

# **SMART DRAINAGE AND HEALTH MONITORING SYSTEM OF MANUAL SCAVENGER USING IOT**

Submitted in partial fulfillment of the requirements for  
the award of  
Bachelor of Engineering degree in Computer Science and Engineering

by

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**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING  
SCHOOL OF COMPUTING**

## **SATHYABAMA**

INSTITUTE OF SCIENCE AND TECHNOLOGY

**(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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119



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### **BONAFIDE CERTIFICATE**

This is to certify that this project report is the bonafide work of **SUNDARAM ANAND** (17SCS0446) and **SHARMA PANKAJ KUMAR RAMADHIN** (17SCS8087) who carried out the project entitled "**Smart Drainage System and Health Monitoring System Using IoT**" under my supervision from **August 2020 to March 2021**.

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## **DECLARATION**

We **SUNDARAM ANAND AND SHARMA PANKAJ KUMAR RAMADHIN** hereby declare that the Project Report entitled “**SMART DRAINAGE AND HEALTH MONITORING SYSTEM USING IoT**” is done by me under the guidance **Ms.R.Aishwarya,M.E.(Ph.D)**, Department of Computer Science and Engineering at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering.

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## ABSTARCT

Most of the cities adopted the underground drainage system and it's the duty of Municipal Corporation to maintain cleanliness, healthy and safety of cities. If the drainage system is not properly managed then pure water gets contaminate with drainage water and infectious diseases may getsread. Drainage cleaning people are not aware of risk by sudden attack of poisonous gas since the gases are odorless if exposed for long time which may cause serious health problems. Due to the lack of using proper gas leakage detection system, a number of dangerous accidents occurred during the last few decades. To overcome all these problems effective monitoring system is needed in the drainage channels. The detected system is proposed with gas sensors like Carbon Monoxide, Hydrogen sulphide sensors and Methane, one Heart Beat sensor used to Calculate the pulse rate of Human. Carbon Monoxide, Hydrogen sulphide, Methane gases are highly toxic to human hence the proposed system will gives alert through IOT after reaching the threshold level of each gas sensors then people gets alerts Heart Beat sensor will calculate the range of the Pulse rate then output at the abnormal range will give alert through notification through an IoT

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# CHAPTER 1

## INTRODUCTION

As the water supply and sewerage infrastructure built in Japan since the period of high economic growth is now coming due for replacement, work on these upgrades needs to be undertaken in a way that maintains a safe and secure water environment. Meanwhile, with the population of Japan declining, the work needs to be undertaken efficiently, with a limited workforce and severely constrained finances. Against this background, work on monitoring and control systems extends beyond daily facility operation and maintenance to include making good use of the operational technology (OT) data obtained via these systems to resolve the challenges facing the water supply and sewerage infrastructure, and to contribute to the sustainability of the water environment. Furthermore, along with growing possibilities for sensing with the Internet of Things (IoT) in recent years, consideration is being given to using more detailed information and sources such as image data that have not been used as sensing data in the past. This article presents examples of these possibilities in the form of a gateway that makes the OT data obtained by monitoring and control systems available for use on an IoT platform, an optical fiber sensing system for use inside sewage pipes (an application that has been difficult in the past), and the use of images and audio data as new sensing media.

Drainage system plays a very important role in big cities where millions of people live. Drainage system is known as the base for land dryness from the excess and unused water. Rain water and waste water. Drainage conditions should be monitored in order to maintain its proper function. In fact, not all areas have drainage monitoring team. It leads to irregular monitoring of the drainage condition. The irregular monitoring has contribution on the blocking of the drainage that imply to the salutation which trigger flooding in the neighborhood. Manual monitoring is also incompetent. It needs a lot of dedicated persons who are only able to record limited report with low accuracy. The problem arises in such drainage lines can cause serious issues to the daily routine of the city. Problems such as blockage due to waste material, sudden increase in the water level as well as various harmful gases can be produces if the proper cleaning actions are not taken time to time. Today's

drainage system is not computerized due to which it is hard to know if blockage is occurring in particular location. Also sometimes due the waste in those drainage lines can produce various gases like methane ( $\text{CH}_4$ ), carbon monoxide ( $\text{CO}$ ), etc which are harmful and can cause serious problem if inhaled by humans in large amount and these problems are generally faced by the drainage workers due to which death can occurs. Also we don't get early alerts of the blockage or rise in amount of those gases or the increase in water level. Hence detection and repairing of the blockage becomes time consuming and hectic. WSN is a monitoring technology which inhere of node sensors that expanse and integrate use of a wireless network system. Every node consist the data processing (microcontroller, eg - Arduino) memory (program, data, flash memory), NRF transceiver, power supply system and involves one or more sensors. WSN systems have a higher level of precision than wired network system with respect to cost; flexibleness and reliability are expected to replace hybrid or combined technology.

As the water supply and sewerage infrastructure built in Japan since the period of high economic growth is now coming due for replacement, work on these upgrades needs to be undertaken in a way that maintains a safe and secure water environment. Meanwhile, with the population of Japan declining, the work needs to be undertaken efficiently, with a limited workforce and severely constrained finances. Against this background, work on monitoring and control systems extends beyond daily facility operation and maintenance to include making good use of the operational technology (OT) data obtained via these systems to resolve the challenges facing the water supply and sewerage infrastructure, and to contribute to the sustainability of the water environment. Furthermore, along with growing possibilities for sensing with the Internet of Things (IoT) in recent years, consideration is being given to using more detailed information and sources such as image data that have not been used as sensing data in the past. This article presents examples of these possibilities in the form of a gateway that makes the OT data obtained by monitoring and control systems available for use on an IoT platform, an optical fiber sensing system for use inside sewage pipes (an application that has been difficult in the past), and the use of images and audio data as new sensing media.

Effluent around the IoT system and network that detect toxic gases has been developed as a measure to help sanitation staff who risk their life to ensure reduced health hazards due to these toxic contaminants, sanitation employees' death rates have increased over the past few years. After reaching hazardous levels, the lack of proper sewage decontaminating results in the deaths of sewage cleaning staff from injuries and Specific illnesses including influenza and dysentery caused by abrupt yet prolonged harmful gas exposure. Septic pipes are structures commonly found in a variety of locations, ranging from housing areas to mostly industrialized urban areas, providing treatment for waste material diagnosis. Sewage gases are usually the result of decomposition of organic waste products and mixtures of compost that result in assembly of noxious waste which releases lethal gases. Alkane series, small traces of carbonic acid gas, other sulfur dioxide elements, ammonia, hydrogen sulphide , methane and carbon monoxide gas traces are predominantly recognized in septic tank gases. Sensors are used to

measure the quantity of toxic gas detected in the waste product environment and to give a signal. The harmful toxins emitted from the waste product, such as hydrogen sulfide, alkane series and carbon monoxide gas, are detected by gas sensors at each moment and modified until they reach the conventional standard. The paper aims to provide an example for the timely tracking of waste product power station or septic system to keep a watch on the level in gas accumulation. The proposed system will be installed for waste products, both remote and urban, in different locations. In addition to being industrial plants, the system can be created to figure properly in each household through dynamic tiny style specifications. Ubidot IoT platform would be operated from all over the world via the internet for remote monitoring to contamination or toxicity values. This research also recognized the advancement of the Internet of things framework as its main part as the devices for controlling the installation. This approach offers a complex sewer setting solution than before the existing systems that ignored real-time monitoring and shifts in air concentrations of gases and moisture. This is because the flux of waste product water varies greatly over duration and relies on the lot of different things such as filter quality, accumulation of energy and plant disruption. The above approach tracks variables such that every minute evaluation is visible via isolated areas due to electronic monitoring that allows for a firm interpretation of CH<sub>4</sub>, CO as well as

alternative sewage pollutants and even the release through gutters and helps to monitor and efficiently sanitize municipal management, a factor which was lacking from previous solutions.

The world is growing rapidly into smart cities but the problems faced are still the ones from primitives. The modern world has a great need of modern advancements and sophistication in its planning systems. Smart cities need smart solutions where the city's infrastructure is survived by the installation of sensors to the age-old problems. The one such problem is to detect the blockage in the underground sewage system. If this problem is not acknowledged it causes some serious consequences. For initial evaluation the presented system is mounted in a number of strategic sewers. Smart sewage system uses the properties of microprocessors. This reduces the man-effort and also gives quick check over the problem. The system should be able to integrate into normal monitoring/alarm systems so that the sewer variations can be scrutinized.

### **1.1. BACKGROUND OF THE PROBLEM/EXISTING SYSTEM**

Sewage Overflow is a condition in where untreated wastewater is discharged from a sanitary sewer or drainage system into the environment prior to reaching sewage treatment facilities. It generally caused by heavy rainfall and it is also known as wet weather overflow. It is primarily adequate in developed countries, which have extensive waste water treatment facilities. This overflow water form stagnant pools over the roads. We can see people wading over this overflown road till the municipal services are done. These services are not done immediately because of the delay in passing the information to the municipality corporation. Frequent causes of sewage system overflow are: Sewer lines get blocked sometimes. Inflow of excessive storm water into sewer lines during heavy floods and broken drainage channels.

### **1.2 OBJECTIVES OF PROPOSED WORK**

The major objectives of the work are listed below: Smart and Clean cities by efficient management system Continuous detection of drainage water level and blockages in the sewer lines Monitor water flow rate continuously, as well as sending automatic mail, display on the LCD To obtain a low-cost is the main objective and flexible solution for monitoring with a good condition.

### 1.3 DESIGN OF SYSTEM

Smart Sensors and ARM based Drainage monitoring System implantation is discussed below. The core unit of this system is ARM7. The ARM7 processor is programmed to sense the sewage water level and blockage. Attached gas sensors give the early report if any gas leakage by alert message or sound by buzzers.

### 1.4 Background

The Future Internet goal is to provide an infrastructure to have an immediate access to information about the physical world and its objects. Physical objects can be applicable to different application domains, such as e-health, warehouse management, etc. Each application domain may have different types of physical devices. Each physical device can have its own specifications, which is required to use in order to interact with it. To achieve the future Internet goal, a layered vision is required that can facilitate data access. Internet of Things (IoT) is a vision that aims to integrate the virtual world of information to the real world of devices through a layered architecture.

The term „Internet of Things“ consists of two words, namely *Internet* and *Things*. *Internet* refers to the global network infrastructure with scalable, configurable capabilities based on interoperable and standard communication protocols. *Things* are physical objects or devices, or virtual objects, devices or information, which have identities, physical attributes and virtual personalities, and use intelligent interfaces [1]. For instance, a virtual object can represent an abstract unit of sensor nodes that contains metadata to identify and discover its corresponding sensor nodes. Therefore, IoT refers to the *things* that can provide information from the physical environment through the Internet.

Middleware is as an interface between the hardware layer and the application layer, which is responsible for interacting with devices and information management [2]. The role of a middleware is to present a unified programming model to interact with devices. A middleware is in charge of masking the heterogeneity and distribution problems that we face when interacting with devices [3].

### 1.5. IoT definition

In this section, we explain some of the IoT definitions. Also, we explain the layered architecture for IoT.

Internet of Things (IoT) has increasingly gained attention in industry to interact with

different types of devices. IoT can have influence on industry and society by integrating physical devices into information networks [8]. IoT impacts can be on different perspectives, namely for private and business users. From the perspective of a private user, IoT has effect on both working and personal fields, such as smart homes and offices, e-health and assisted living. From the aspect of a business user the impacts would be in fields such as automation and industrial manufacturing, logistics, business process management, intelligent transportation of people and goods [9]

IoT integrates physical things into information networks. IoT covers the overall infrastructure, including software, hardware and services, which is used to support these information networks. The integrated physical things can exchange data about the physical properties and information that they sense in their environment. To identify devices, we can use identification technologies like for example RFID, which allow each device be uniquely identified [10].

