can be very difficult, especially if the chemical is released from an active source. In this case, detecting the source and its neutralization becomes a priority. In such a dangerously hazardous area, the use of animal teams is not preferable. Human teams with hazard suits and detection devices could locate the gas source efficiently, given enough time, but the risk of flammable or explosive chemicals puts them to risk. The use of autonomous robotic teams acting as mobile sensor networks is an alternative way. Wireless sensor networks are novel monitoring tools for small scale

monitoring. Through a wireless network, a large number of tiny sensor nodes can be deployed to a monitoring area.[1] Simple, inexpensive, replaceable mobile units can be deployed in the area of that landfill and trace the chemical's odor plume, finding its source while avoiding any additional risk to human or animal lives. Advanced robotic and measurement technologies have to be largely applied for the need of mobility and autonomy of the environmental monitoring.

II. Existing System

Landfill gas monitoring is a necessary process by which gases that are emitted from landfills are monitored by electronic systems. Landfill gas may be measured as it escapes the landfill called as "Surface Monitoring" or may be measured as it is collected and redirected to a power plant or flare ("Collection System Monitoring") [10].

In order to conduct adequate screening monitoring for landfills with or without monitoring systems, the following equipments are often used:

1. Properly calibrated infrared detector, combustible gas indicator (CGI), flame ionization detector (FID), or an equivalent instrument capable of detecting methane gas at concentrations of 0.5-100.0 percent by volume in air.
2. Plastic tubing and assorted connectors for ensuring airtight connections when hooking up the monitoring instrument to probes.
3. Auxiliary air pump (AP).
4. Tedlar bags or stainless steel summa canisters.
5. Evacuation chamber
6. Magnehelix [11].

To conduct periodic checks on the gaseous emissions from the land pits, the animals and human team with sensing equipments are sent to the field which is hazardous as well as non efficient practice. This also makes the process lengthy and expensive. There is also need for constant maintenance when there is such a huge setup. There is a need to automate all the devices and techniques used in monitoring the gases thus eliminating the need of human and animal teams to venture into the sea of hazards.

III. PROPOSED SYSTEM

The purpose of the proposed system is to automate and regulate the entire process of measuring the gaseous levels of the landfill pits. Often the waste which is dumped in the pit contains domestic as well as industrial waste which has not been treated. Hence the gases that would be emitted may prove to be inflammable also. This system consists of a mobile vehicle which will consist of an Arduino along with sensors mounted on it. This vehicle will be controlled and navigated with the help of the android application which will be handled by the master. As soon as the mobile vehicle senses the gases which are above the threshold level, it will immediately raise an alarm and send the gaseous effluent location to the master via the Android application. This wireless communication is between two systems. One is the device that runs the Android OS, while the second system is the robot with a Bluetooth module attached. On the Android device, the control system to navigate the vehicle is simple and uses an application to control the Bluetooth service on Serial Port Profile (SPP) connection. The application has to be able to send data over Bluetooth module with accordance to the sensors, touch screen, and the application features.

On the robot side, a Bluetooth module connected to the robot controller has to be added. The Bluetooth module is a little device designed to transmit data between peripheral devices. In other words, this little device is able to synchronize the I/O data between the robot and the Android.

A. Architecture of the proposed system

The system is a combination of hardware and software components. On the robotic mobile vehicle there is an Arduino chip and sensors mounted to it. There are also RFID cards which will be used for tracking the location of the gaseous effluents. There will be a driver component to drive the vehicle using Bluetooth navigation controlled using Android. Various sensors which will be mounted would be replaceable depending upon the area where it is used.