International Telecommunication Union (ITU)<sup>1</sup> defines IoT as “A *global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies*”[11]

- Access Gateway layer

This layer is concerned with data handling, and is responsible for publishing and subscribing the services that are provided by the *Things*, message routing, and hovelling the communication between platforms.

- Middleware layer

This layer has some critical functionalities, such as aggregating and filtering the received data from the hardware devices, performing information discovery and providing access control to the devices for applications.

- Application layer

This layer is responsible for delivering various application services. These services are provided through the middleware layer to different applications and users in IoT-based layer.

Drainage is the system or process by which water, sewage or other liquids are drained from a place and to maintain the proper function of drainage, its condition should be monitored regularly. But manually it is very difficult to monitor all area where a human cannot reach. This influences the blockage of underground pipes and overflows of water cause the health problem. To mitigate all these issues here we are developed and implemented the system using wireless sensor network. It consisting of small devices used to collect data. These sensing devices are called node. The proposed system is low cost, less maintenance, long life and web-based real time system, which update the municipal officer by text message when any manhole crosses the threshold value. This system directly impacts on the health issues of citizens and worker who cleans the underground drainage. It also avoids spreading of infection due to mosquitoes and gives clean and healthy environment as well as controls the diseases such as malaria, dengue, diarrhea, etc. The system reduces the accident caused by an exposed manhole.

Drainage system plays a very important role in big cities where the population is very large. In most of the cities the drainage management system is monitored manually which is incompetent and needs a lot of persons who are only able to record limited report with inefficient accuracy, also it becomes inconvenient for the government persons to detect the accurate location of the manhole which is facing issues such as blockage arising due to unwanted waste materials, abrupt increase in the level of water as well as various toxic gases such as methane, carbon monoxide, etc if the proper cleaning actions are not taken time to time and these gases are harmful and cause severe problems to human health if inhaled in large quantities. Most of the drainage systems are not computerized due to which it is hard to know if the blockage is occurring in particular location and also the early alerts of the blockages are not received, hence detection of the blockage and its repair becomes time-consuming. Such problems can cause issues in the daily routine of the city. The system also explains various functions that are used for the purpose of monitoring of the underground drainage system, monitoring the water level, rate of flow of water as well as the content of the toxic gases. If there is a blockage in the drainage system and sewage starts overflowing through it then it can be detected by the sensor system which is interfaced to the microcontroller and this information is sent to the respective authority via GSM (Global System for Mobile)

## CHAPTER 2

### LITERATURE SURVEY

#### 2.1 USING INTERNET OF THINGS IN MONITORING AND MANAGEMENT OF DAMS IN SERBIA

**Author:** Rastko Martać<sup>1</sup>, Nikola Milivojević<sup>1</sup> , Vladimir Milivojević<sup>1</sup> , Vukašin Ćirović<sup>1</sup> , Dušan Barać<sup>2</sup>

This paper discusses harnessing Internet of Things in monitoring and managing dams in Republic of Serbia. Large dams are of major importance, primarily because of their use for electricity, but risks which are associated with it should be greatly taken into account. There is a need to consolidate information related to dam facilities in order to use them for dam management in the Republic of Serbia. An information system has been developed based on the existing systems, allowing utilization of intelligent network sensors. The aim of the paper is to describe possibilities of the Internet of Things application within a specific system for dam safety management. In order to facilitate the inclusion of a large number of intelligent sensors, a new data acquisition module for communication with sensors in the monitoring network is defined. The system should provide on time alerting in case security parameters deviate from the expected values.

Yash Narale et al. [1] published the Underground Drainage Monitoring System using IOT which describes the need of the smart underground infrastructure to keep the city clean, safe and healthy. The system makes use of ARM 7 microcontroller which collects the information from all the sensors which are interfaced to it and the obtained results are sent as early alerts to the government persons through GSM and the location of the manhole is identified using GPS. Since GSM is sending the alerts along with which the location can also be sent, hence there is no need of using GPS as it requires an extra power supply. Gaurang Sonawane et al. [2] proposed a Smart Real-Time Drainage Monitoring System using the Internet of Things. The system makes use of microcontroller Atmega 328 which collects the information through a gas sensor, level sensor, and blockage sensor. The monitoring system checks the status of the manhole and detects if there is a blockage between the two

manholes and also senses the rise in the concentration of various toxic gases. The system is not the most efficient way of monitoring the drainage because it does not make use of the overflow sensor which detects the overflow of the sewage. Prof. S. A. Shaikh L et al. [3] published Monitoring Smart city Applications using Raspberry Pi based on IOT which describes monitoring of peculiarity of the resources in the city to improve the development of the city.

## **2.2: Network Traffic Classifier with Convolutional and Recurrent Neural Networks for Internet of Things**

**Author:** Manuel Lopez-Martin ; Belen Carro ; Antonio Sanchez-Esguevillas ; Jaime Lloret

A network is an important part of current network monitoring systems, being its task to infer the network service that is currently used by a communication. The detection is based on a number of features associated with the communication for example, source and destination ports and bytes transmitted per packet. NTC is important, because much information about a current network can be learned and anticipated just by knowing its network service. This is of particular interest for the management and monitoring of Internet of Things networks, where NTC will help to segregate and behaviour of heterogeneous devices and services. In this paper, we present a new technique for NTC based on a combination of deep learning models that can be used for IoT.

Many cities across the world are facing drainage system problems despite the use of technology and cost-effective solutions. The underground drainage system has its own limitation. The two main most pointed limitations are poor maintenance and contaminating water bodies. Poor maintenance is generally related to difficulty in identifying leakages. The main cause of leakage is clogging. High pressure due to excess clogging can lead to minor leakage which in turn cause a major breakage in drainage pipe. Replacing a drainage tile is yet another a difficult process. Expelling water-cherishing trees, for example, pear, stick oak, willow, delicate maple and cottonwood, from inside 100 feet of the pipe will keep your pipe from blockages brought about by fallen leaves, branches and congested roots originating from these trees. Ochre for instance, an iron oxide that can square deplete pipe, may likewise

develop and in this manner, there is a steady need to lookout for it. Then again, drainage systems can likewise add to defilement issues, particularly when not appropriately kept up. Subsurface drainage systems can help nitrate through the drain pipes, diverting it straightforwardly into the waterways, for example, lakes, waterways and streams. Upon clogging, the drainage water will face penetration and in case of excess clog in the pipe, the water does not penetrate. This can cause increase in the level of drainage water and thereby causing overflow. It could lead to hefty cost for manpower and resource for replacing. Therefore, the process of identifying a blockage in underground drainage pipe still remains a tiresome and time-consuming process if done manually that is by using traditional methods. The Internet of Things (IoT) consists of real-life objects and communication devices attached to sensor networks in order to provide communication and actions between real world and information world. Various methods using IoT and prior studies have been proposed for the same for improvisation for drainage systems. The advancement objective of Smart city is to screen the nature of asset in the city to improve great administration and quicker advancement of the city expects need to overhaul sound and safe urban areas that conveying continuous administrations and most recent office to actualize the idea of brilliant city use IoT idea by which simple remote correspondence is conceivable. Prof. S A. Shaikh et al [3] have proposed Monitoring Smart City Applications utilizing Raspberry PI Based on IOT. The framework comprises a lot of sensors which gather various sorts of information from sensors and move to the Raspberry Pi3 controller. At that point yield from the controller is sent to the control room through the E-mail and furthermore show on the PC. Yash Narale et al [4] has proposed Underground Drainage Monitoring System Using IoT by using flow sensor, level sensor, temperature sensor and gas sensor to detect flow rate of water with respect to speed, the level of liquids and other fluids, temperature in Celsius, and to sense CO concentration in air respectively. It traces location utilizing GPS and send SMS through GSM. This venture speaks to various methodologies of the usage and configuration capacities for checking and overseeing underground drainage system and gives a depiction of water wise system and detection method to detect leakage defects in sewer pipeline. To beat the restricting components of human entered information, and to accomplish cost, precision and simplification factors, IoT appeared on the grounds that, without human connection, PCs had the option to get to information from objects and

devices. In regard to this, Muragesh et al [5] proposed Automated Internet of Things for Underground Drainage and Manhole Monitoring System for Metropolitan Cities. The IoT comprises of real-life objects and communication devices attached to sensor networks so as to give correspondence and computerized activities between real world and information world. Sensor Network is a key empowering influence for IoT worldview and represents the implementation and design function of an Underground Drainage and Manhole Monitoring System (UDMS) for IoT applications [4-5]. This structure incorporates factors, for example, minimal effort, low upkeep, fast deployment, and a high number of sensors, long life-time and high caliber of service. The model of proposed framework gives a system to observing the water level, atmospheric temperature and pressure inside a manhole and to check whether a manhole cover is open. The complaints regarding overflow of sewage water is not properly answered or taken into account. To solve this issue, Sumathy et al [6] has developed Sewage Level Maintenance using IOT which provides a system design includes a sensor to sense the level, a controller to command, a communication network to register the complaints on blockage and continues increase in the level of sewage. The system simply monitors the level and provokes alarm signals via complaints to the required departments through mail and SMS prior to overflow. Recent studies demonstrated that storm water coagulates into sewer system and causes sewer overflow problems. Storm Water Management Model (SWMM) is examined by Hussein et al [7] for reenacting precipitation driven stream in a sewer framework that could cause flood in sewer systems.

### **2.3: An Integrated System for Regional Environmental Monitoring and Management Based on Internet of Things**

**Author:** Shifeng Fang ; Li Da Xu ; Yunqiang Zhu ; Jiaerheng Ahati ; Huan Pei ; Jianwu Yan ; Zhihui Liu

Climate change and environmental monitoring and management have received much attention recently, and an integrated information system is considered highly valuable. This paper introduces a novel IIS that combines Internet of Things, Cloud Computing, Geoinformatics, and e-Science for environmental monitoring and management, with a case study on regional climate change and its ecological effects. Multi-sensors and web services were used to collect data and other

information for the perception layer; both public networks and private networks were used to access and transport mass data and other information in the network layer. The key technologies and tools include real-time operational database; extraction–transformation–loading; on-line analytical processing and relational OLAP; naming, addressing, and profile server application gateway application software for different platforms and tasks.

## **2.4: Design and Application of Water Environment SCADA for Tuojiang River**

**Author:** Yin Kuang; Yong Zhang

To protect the water environment of Tuojiang River, a supervisory control and data acquisition system was designed as three-tier structure: monitoring station, central station, and control & management centre. In monitoring station, data from survey instrument were transmitted to computer system through RS-232. Because of geographical and economic conditions, there were several different plans for data transmission between monitoring station and central station. A classic one was based on MOTOROLA SCADA, mainly including MOSCAD-M RTU, MOSCAD FIU, and MDLC. Usually Internet connects central station and control & management center. To draw concise and accurate conclusions of water pollution, factor analysis method was used to process the original data by statistical program for social sciences. According to the results, the accumulative contribution rate of 6 common factors accounts for 94.053%, including most information of 14 original indexes. It proves that at present total inorganic nitrogen, total phosphorus, and organic pollutants mainly pollute the water of Tuojiang River. So the work of protection should focus on industrial pollution, agricultural irrigation, and domestic sewage. The system has been applied for 2 years and it has been proved that the reliability, accuracy and real-time performance can be used as needed.

Drainage system plays a very important role in big cities where millions of people live. Drainage system is known as the base for land dryness from the excess and unused water. Rain water and waste water. Drainage conditions should be monitored in order to maintain its proper function. In fact, not all areas have drainage monitoring team. It leads to irregular monitoring of the drainage condition. The irregular monitoring has contribution on the blocking of the drainage that imply to the

salutation which trigger flooding in the neighborhood. Manual monitoring is also incompetent. It needs a lot of dedicated persons who are only able to record limited report with low accuracy. The problem arises in such drainage lines can cause serious issues to the daily routine of the city. Problems such as blockage due to waste material, sudden increase in the water level as well as various harmful gases can be produces if the proper cleaning actions are not taken time to time. Today's drainage system is not computerized due to which it is hard to know if blockage is occurring in particular location. Also sometimes due the waste in those drainage lines can produce various gases like methane ( $\text{CH}_4$ ), carbon monoxide ( $\text{CO}$ ), etc which are harmful and can cause serious problem if inhaled by humans in large amount and these problems are generally faced by the drainage workers due to which death can occurs. Also we don't get early alerts of the blockage or rise in amount of those gases or the increase in water level. Hence detection and repairing of the blockage becomes time consuming and hectic. WSN is a monitoring technology which inhere of node sensors that expanse and integrate use of a wireless network system. Every node consist the data processing (microcontroller, eg - Arduino) memory (program, data, flash memory), NRF transceiver, power supply system and involves one or more sensors. WSN systems have a higher level of precision than wired network system with respect to cost; flexibleness and reliability are expected to replace hybrid or combined technology alleviate this issue with regards to the developing populace. Fujitsu [9] have built up a Technology for Low-Cost Detection of Potential Sewer System Overflows by making a detecting framework to identify social foundation chance. He has created innovation that uses ICT for minimal effort discovery of early science sewer framework so as to moderate harm in urban areas originating from heavy downpours, for example, Japan. They have prepared manholes in which sensors can measures water levels so as to precisely identify early indications of flood. This innovation can likewise decide the area and number of manholes where sensors are introduced, in light of an investigation of the time required for water to spill out of upstream pipes to downstream area as per land geology and the shape and length of sewer pipes, which makes it conceivable to follow and foresee the flood through a sewer framework utilizing just a single fifth the same number of sensors. This innovation diminished power utilization by roughly 70%. With the rapid technological development of sensors, WSN has become one of the key technologies for IoT. To

overcome irregular and manual monitoring process, Retno Tri Wahyuni et al [10] discusses about the plan of drainage systems expected to screen conditions at a few points in drainage system utilizing remote sensor systems. It comprises of a few phases: plan of sensor hub, structure of correspondence unit, plan of spread out sensor hub, and plan of information base framework. The sensors utilized are rainfall sensor, water level sensor, and water release sensor. The significant part on sensor hubs comprise of sensors unit, processor, RTC (Real time Clock), SD cards, remote correspondence unit, and supply units which speak with one another utilizing the Radio Frequency module (XBeeTM). The GSM module is utilized for correspondence among passage and server and the recorded information will be put away into a database that can be pictured by Geographical Information System (GIS). Ka-Heng Chan et al [11] suggested ZigBee Wireless Sensor Network for Surface Drainage Monitoring and Flood Prediction. A Wireless Sensor Network (WSN) in view of the ZigBee is proposed and executed for the water level location utilizing ultrasonic sensor and give flood prediction. The constructed sensor hubs report under 0.52% average error for the separation inside 0.20m to 4.00m. All model sensor nodes utilized in this work are fueled up by a single standard 3.70V battery. An experiment is arranged utilizing variable stream in water and drainage at the same time to check execution of water level detection and shows the flood forecast capability. A similar process is carried out by Li Xiaoman et al [12] for monitoring aquaculture using ZigBee Wireless Sensor Network. The structure of aquaculture remote sensor organize for information transmission is done utilizing ZigBee technology. The equipment configuration utilized are ZigBee RF module node, the parent node correspondence module, and the child node communication module. The design of the correspondence software are ZigBee node coordinator device, the ZigBee terminal device, and the control software of terminal device. The capacity of remote sensor systems to gather, process, and transmit aquaculture natural data dependably fills in as strong specialized help for remote continuous observing by joining sensor innovation and ZigBee remote network technology. In our proposed system, we detect the location by using IoT and the live data for each area is monitored continuously by using ZigBee. The data are then transmitted to the mobile app designed especially for the authorities in municipal corporation via sensors. In case of any occurrence of blockage or overflow, an alert is sent to the app

The deployment of WSN on numerous applications areas such as conveying, logistics, environmental and surrounding monitoring, security and supervision, industrial, automation, military, agriculture and health related works has been reported. [2] Use of WSN to monitor volcanic activities. [3] Predictive flood detection system using IoT are implemented in river like Honduras and other rivers [7]. WSN can be useful

Monitoring Smart City Applications using Raspberry PI Based on IOT Authors: Prof. S A. Shaikh 1, Suvarna A. Sonawane.

Description: the Smart city is the development goal to monitor the quality of resource in the city to improve good management and faster development of the city required necessity is to upgrade healthy and safe cities that delivering real time services and latest facility to implement the concept of smart city use IoT concept by which easy wireless communication is possible. The system consist of sensors, collect different types of data from sensors and transfer to the Raspberry Pi3 controller. The acquired output from the controller is sent to the control room through the E- mail and also display on the personal computer.

B. Automated Internet of Things for Underground Drainage and Manhole Monitoring System for Metropolitan Cities. Author: Muragesh S. K1 and Santhosha Rao  
Description: The Internet of Things (IoT) consists of real life objects, communication devices attached to sensor networks in order to provide communication and automated actions between real world and information world. IoT came into existence because, without human interaction, computers were able to access data from objects and devices, but it was aimed at, to overcome the limiting factors of human entered data, and to achieve cost, accuracy and generality factors. Sensor Network is a key enabler for IoT paradigm. It represents the implementation and design function of an Underground Drainage and Manhole Monitoring System (UDMS) for IoT applications. The vital considerations of this design are low cost, low maintenance, fast deployment, and a high number of sensors, long life-time and high quality of service. The proposed model provides a system for monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. In real time, UDMS can remotely monitor current states of the manholes.

Muragesh S. K<sup>1</sup> and SanthoshaRao [1] proposed a model that provides a system for monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. The vital considerations of this design are low cost, low maintenance, fast deployment, and a high number of sensors, long life-time and high quality of service. The Internet of Things (IoT) consists of real life objects, communication devices attached to sensor networks in order to provide communication and automated actions between real world and information world. IoT came into existence because, without human interaction, computers were able to access data from objects and devices, but it was aimed at, to overcome the limiting factors of human entered data, and to achieve cost, accuracy and generality factors. Sensor Network is a key enabler for IoT paradigm. It represents the implementation and design function of an Underground Drainage and Manhole Monitoring System (UDMS) for IoT applications. Prof.S A.Shaikh<sup>1</sup>, Suvarna A. Sonawane [2] proposed the system for the Smart cities for the development goal to monitor the quality of resource in the city to improve good management and faster development of the city required necessity is to upgrade healthy and safe cities that delivering real time services and latest facility to implement the concept of smart city use IoT concept by which easy wireless communication is possible. Different type of data is collected from the sensors and transferred to Raspberry Pi3 Controller in the system. The acquired output from the controller is sent to the control room through the E-mail and also display on the personal computer. Yash Narale, Apurva Jogal, Himani Chaudhari, S.P Bhosale [3] introduced the underground drainage monitoring system that will not only help in maintaining the proper health and safety of the city but additionally in reducing the work of government personnel numerous varieties of sensors (flow, level, temperature and gas sensors) are interfaced with microcontroller ARM7 so as to form the system smart. Once the various sensors reach the threshold level, the indication of that respective worth and sensor is being sent to the microcontroller. Further more, ARM7 then sends the signal and location of the manhole to the municipal corporation through GSM and GPS and the officials could easily locate which manhole is having the problem and could take appropriate step. G. Gowthaman, K. Hari Haran proposed [4] system to simply monitoring the level, it generates alarm signals via complaints to the required departments through mail and SMS regarding prior to overflow. MS T.Deepiga [5] introduced the Smart

water monitoring system using wireless sensor network. The system consists of a sensible sensing unit that detects and controls the home electrical appliances used for daily activities by following totally different tariff rates. Retno Tri Wahyuni<sup>1</sup>, et.al [6] proposed sensible devices once integrated into the city's infrastructure through the effective preparation of ICT, will build life during a every town lots easier. During this paper, we tend to style sensible period drain monitoring system mistreatment varied sensors like water level, blockage and gas detector. Wirawam,et.a [7] introduced predictive flood detection system mistreatment IoT are enforced in stream like Central American nation and different rivers. Gunasekaran, M.pavitra, S.Priyanka, R,Reeva [8] proposed a system that has underground aquifers and above-ground rivers, lakes, streams, marshes, comprising solely 65% of the water present on the world. The previous water that's

Urban areas are most affected by floods which are man made such as shrinking open spaces, use of non recycled plastic, drains which are not monitored regularly that leads to heavy water accumulation after heavy rainfall. In 2017 in Bellundur Lake (Bangalore) was with dirt, foulsmelling froth due to heavy rainfall and lack of proper drainage system. Due to Bellandur lake tragedy 76 polluting Industries were shut. Delhi was flooded with water after a continuous heavy rainfall which caused traffic congestion. Chennai has witnessed severe flooding in 2015 while floods in Mumbai had killed 500 people. This tragedies are result of lack of drainage system indulged with advanced technology. Manual monitoring is time consuming and also risky for human life. In 2019 in Agra a probe was ordered into construction of drainage and it was suppose to be constructed in 50 meter radius.

A system of sewer pipes collectively called sewers, collects the sewage and takes it for further treatment or disposal. Properly functioning septic tanks require emptying every 2–5 years depending on the load of the system. An underground sewage system was designed where all the waste from the home and industrial waste water are collected together and driven together. Sewage overflow on roads is a major problem in cities, where large numbers of complaints are launched and no actions are being taken. A sewage level monitoring system was developed where paper discuss about the design of drainage systems intended to monitor conditions at several points in drainage system using wireless sensor networks [4]. Some sensor nodes are deployed at several determined points to be connected with each other.

The recorded data will be stored into a database that is visualized by Geographical Information System (GIS). The monitoring parameters are water levels in drainage, water discharge and rainfall conditions around the drainage area. This system is expected to monitor the drainage conditions real time continuously, and to store the data properly. The presenting data through GIS is expected to be a reference for determining drainage master plan in an area [4]. Recent studies proved that storm water coagulate into sewer system and causes sewer overflow problems, for which Storm Water Management Model (SWMM) is used in a study for simulating rainfall driven flow in a sewer system that could cause overflow in sewer networks [5]. The simulation is carried out in a residential area where storm water network is not fully developed. The report says that severe rainfall causes sewer overflow and surface inundation in the area. A number of actions have been proposed which includes capacity upgrading of sewer system, decline of discharge peak and reduction of exfiltration as a counter measure to solve this problem [5]. In many places sewer level detection is being carried to detect the level of the fluid in advance to overflow problems. In recent years Japan has often experienced unexpected intense rain due to the development of cumulonimbus clouds; these are frequently occurring torrential downpours. According to the Meteorological Agency, in 2014 short period heavy rainfall exceeding 50 millimeters per hour occurred 237 times (at 1,000 observation points). The long-term statistics from 1976 clearly shows this as an increasing trend [6]. Due to relentless downpours, sewer systems have overflowed and numerous instances of flood damage have been experienced mainly in cities [5]. Equipping manholes in sewer line infrastructures with sensors can measure water levels and accurately detect early signs of overflow. However, the operating cost for each sensor is expensive, making it difficult to install sensors across a wide area. For this reason the number of sensors installed needs to be minimized. However, the effective installation of sensors was largely dependent on intuition and experience of the workers and now "there are growing expectations on ICT" to achieve this.