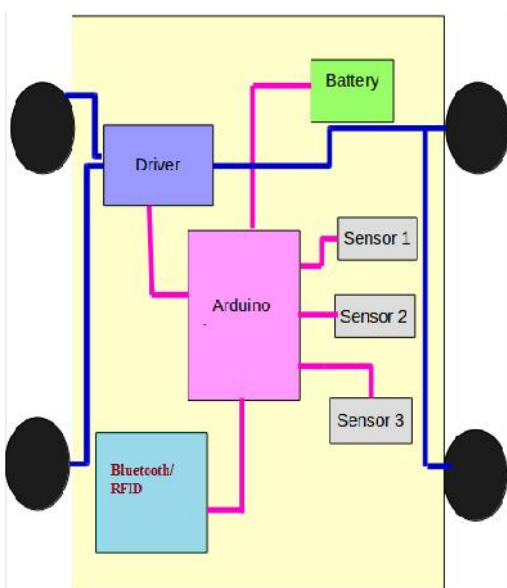


Fig. 1 Overview of hardware of mobile vehicle

This mobile vehicle will be driven around using an android device, but it will only be the navigation part. The main hardware component that drives the vehicle is L293D. It is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. [12]

B. Air sensing application

Arduino microcontroller is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. Arduino projects can be stand-alone or they can communicate with software running on a computer [3]. There are several AVR series of Arduino boards available and we use Arduino Uno microcontroller. For example MQ-4 methane sensor is used to sense the methane in air.

	Parts	Materials
1	Gas sensing layer	SnO ₂
2	Electrode	Au
3	Electrode line	Pt
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al ₂ O ₃
6	Anti-explosion network	Stainless steel gauze (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite

Table: Sensor MQ-4 specification

Sensor will be area specific. The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses. They can be calibrated more or less (see the section about "Load-resistor" and "Burn-in") but a know concentration of the measured gas or gasses is needed for that. The output is an analog signal and can be read with an analog input of the Arduino. MQ-4 sensor has detecting concentration scope: 200-10000ppmCH₄ and natural gas. The standard detecting condition is Temp: 20 degree Celsius and Vc: 5V±0.1, Humidity: 65%±5% Vh: 5V±0.1.

A simple wiring is done to connect sensor to Arduino. We write the program to measure the air quality in the Arduino software. The results can be displayed in the android application using pie chart or bar graph. A landfill gases contains the following gases: Methane, nitrogen, carbon dioxide, oxygen, moisture, other trace species etc. [4]

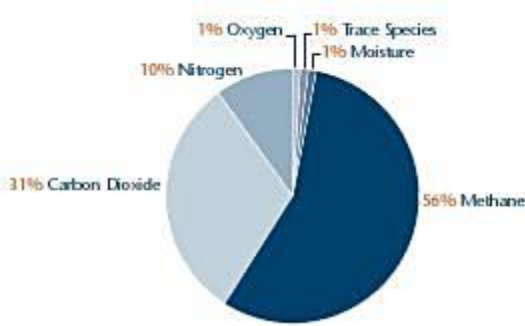


Fig. 2 Contents of a landfill effluent gas

Major component is methane in the landfill effluent gases. So here this project will use this methane sensor as one of its three sensors mounted on the Arduino board. Along with methane many other gases are also present. Hence different types of sensors can be used depending upon the nature of environment.

C. RFID for specifying location

RFID stands for Radio-Frequency Identification. The acronym refers to small electronic devices that consist of a small chip and an antenna. The chip typically is capable of carrying 2,000 bytes of data or less. It provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.[5]An RFID reader is used to read RFID tags (which contain certain unique data stored in a chip). An RFID reader and an RFID tag, both have a coil surrounding them. When an RFID tag is shown near an RFID Reader, it collects the unique tag data (a combination of digits and characters) from the RFID tag. RFID tag is shown near the reader, electromagnetic induction will take place between the coils and this powers the chip inside tag. This chip will send data electromagnetically to the reader. The reader will receive this electromagnetically transferred data and outputs it serially. Every RFID reader comes with Serial output pins. The read data is collected through these serial pins using Arduino. Each RFID tag is a 12 character unique number. We read this 12 characters serially using Arduino. [13] In this system the entire landfill area will be divided in small sectors, when a robotic vehicle will enter that sector it will read the RFID reader and give its location to the master via the Android system.