In the method proposed, development of IoT based sewage level maintenance is designed, where the sewage level is monitored using a magnetic float level sensor[7]. The minimum and maximum levels are set and the level sensor keeps on monitoring the level of the sewage. As the level reaches the maximum set point, the float level sensor detects and send the signal to the controller where the controller

commands the IoT network to generate alert complaints to the municipal and corporation departments in prior to overflow [8][9]. The complaints will be repeatedly registered until the level reaches the minimum set. The communication is done based on IoT where the complaints are auto registered via mails or sms and the entire system is controlled using a ARDUINO microcontroller [10].

### 3.1. Function Block Diagram

The function block diagram describes the monitoring of sewage level in the underground sewage system. The sewage being disposed from domestic and industrial sites are together passed on to a drainage system. During the cases of any blockage in the pipe lines or during the affect of storm water, level of the sewage increases. This continues increase in sewage level causes overflow which is to be controlled. This increase in level of sewage is monitored using a float switch (level sensor) [10]. The signal from the level sensor is fed to the micro controller where the controller commands the IoT module to alarm complaints via mails and sms. The controller is programmed such that the complaint alarms would be triggered repeatedly unless the level reaches the minimum set.

Wemer-Allen,et.al..., [1] presented of WSN on varied applications areas like transference, logistics, environmental and surrounding watching, security and oversight, industrial, automation, military, agriculture and health related works has been reported. Basha,et.al..., [2] analyze use of WSN to monitor volcanic activities.

Wirawam,et.al..., [3] papered predictive flood detection system mistreatment IoT are enforced in stream like Central American nation and different rivers.

Yuwat,et.al..., [4] represents WSN will be helpful in style of environmental watching systems in developing countries. Designed a prophetic disaster and alert generation system exploitation WSN to provide weather info and early alerts. Smart town infrastructure may well be in terms of intelligent traffic signals, sensors, active lanes, communication, and so on.

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 EXISTING SYSTEM**

- The discussion is about the development of an intelligent irrigation system, which can be used in plantation. The utilization of greenhouse concept is used in the paper for reducing atmosphere pollution.
- The system consists of hardware and software and, finally, the integration of the two parts to provide the results. The hardware system consists of the sensors, actuators, drivers and PLC.
- The software is all about designing SCADA system, in which, it has the ability to read from the automatic system and write into the system. In software design, there is a need for full development of NI instruments, such as DSC module, OPC server, MODBUS server.
- In hardware design, we need all the components that are necessary to accomplish the project, and these components are PLC, DC water pump motor, actuators, sensors and some minor components like tank and reservoir.

#### **3.2 PROBLEM STATEMENT**

- In the existing systems the power generation is carried out by the conventional energy sources.
- This conventional energy sources causes greenhouse gases emission which leads to the global warming.

- The existing systems today are for flood detection and control
- Hard to implement in the real time systems

### **3.3 PROPOSED SYSTEM:**

- In our proposed system, we are using the Arduino Microcontroller, Ultrasonic sensor, Gas sensor, Heart beat sensor, Respiratory sensor , Node MCU, Relay, power supply.
- An underground drainage monitoring system will not only help in maintaining the proper health and safety of the city but also in reducing the work of government personnel. Various types of sensors ( level, Heartbeat and gas sensors) are interfaced with microcontroller Arduino uno in order to make the system smart.
- When the respective sensors reach the threshold level, the indication of that respective value and sensor is being sent to the microcontroller. Furthermore, Arduino uno then sends the signal and location of the manhole to the municipal corporation through GSM and GPS and the officials could easily locate which manhole is having the problem and could take appropriate steps.
- Also, Arduino Uno updates the live values of all the sensors in the manholes falling under the respective area using IoT. A message will also be displayed on the LCD.
- The sensors data are monitored through the IOT Cloud webpage. The updates are frequently happening at the time of sensors data variation.
- The location of the sewage we can monitor through the IOT. At the same time we can get status of the sewage and health monitoring of that person via IOT
- We can give alert to the people if any problem via buzzer module which is connected with the Arduino
- We can control the exhaust fan via IOT at the time of poisonous gas detection

### **3.4 Motivation**

- IoT-based system is in charge of providing knowledge from an environment to an non-expert user. IoT-based system can be used in different environments,

so it needs to be able to address many heterogeneous devices. Thus, a major concern within developing an IoT-based system is how to handle the interaction with the heterogeneous devices for non-expert users. This concern can be addressed by a middleware layer between devices and non-expert users. This layer is responsible to hide the diversity of devices from the user perspective, and provides access transparency to the devices for the end users.

- The idea of creating abstractions of devices been addressed in the literature. The middleware we found in the literature can provide satisfaction by facilitating the interaction with devices, but they do not support low-level device configuration [4].

### **3.5 ADVANTAGES:**

- Simple system to monitor the sewage and health parametes
- Response time is too good
- Immediate update in the IOT cloud web server
- Easy to implementation
- Cost effective system

### **3.6 HARDWARE REQUIREMENTS-**

- Arduino
- Ultrasonic sensor
- Gas sensor
- Oxymeter sensor
- Heart beat sensor
- Buzzer
- Node MCU
- IOT MODULE
- Power supply
- Connecting cable

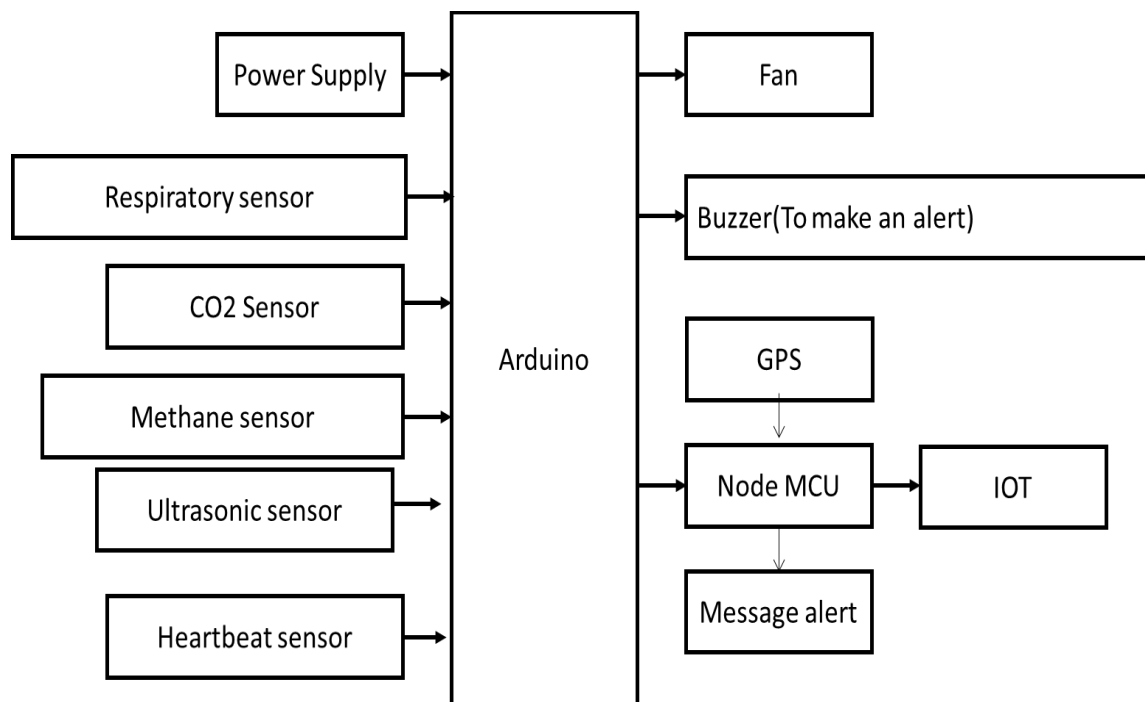
### 3.7 SOFTWARE REQUIREMENTS

- Arduino IDE
- EMBEDDED C.
- Proteus simulation tool
- IOT Cloud Software.

## CHAPTER 4

### SYSTEM ARCHITECTURE

#### 4.1 BLOCK DIAGRAM



#### 4.2 Project implementation

The smart drainage system will have: Sensors to detect blockage, flood and gases.

The intelligence of sensors and system will identify the clogging inside the drainage system and will give the details of the location and other information for further actions.

The system will also sense the presence of various harmful gases such as Methane (CH<sub>4</sub>), Sulphur dioxide (SO<sub>2</sub>), Carbon monoxide (CO) etc.

As the level of such gases pass the threshold value the system will generate the alert using alarm system by which the Health department will take proper action on it.

The module is implemented using Wireless Sensor Networking (WSN) technology each node will carry its own data along with the data of neighbouring node and will pass it to next node by hopping techniques.

These entire data packet will be collectively sent by the gateway node and stored at the cloud all these data will be accessible in real-time scenario for continuous monitoring.

### **4.3 HARDWARE DESIGN:**

#### **4.3.1.ARDUINO UNO AND ITS PROGRAMMING**

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

Arduino Uno:

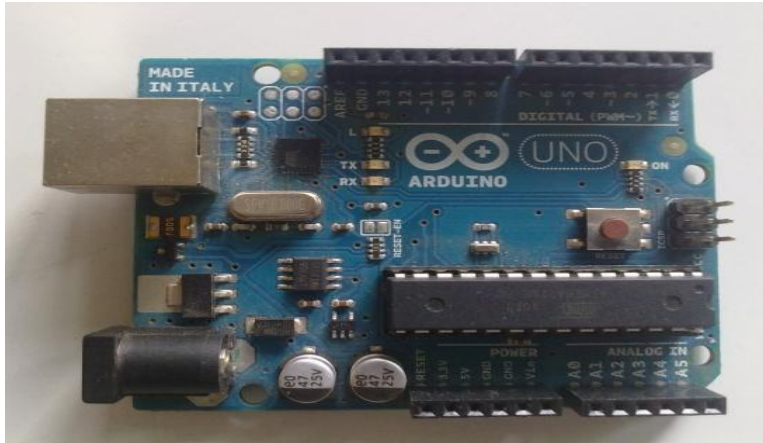


Fig 4.1 ARDUINO UNO

## Overview

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the

This is what the Arduino board looks like.



Fig.4.2

The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to

about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors.

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

#### **4.3.2 Summary:**

Microcontroller ATmega328

Operating Voltage 5V

Input Voltage (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin 40 mA

DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM 2 KB (ATmega328)

EEPROM 1 KB (ATmega328)

Clock Speed 16 MHz

### 4.3.3 Pin Configuration

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.

- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.
- **IOREF.** This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.
- **Memory-** The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM.

**Input and Output;** - Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digital Write( )`, and `digital Read( )` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kohms. In addition, some pins have specialized function.

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and Transmit (TX) TTL serial data.

These pins are connected to the corresponding pins of the ATmega8U2 USB-to- TTL Serial chip.

**External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attach Interrupt ()` function for details.

- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the `analog Write ()` function.

- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication using the SPI library.

- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the `analog Reference ()` function. Additionally, some pins have specialized functionality:

- **TWI: A4 or SDA pin and A5 or SCL pin.** Support TWI communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analog Reference ().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

#### 4.4 Communication

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open source Processing platform ([www.processing.org](http://www.processing.org)) which is described by its creators as a “programming language and environment for people who want to program images, animation, and interactions.” The Arduino programming language leverages an open source project known as Wiring ([wiring.org.co](http://wiring.org.co)). The Arduino language is based on good old- fashioned C. If you are unfamiliar with this language, don't worry; it's not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the

documentation for details. For SPI communication, use the SPI library.

As you go through the list of programming statements available in the Arduino IDE (choose Help->Reference), you might think there isn't much power for doing things like running servos, operating stepper motors, reading potentiometers, or displaying text on an LCD. Like most any language based on C, the Arduino supports the notion of "libraries" code

Repositories that extend core programming functionality. Libraries let you re-use code without having to physically copy and paste it into all your programs. The standard Arduino software installation comes with several libraries you may use, and you can download others from the Arduino support pages and from third-party websites that publish Arduino library code. A good example of a library you'll use with the Robot and likely many other robot projects is

Servo. This library allows you to connect one or more hobby R/C servos to the Arduino's digital I/O pins. The Servo library comes with the standard Arduino installation package Library->Servo. This adds the line

```
#include <Servo.h>
```

Which tells the Arduino IDE that you wish to include the Servo library in your sketch. With the functionality of the library now available to you, you can use its various functions to control one or more servos. For example, you can use the write function to rotate a servo to a specific position, from 0 to 180 degrees. The following code

```
myServo.write(90);
```

Moves a servo to its midpoint, or 90 degree position. Structurally, Arduino sketches are very straightforward and are pretty easy to read and understand. The Arduino program contains two main parts: setup () and loop (). These are programming functions that do what their names suggest: setup () sets up the Arduino hardware, such as specifying which I/O lines you plan to use, and whether

They are inputs or outputs. The loop () function is repeated endlessly when the Arduino is operating.

Arduino IDE (Integrated development environment) is used to write the program and dump into the Arduino board