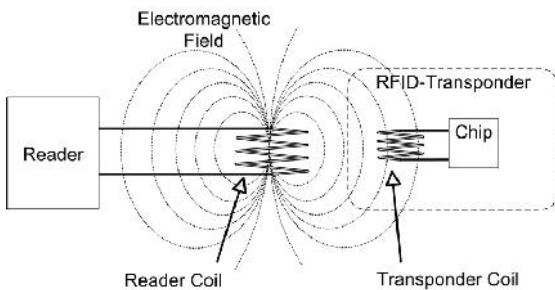


Fig. 3 RFID Working

D. Android application development

This is the final step of our project where the movement of the robot is controlled by the Android application. Android is an open source phone operation system based on Linux platform and it's the first truly open and complete mobile software for mobile terminal. In order to solve the shortcomings of traditional surveillance system, this project proposed a surveillance scheme based on android smart phone, which makes it possible to monitor target site in anywhere and anytime via android smart phone under the coverage of wireless network. [6] To develop it we use the eclipse for coding (java) and Android SDK for development of the apps. In this we write two set of coding. One is Bluetooth adapter coding to connect Bluetooth shield with mobile Bluetooth. And next is sending commands to the Robot to move in user desired direction. [7]



Fig. 4 Representation of the UI in Android

E. System Flow

The android application controlled robot communicates via Bluetooth to the Bluetooth module present on the robot. While pressing each button on the application, corresponding commands are sent via Bluetooth to the robot. The commands that are sent are in the form of ASCII. The Arduino on the robot then checks the command received with its previously defined commands and controls the servo motors depending on the command received to cause it to move forward, backward, left, right or to stop, thus allowing us to create an android controlled robot.

The sensors then sense the gases around in the surrounding and give live updated values to the master through the android UI along with the location. If the gaseous effluents are found to be harmful and above the permissible level the mobile vehicle sends back the alert message to the master with the location of the gas. If no threat detected then the mobile robotic vehicle will move ahead into the next desired sector and repeat all the steps. The gaseous values will constantly be updated. The diagrammatic representation of the above discussion is shown in the adjacent fig 4.