#### **4.5 ARDUINO SOFTWARE:**

1. Open Arduino IDE as shown below

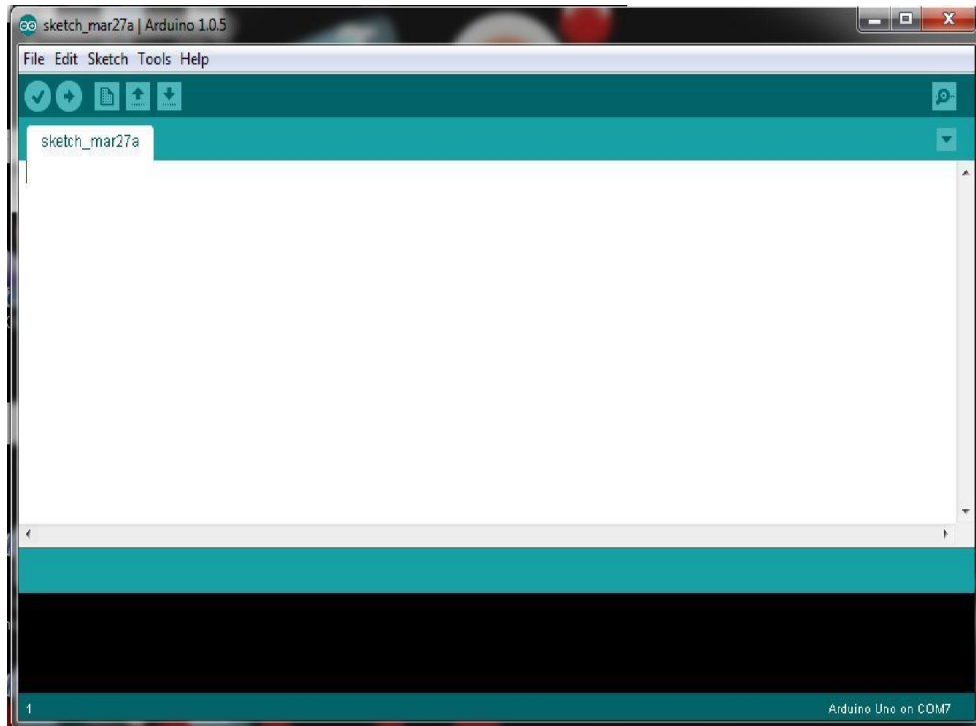


Fig.4.1

2. Select the COM Port and Select the COM Port

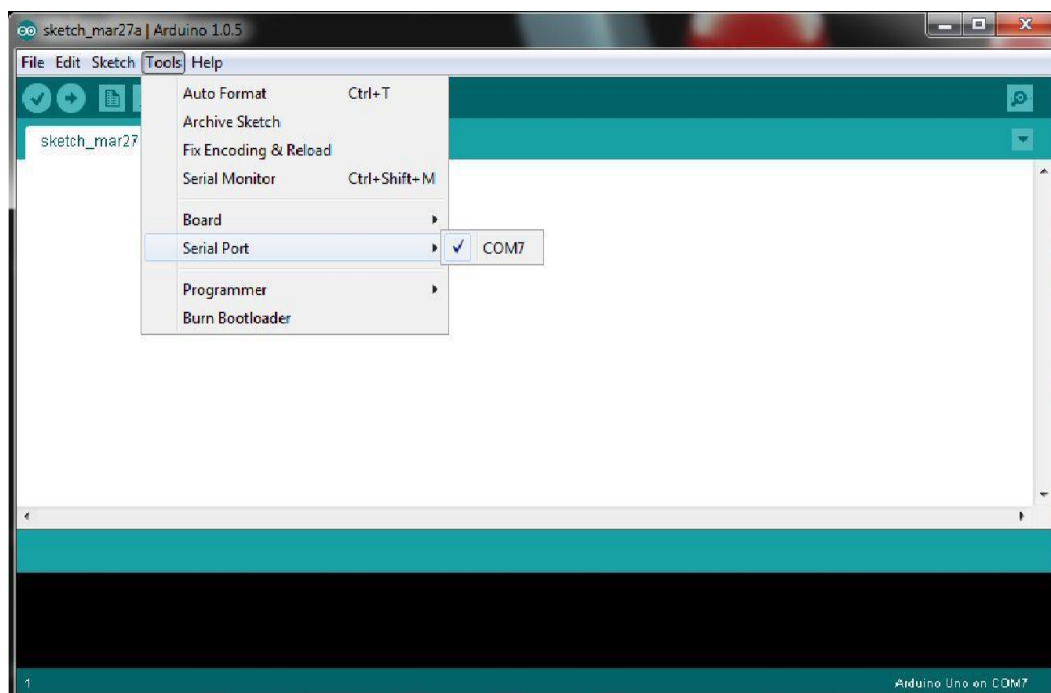


Fig.4.2

3. Select the required Arduino board from Tools as shown below

Select the required Arduino board

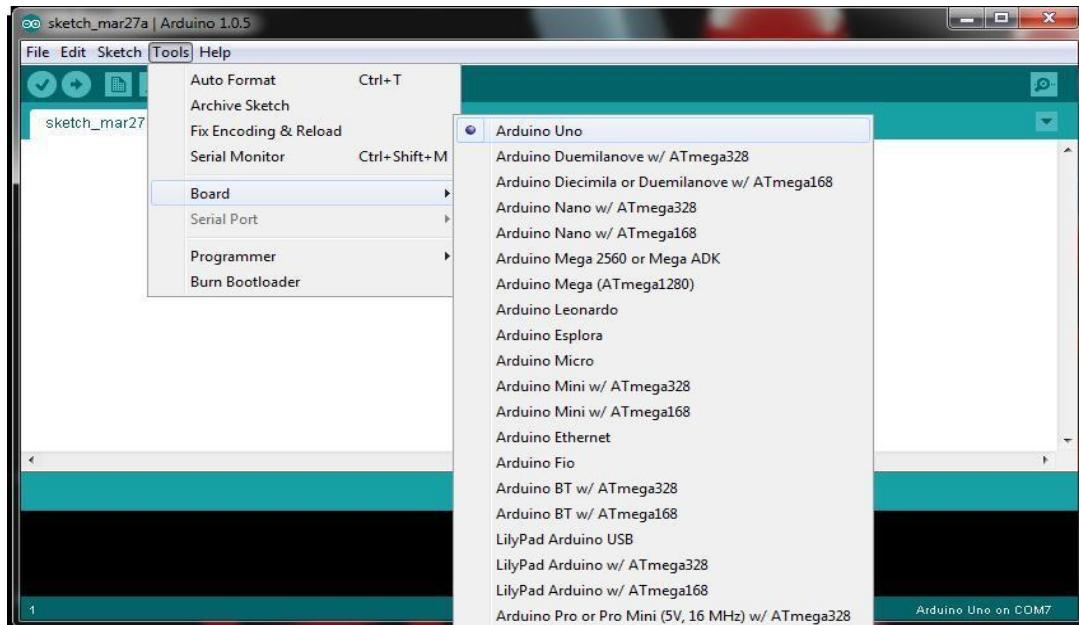


Fig.4.3

4. Write the sketch in Arduino IDE and then sketch in Arduino IDE

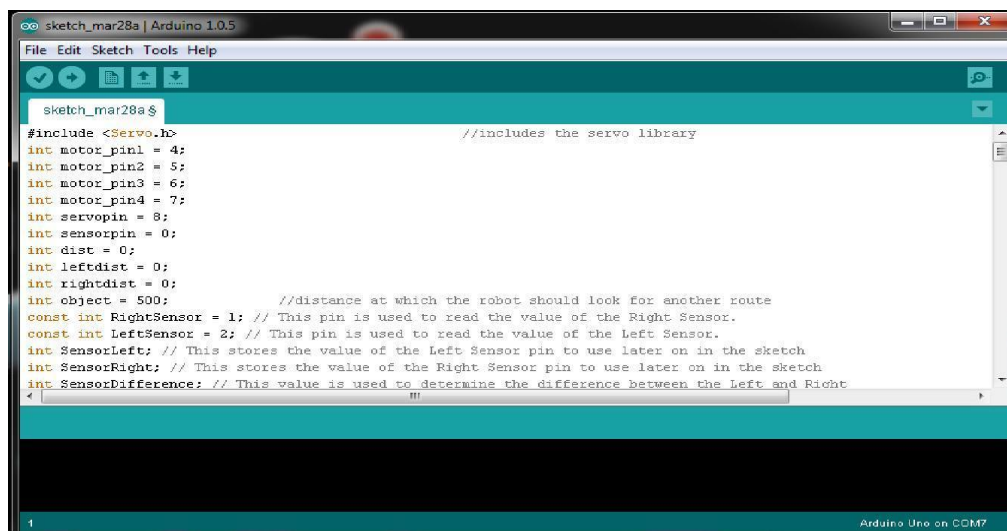


Fig.4.5

5. Compile and upload the Sketch to Arduino board upload the Sketch to Arduino board

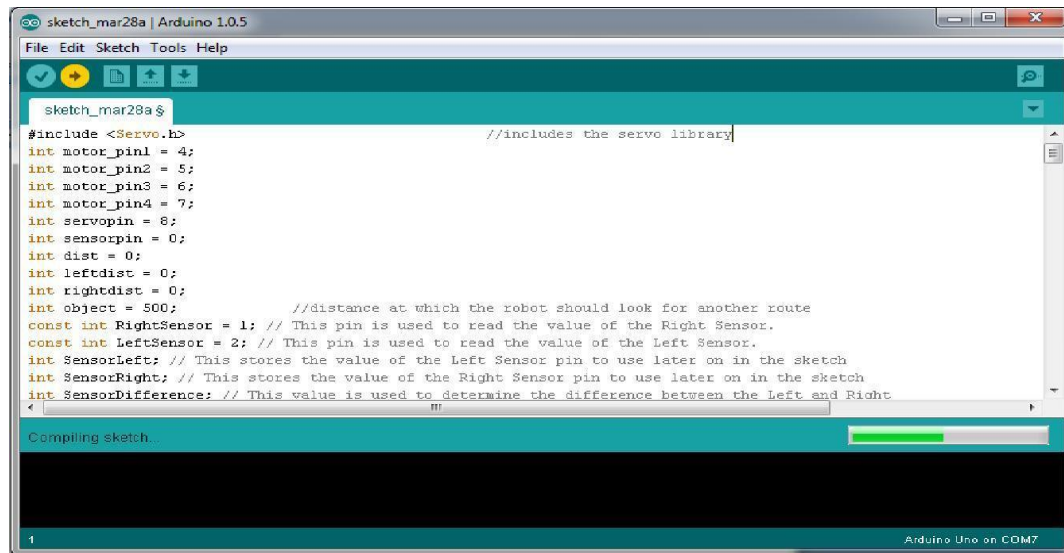


Fig.4.6

## 4.6 NODE MCU

NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module

### Programming NodeMCU ESP8266 with Arduino IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use.

Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this [Getting Started Tutorial for NodeMCU](#) to prepare your Arduino IDE for NodeMCU.

NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).<sup>[8]</sup> The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits.<sup>[citation needed]</sup>

Both the firmware and prototyping board designs are open source.<sup>[8]</sup>

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson<sup>[9]</sup> and SPIFFS.<sup>[10]</sup> Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects).

## History<sup>[edit]</sup>

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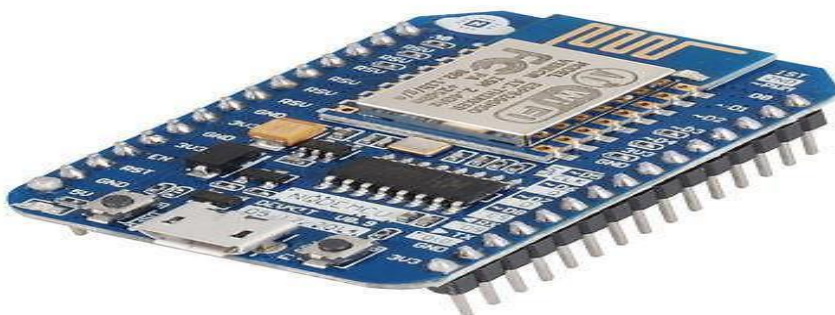
NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems<sup>[6]</sup> began production of the ESP8266.<sup>[11]</sup> NodeMCU started on 13 Oct 2015, when Hong committed the first file of nodemcu-firmware to GitHub.<sup>[12]</sup> Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9.<sup>[13]</sup> Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform,<sup>[14]</sup> and committed to NodeMCU project, then NodeMCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib<sup>[15]</sup> to the NodeMCU project,<sup>[16]</sup> enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In the summer of 2015 the original creators abandoned the firmware project and a group of independent contributors took over. By the summer of 2016 the NodeMCU included more than 40 different modules.

## ESP8266 Arduino Core<sup>[edit]</sup>

As [Arduino.cc](http://Arduino.cc) began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the [Arduino IDE](#) so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFi SoC, popularly called the "ESP8266 Core for the Arduino IDE".<sup>[17]</sup> This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs.

NodeMCU is an open-source [LUA](#) based firmware developed for the ESP8266 wifi chip. By exploring functionality with the ESP8266 chip, NodeMCU firmware comes with the ESP8266 Development board/kit i.e. NodeMCU Development board.

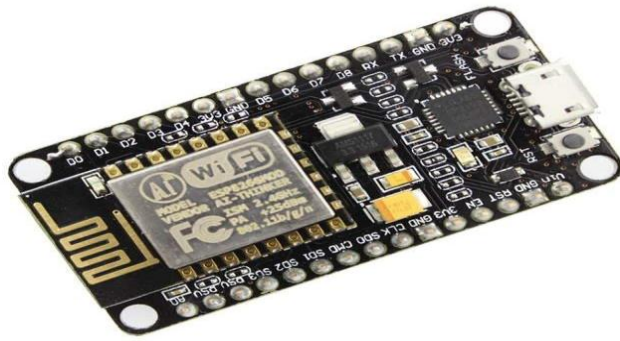


## NodeMCU Development Board/kit v0.9 (Version1)

Since NodeMCU is an open-source platform, its hardware design is open for edit/modify/build.

NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The **ESP8266** is a low-cost [Wi-Fi](#) chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer to the [ESP8266 WiFi Module](#).

There is Version2 (V2) available for NodeMCU Dev Kit i.e. **NodeMCU Development Board v1.0 (Version2)**, which usually comes in black colored PCB.



## NodeMCU Development Board/kit v1.0 (Version2)

For more information about NodeMCU Boards available in the market refer to [NodeMCU Development Boards](#)

NodeMCU Dev Kit has **Arduino like** Analog (i.e. A0) and Digital (D0-D8) pins on its board.

It supports serial communication protocols i.e. UART, SPI, I2C, etc.

Using such serial protocols we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards, etc.

## How to start with NodeMCU?

NodeMCU Development board is featured with wifi capability, analog pin, digital pins, and serial communication protocols.

To get started with using NodeMCU for IoT applications first we need to know about how to write/download NodeMCU firmware in NodeMCU Development Boards. And before that where this NodeMCU firmware will get as per our requirement.

There are online NodeMCU custom builds available using which we can easily get our custom NodeMCU firmware as per our requirement.

To know more about how to build custom NodeMCU firmware online and download it refer to [Getting started with NodeMCU](#)

## **How to write codes for NodeMCU?**

After setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for the development of NodeMCU.

### **NodeMCU with ESPlorer IDE**

Lua scripts are generally used to code the NodeMCU. Lua is an open-source, lightweight, embeddable scripting language built on top of C programming language.

For more information about how to write Lua script for NodeMCU refer to [Getting started with NodeMCU using ESPlorerIDE](#)

### **NodeMCU with Arduino IDE**

Here is another way of developing NodeMCU with a well-known IDE i.e. Arduino IDE. We can also develop applications on NodeMCU using the Arduino development environment. This makes it easy for Arduino developers than learning a new language and IDE for NodeMCU.

For more information about how to write Arduino sketch for NodeMCU refer to [Getting started with NodeMCU using Arduino IDE](#)

## **The difference in using ESPlorer and Arduino IDE**

Well, there is a programming language difference we can say while developing an application for NodeMCU using ESPlorer IDE and Arduino IDE.

We need to code in C/C++ programming language if we are using Arduino IDE for developing NodeMCU applications and Lua language if we are using ESPlorer IDE.

Basically, NodeMCU is Lua Interpreter, so it can understand Lua script easily. When we write Lua scripts for NodeMCU and send/upload it to NodeMCU, then they will get executes sequentially. It will not build a binary firmware file of code for NodeMCU to write. It will send Lua script as it is to NodeMCU to get executed.

In Arduino IDE when we write and compile code, the ESP8266 toolchain in the background creates a binary firmware file of code we wrote. And when we upload it to NodeMCU then it will flash all NodeMCU firmware with newly generated binary firmware code. In fact, it writes the complete firmware.

That's the reason why NodeMCU not accept further Lua scripts/code after it is getting flashed by Arduino IDE. After getting flashed by Arduino sketch/code it will be no more Lua interpreter and we got an error if we try to upload Lua scripts. To again start with Lua script, we need to flash it with NodeMCU firmware.

Since Arduino IDE compiles and upload/writes complete firmware, it takes more time than ESPlorer IDE.

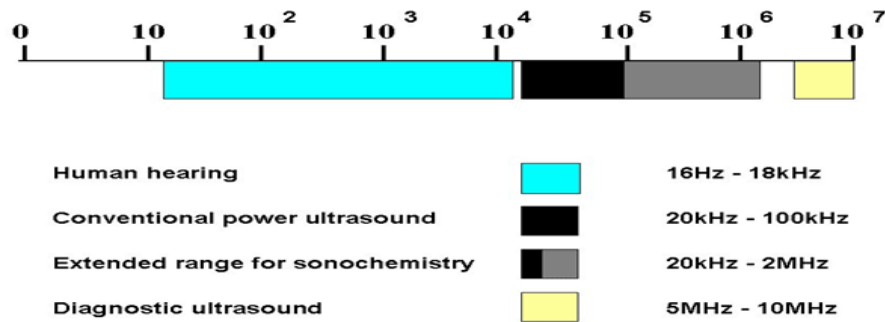
## 4.7 Ultrasonic (UV) Sensors or Ultrasound Sensors

- Bats are wonderful creatures. Blind from the eyes and yet a vision so precise that could distinguish between a moth and a broken leaf even when flying at full speed. No doubt the vision is sharper than ours and is much beyond human capabilities of seeing, but is certainly not beyond our understanding. **Ultrasonic ranging** is the technique used by bats and many other creatures of the animal kingdom for navigational purposes. In a bid to imitate the ways of nature to obtain an edge over everything, we humans have not only understood it but have successfully imitated some of these manifestations and harnessed their potential to the greatest extent.

### **How Ultrasonic Sensors work?**

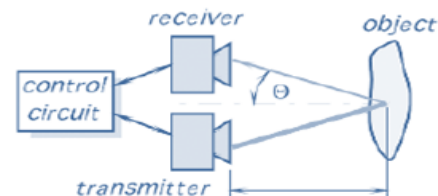
- Ultrasonic sensors are devices that use electrical–mechanical energy transformation, the mechanical energy being in the form of ultrasonic waves, to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a succession of compressions and rarefactions along the direction of wave propagation through the medium. Any sound wave above the human auditory range of 20,000 Hz is called ultrasound. Depending on the type of application, the range of frequencies has been broadly categorized as shown in the figure below:

## The Frequency Ranges of the Sound



- When ultrasonic waves are incident on an object, diffused reflection of the energy takes place over a wide solid angle which might be as high as 180 degrees. Thus some fraction of the incident energy is reflected back to the transducer in the form of echoes and is detected. The distance to the object (L) can then be calculated through the speed of ultrasonic waves (v) in the medium by the relation

$$L = \frac{vt \cos \theta}{2}$$



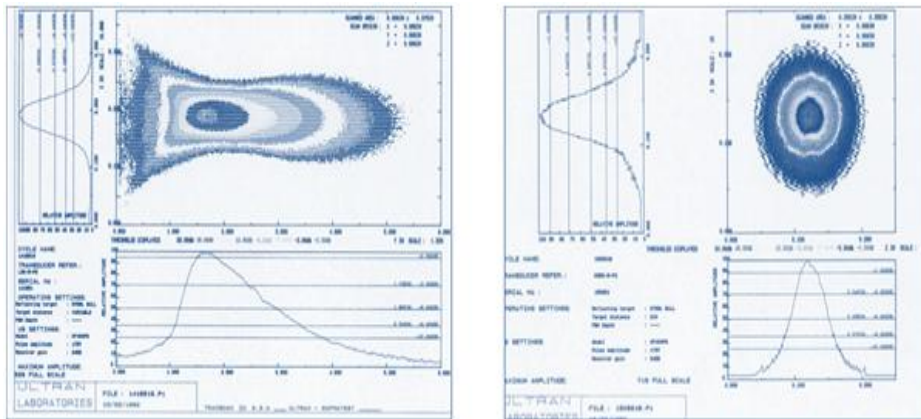
- Where 't' is the time taken by the wave to reach back to the sensor and 'θ' is the angle between the horizontal and the path taken as shown in the figure. If the object is in motion, instruments based on Doppler shift are used. Get all the details about internal structure and working of an ultrasound sensor at [Insight-How Ultrasonic Sensors Work](#).

## Generating Ultrasonic Waves

- For the generation of such mechanical waves, movement of some surface like a diaphragm is required which can then induce the motion to the medium in front of it in the form of compression and rarefaction. Piezoelectric materials operating in the motor mode and magnetostrictive materials have been widely employed in the generation of ultrasonic waves at frequency ranges of 1-20 MHz and 20-40 kHz respectively. The sensors employ piezoelectric ceramic

transducers which flex when an electric signal is applied to them. These are connected to an electronic oscillator whose output generates the oscillating voltages at the required frequency. Materials like Lead Zirconate Titanate are popular piezoelectric materials used in medical ultrasound imaging. For best results, the frequency of the applied oscillations must be equal to the natural frequency of the ceramic, which produces oscillations readily through resonance. It offers maximum sensitivity and efficiency when operated at resonance.

- Piezoelectricity being a reversible phenomenon produces electrical voltages when ultrasonic waves reflect back from the target and impinge upon the ceramic structure. In this way, a transducer may work both as a transmitter and a receiver in pulsed mode. When continuous measurement of distances is required, separate transducers may be used for transmission and reception. The sensors when used in industry are generally employed in arrays which may be mechanical arrays consisting of oscillating or rotating sensors, or electronic arrays which may be linear, curved or phased. To visualize the output of an ultrasonic sensor, displays of different kind are used whose shape depends on the type of transducer array used and the function. A sectorized Field of View is produced by mechanical arrays and curved and phased electronic arrays, while a linear field is generated by linear arrays. The display modes may be linear graphical plotting with amplitude on y-axis and time on x-axis called Amplitude mode or A-mode, or intensity modulated B-scans where the brightness of a spot indicates the amplitude of reflected waves. Other modes include M-mode, Doppler (D) Mode etc.
- The parameterization of these sensors is generally done by monitoring the reflected and transmitted signals from the lateral and axial motion of transducer while keeping the target fixed in a specific medium (water in general). The sound beam diverges rapidly, hence care is taken that the transducer produces the smallest possible beams. The narrower the beam pattern, the more sensitive the sensor is. However, the angle possible between the transducer and the surface increases with the beam width. The beam patterns of the kind shown below are observed:



Axial and Cross Sectional beam profiles

- The parameters on which the performance of an ultrasonic sensor is measured include bandwidth, attenuation, dynamic range and resolution like grayscale, axial and lateral resolution. Other parameters are Nominal Frequency, Peak Frequency, Bandwidth center Frequency, Pulse Width, sensitivity and Signal to Noise Ratio (SNR).

### Importance of Ultrasonic Sensors

- There are a variety of sensors based on other physical transduction principles like the optical range finding sensors and the microwave based devices too. Then why should one use ultrasonic transducers in the first place, given that the speed of sound is very slow than the speed of electromagnetic waves? The answer lies in the question itself. Because the EM waves based devices are too fast. Being slower than the EM waves, the time taken by ultrasonic waves is much longer than that taken by the latter and hence its measurement can be done more easily and less expensively. Because these are based on sound waves rather than EM waves, these would work in places where the latter would not.
- For example, in the case of clear object detection and measurement of liquid levels or high glare environments, light based sensors would suffer greatly because of the transmittance of the target or the translucence of the propagating media. Ultrasonic devices being based upon sound propagation would remain practically unaffected. These also function well in wet environments where optical beams may suffer from refraction from the water droplets in the environment. On account of range and accuracy, the ultrasonic

sensors may lie in between two EM wave based sensors, the Infrared rangefinders on the lower end and the LIDARs on the upper end. Not as accurate or long distance as the LIDARs, the Ultrasonic rangefinders fare better than the IR rangefinders which are highly susceptible to ambient conditions and require recalibration when environment changes. Further these devices offer advantage in medical imaging as compared to MRI or X-Ray scans due to inexpensiveness and portability. No harmful effects of ultrasonic waves at the intensity levels used have been detected in contrast to X-rays or radioactivity based methods and is particularly suited for imaging soft tissues.

### **Problems & Concerns**

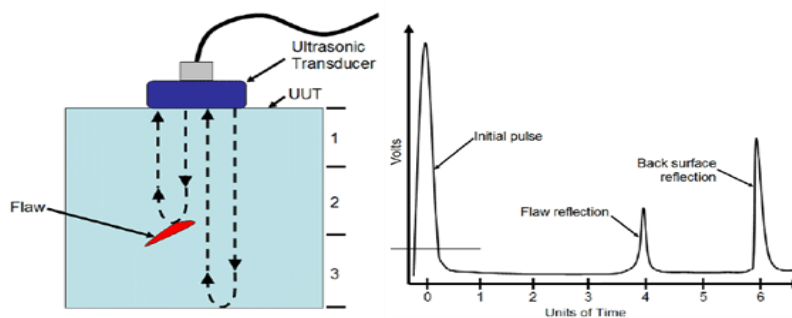
- However, Ultrasonic sensors too aren't free of all the problems. The speed of sound in a medium increases as the temperature of the medium increases. Thus even when the target has remained in the same place, it may now seem that it has shifted to a place closer to the sensor. Air currents due to varied reasons may disturb the path of the wave which could lead to 'Missed Detection' or a wrong measurement. Acoustic noise like high pitched sounds created due to whistling or hissing of valves and pneumatic devices at the frequency close to the operating frequency may interfere with the output of the sensor. Electrical noise also affects the performance of the sensor. These may generate artifacts which are not a true representation of the imaged object. Just like the vision starts to blur when the distance of the object from the eye gets too small for the eyes to see it, ultrasonic devices also have a 'dead zone' where the sensor cannot reliably make measurements. This happens due to a phenomenon called ringing which is the continuous vibration of the transducer after emitting the pulse. Thus when the distance is too small, the transducer has not yet come to rest to be able to differentiate between the vibration due to the incident radiation or the oscillation from the electrical excitation. The dangers of Ultrasonic waves are also well founded. If the intensity is too high, it can cause human tissues to heat and may cause ruptures in people exposed to it.

### **4.7.2 Applications**

- The applications of ultrasonic sensors can be classified on the basis of the property that they exploit. These can be summarized as:

| Domain      | Parameter                                                              | Applications                                                                  |
|-------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Time        | Time-of-Flight, Velocity                                               | Density, Thickness, Flaw Detection, Anisotropy, Robotics, Remote Sensing etc. |
| Attenuation | Fluctuations in reflected and Transmitted Signals                      | Defect characterization, microstructures, interface analysis                  |
| Frequency   | Ultrasonic Spectroscopy                                                | Microstructure, grain size, porosity, phase analysis.                         |
| Image       | Time-of-Flight, velocity, attenuation mapping in Raster C-Scan or SARs | Surface and internal Defect imaging, density, velocity, 2D and 3D imaging.    |

- Research has been going on to overcome the problems of ultrasonic sensors, particularly in medical imaging where it is known as ultrasound. The artifacts of ultrasonic sensors like Acoustic shadowing and Acoustic Enhancement are being exploited to characterize tissues which allow the differentiation between solid and cystic tissues. The industry too has reaped the benefits from ultrasonic sensors in applications like plastic welding, jewelry cleaning, remote sensing and telemetry, assisted parking systems etc. Robotics has been known to use ultrasonic rangefinders as a favorite tool for distance ranging and mapping. Even the fashion industry is using ultrasonic sensors in hair styling like hair extension implants.



#### Flaw Detection Using Ultrasonic Sensors

- Non destructive testing and flaw detection uses ultrasonic waves in various modes like the Longitudinal (L-wave) mode and the Shear (S-wave) mode to

detect flaws in materials. With the advances in Science, new materials offering increased performance at lower voltages like the capacitive micromachined ultrasonic transducers (CMUTs) are being developed which are expected to have higher bandwidth and greater potential for integration with electronic circuits.

- These devices provide non-invasive measures for the detection of problems in all kinds of materials, be it a living tissue or non-living manufactured goods. With a healthy history of being able to detect many problems which otherwise left the doctors dazed and the problem untreated, ultrasonic sensors do offer a lot of promise even in the coming times. The environmental and psychological effects of exposure to EM-radiation being rigorously being put under the scanner, ultrasonic applications are expected to thrive and offer a substantial alternative to the contemporary technologies.

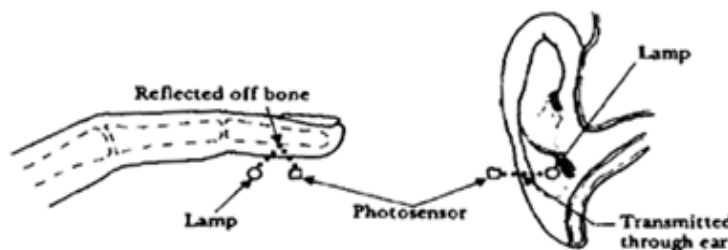
## **4.8 HEARTBEAT SENSOR**

A person's heartbeat is the sound of the valves in his/her's heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

- **Two Ways to Measure a Heartbeat**
- **Manual Way:** Heart beat can be checked manually by checking one's pulses at two locations- wrist (the radial pulse) and the neck (carotid pulse). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.
- **Using a sensor:** Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

- **Principle of Heartbeat Sensor**

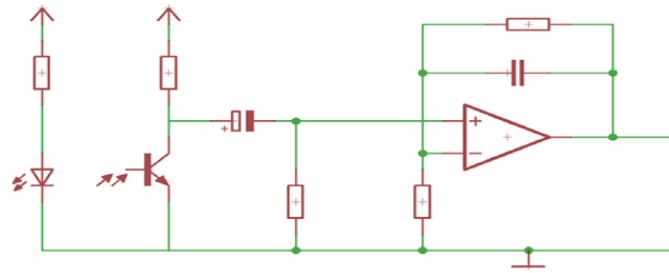
- The heartbeat sensor is based on the principle of photo plethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.
- There are two types of photoplethysmography:
- Transmission: Light emitted from the light emitting device is transmitted through any vascular region of the body like earlobe and received by the detector.
- Reflection: Light emitted from the light emitting device is reflected by the regions.



#### 4.8.1. Working of a Heartbeat Sensor

- The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.
- This signal is actually a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal.

Thus the major requirement is to isolate that AC component as it is of prime importance.