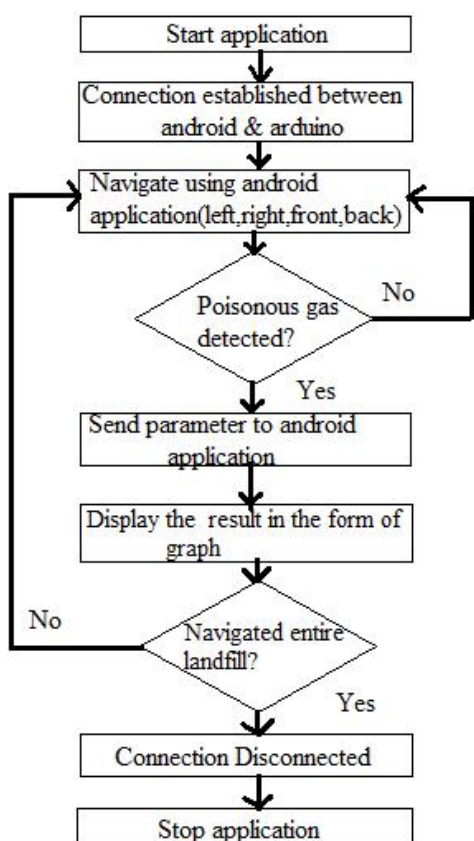


Fig. 5 Flow of the system operation

IV. CONCLUSION

Anaerobic decomposition of organic solid waste in the landfill site produces landfill gas (LFG). LFG mainly consists of methane and carbon dioxide, both of which are odorless. Trace constituents of other volatiles, often malodorous or toxic gases, are also found in LFG. LFG can migrate through soil into structures located on or near landfills. Since methane presents a fire or explosive threat, LFG must be controlled to protect property, public health and safety. There are also E.A. requirements of landfill owners/operators to reduce reactive organic gas emissions to improve air quality. Thus, engineered solutions are needed to efficiently and safely monitor, collect, and process landfill gas. In this paper an automated air monitoring system is explained which is controlled by the Android operating system. The hardware and software components are connected to each other via Bluetooth. The navigation of the vehicle is also done with the help of Android user interface. The mobile vehicle which will have all the hardware components mounted on it, will venture in the landfill area after sensing the gases will send real time values to the android device operated by the master. This project addresses the overall problem of harmful gaseous emissions from the pits of garbage dump. This project aims to facilitate the monitoring of air quality in and around the landfill areas where chemical waste along with domestic waste is dumped. This project will be area specific. This paper proposes an overall effective solution for the need of

elimination of the animal and human teams into coming in contact with the hazardous environment.

ACKNOWLEDGMENT

The project team wholeheartedly would like to thank the Head of Department and staff of Computer Department, K.J. Somaiya Institute of Engineering and IT for their support and cooperation into nurturing of this idea. The team would also like to express gratitude to all the well wishers and experts who have guided us during the formulation of this proposal.

REFERENCES

- [1] Application of a reliable MAC protocol for the urban air quality monitoring system based on the wireless sensor network, Tzu-Shiang Lin March 2012, Orlando, FL.
- [2] Sensor-based Emissions Monitoring System, In Chae Jeong, Oct. 2012, Taipei.
- [3] Maik Schmidt: e-book "Arduino – A Quick start guide", Pragmatic Programmers, LLC, 2011.
- [4] Contents of Landfill gas
<http://greenfieldtechnical.com/resources/flare2.jp>
- [5] RFID definitions
<http://www.technovelgy.com/ct/technology-article.asp>
- [6] Mobile Robot Temperature Monitoring System Controlled by Android Application via Bluetooth: Maria Jenifer, T. S. Vasumathi Priyadharshini, Raja Lavanya & S. Raj Pandian.
- [7] Android based Remote monitoring System, Abhishek Barve Department of Electronic Engineering PIIT, New Panvel, Pragnesh shah Department of Electronic Engineering PIIT, New Panvel.
- [8] A New Architecture of Robotic Sensor Networks for Air Quality Monitoring, Ade Silvia, NyayuLatifahHusni, and SitiNurmaini.
- [9] The Robot control using the wireless communication and the serial communication, JONG HOON AHNN
- [10] Landfill Gas Monitoring information:
https://en.wikipedia.org/wiki/Landfill_gas_monitoring
- [11] Landfill monitoring procedures:
http://www.cce.csus.edu/sites/Calrecycle/leaLandfillGas/docs/2_Landfill_Gas_Monitoring_Procedures.pdf.
- [12] L293D Motor Driver IC:
<http://www.rakeshmondal.info/L293D-Motor>
- [13] Omicron Labs: <https://www.omicron-lab.com>

About Authors:

Jyoti Wadmare is Assistant Professor in K.J Somaiya Institute of Engineering and Information Technology, Mumbai-22. She holds a bachelors degree in Computer Engineering and post graduation degree in Computer Engineering from Vidyalankar Institute of Technology, Mumbai. She has mentored students in subjects like Computer Graphics, Microprocessor, Advanced Microprocessor, Computer Organization and Architecture.



Shruti Nair is a student pursuing her graduation in Computer Engineering from K.J Somaiya Institute of Engineering and Information Technology, Mumbai .Her area of interests include Artificial Intelligence, Android and Robotics.



Siddhi Pota is a student pursuing her graduation in Computer Engineering from K.J Somaiya Institute of Engineering and Information Technology, Mumbai .Her area of interests include Operating Systems, Android and Robotics.