- To achieve the task of getting the AC signal, the output from the detector is first filtered using a 2 stage HP-LP circuit and is then converted to digital pulses using a comparator circuit or using simple ADC. The digital pulses are given to a microcontroller for calculating the heart beat rate,
- $\text{BPM}(\text{Beats per minute}) = 60 \cdot f$
- Where  $f$  is the pulse frequency

#### **Practical Heartbeat Sensor**

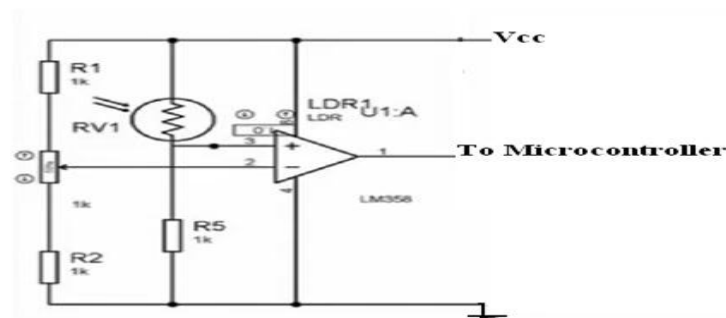
- Practical heartbeat Sensor examples are Heart Rate Sensor (Product No PC-3147). It consists of an infrared led and an ldr embedded onto a clip like structure. The clip is attached to the organ (earlobe or the finger) with the detector part on the flesh.



- Another example is TCRT1000, having 4 pins-
- Pin1: To give supply voltage to the LED
- Pin2 and 3 are grounded. Pin 4 is the output. Pin 1 is also the enable pin and pulling it high turns the LED on and the sensor starts working. It is embedded on a wearable device which can be worn on the wrist and the output can be sent wirelessly (through Bluetooth) to the computer for processing.



- Application Developing your own Heartbeat Sensor System
- A basic Heartbeat Sensor system can also be built using basic components like a ldr, comparator IC LM358 and a Microcontroller as given below



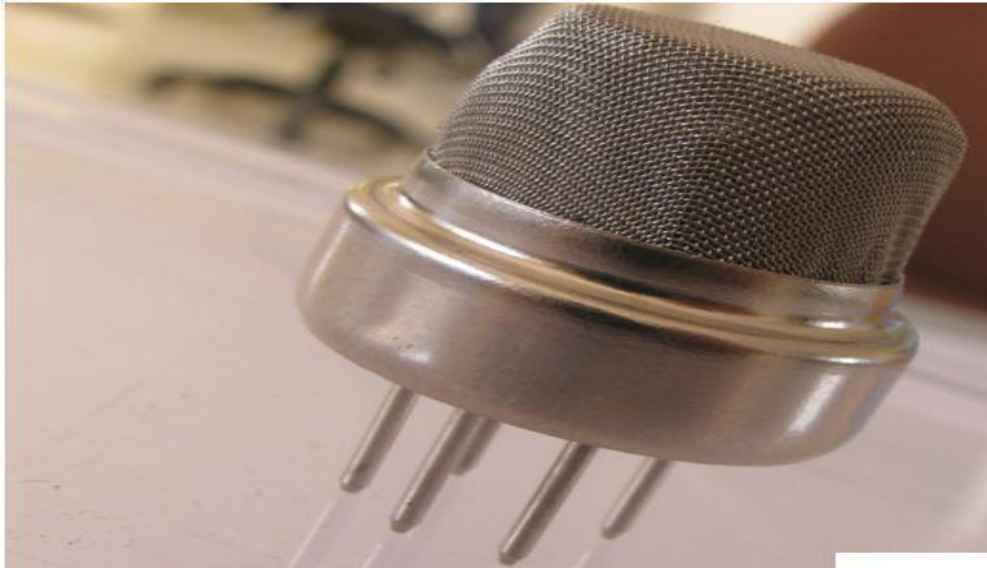
- As described above regarding the principle of heart beat sensor, when the finger tissue or the earlobe tissue is illuminated using a light source, the light is transmitted after getting modulated i.e. a part getting absorbed by the blood and the rest being transmitted. This modulated light is received by the light detector.
- Here a Light Dependant Resistor (LDR) is used as a light detector. It works on the principle that when light falls on the resistor, its resistance changes. As the light intensity increases, the resistance decreases. Thus the voltage drop across the resistor decreases.
- Here a comparator is used which compares the output voltage from the LDR to that of the threshold voltage. The threshold voltage is the voltage drop across the LDR when the light with fixed intensity, from the light source falls directly on it. The inverting terminal of the comparator LM358 is connected to the potential divider arrangement which is set to the threshold voltage and the non-inverting terminal is connected to the LDR. When a human tissue is illuminated using the light source, the intensity of the light reduces. As this reduced light intensity falls on the LDR, the resistance increases and as a result the voltage drop increases. When the voltage drop across the LDR or

the non-inverting input exceeds that of the inverting input, a logic high signal is developed at the output of the comparator and in case voltage drop being lesser a logic low output is developed. Thus the output is a series of pulses. These pulses can be fed to the Microcontroller which accordingly processes the information to get the heart beat rate and this is displayed on the Display interfaced to the Microcontroller.

## **4.9 Gas sensor**

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. Gas sensors are very important part of such systems. Small like a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at gaseous state.

Gas sensors are available in wide specifications depending on the sensitivity levels, type of gas to be sensed, physical dimensions and numerous other factors. This Insight covers a methane gas sensor that can sense gases such as ammonia which might get produced from methane. When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current. What is this sensing element? Is it kept in some chamber or is kept exposed? How does it get current and how it is taken out? Let's find out in this Insight!!!



The gas sensor module consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it, the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it.

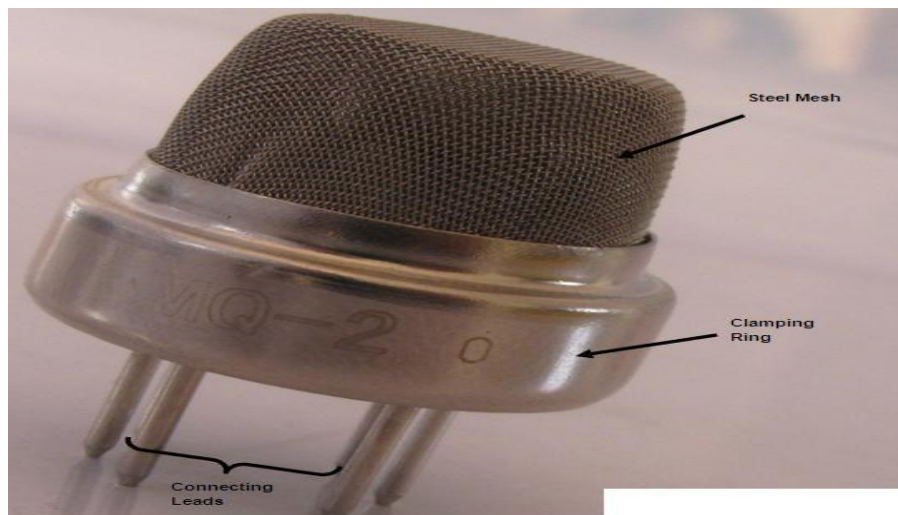


Image shows externals of a standard gas sensor module: a steel mesh, copper clamping ring and connecting leads. The top part is a stainless steel mesh which takes care of the following:

- ✓ Protecting the insides of the sensor.

- ✓ Exhibits an anti-explosion network that keeps the sensor module intact at high temperatures and gas pressures.

In order to manage above listed functions efficiently, the steel mesh is made into two layers. The mesh is bound to rest of the body via a copper plated clamping ring.

The connecting leads of the sensor are thick so that sensor can be connected firmly to the circuit and sufficient amount of heat gets conducted to the inside part. They are casted from copper and have tin plating over them. Four of the six leads (A, B, C, D) are for signal fetching while two (1, 2) are used to provide sufficient heat to the sensing element.

The pins are placed on a Bakelite base which is a good insulator and provides firm gripping to the connecting leads of the sensor. The top of the gas sensor is removed off to see the internal parts of the sensor: sensing element and connection wiring. The hexapod structure is constituted by the sensing element and six connecting legs that extend beyond the Bakelite base.

Image shows the hollow sensing element which is made up from Aluminium Oxide based ceramic and has a coating of tin oxide. Using a ceramic substrate increases the heating efficiency and tin oxide, being sensitive towards adsorbing desired gas' components (in this case methane and its products) suffices as sensing coating.

The leads responsible for heating the sensing element are connected through Nickel-Chromium, well known conductive alloy. Leads responsible for output signals are connected using platinum wires which convey small changes in the current that passes through the sensing element. The platinum wires are connected to the body of the sensing element while Nickel-Chromium wires pass through its hollow structure. While other wires are attached to the outer body of the element, Nickel-Chromium wires are placed inside the element in a spring shaped. Image shows coiled part of the wire which is placed on the inside of the hollow ceramic.

Image shows the ceramic with tin dioxide on the top coating that has good adsorbing property. Any gas to be monitored has specific temperature at which it ionizes. The task of the sensor is to work at the desired temperature so that gas molecules get ionized. Through Nickel-chromium wire, the ceramic region of the sensing element is subjected to heating current. The heat is radiated by the element in the nearby

region where gases interact with it and get ionized. Once, ionized, they are absorbed by the tin dioxide. Adsorbed molecules change the resistance of the tin dioxide layer. This changes the current flowing through the sensing element and is conveyed through the output leads to the unit that controls the working of the gas sensor.

#### 4.10. CO GAS SENSOR

A **carbon monoxide detector** or **CO detector** is a device that detects the presence of the carbon monoxide (CO) gas to prevent carbon monoxide poisoning. In the late 1990s Underwriters Laboratories changed the definition of a single station CO detector with a sound device to **carbon monoxide (CO) alarm**. This applies to all CO safety alarms that meet UL 2034 standard;<sup>[1]</sup> however for passive indicators and system devices that meet UL 2075, UL refers to these as *carbon monoxide detectors*.

CO is a colorless, tasteless and odorless gas produced by incomplete combustion of carbon-containing materials. It is often referred to as the "silent killer" because it is virtually undetectable by humans. In a study by Underwriters Laboratories, "Sixty percent of Americans could not identify any potential signs of a CO leak in the home".<sup>[2]</sup> Elevated levels of CO can be dangerous to humans depending on the amount present and length of exposure. Smaller concentrations can be harmful over longer periods of time while increasing concentrations require diminishing exposure times to be harmful.<sup>[3]</sup>

CO detectors are designed to measure CO levels over time and sound an alarm before dangerous levels of CO accumulate in an environment, giving people adequate warning to safely ventilate the area or evacuate. Some system-connected detectors also alert a monitoring service that can dispatch emergency services if necessary.

While CO detectors do not serve as smoke detectors and vice versa, combined smoke/CO detectors are also sold.<sup>[4]</sup> In the home, some common sources of CO include open flames, space heaters, water heaters, blocked chimneys or running a car or grill inside a garage.<sup>[5]</sup>

The devices, which retail for \$15–\$60 USD and are widely available, can either be battery-operated or AC powered (with or without a battery backup). Battery lifetimes have been increasing as the technology has developed and certain battery-powered devices now advertise a battery lifetime of up to 10 years. All CO detectors have "test" buttons like smoke detectors but the Test Button on a CO alarm only tests the battery, electronic circuit and buzzer, not the alarm's ability to sense gas.

CO detectors can be placed near the ceiling or near the floor because CO has nearly the same density as air,<sup>[6][7]</sup> but the National Fire Protection Association (NFPA) states: "Follow the manufacturer's instructions for placement and mounting height".<sup>[8]</sup>

When carbon monoxide detectors were introduced into the market, they had a limited lifespan of 2 years. However as battery technology developments have increased this and many now advertise up to 10 years however the sensor components can fail at any time for many reasons and failure may not be detected by the test button. Newer models are designed to signal a need to be replaced after a set time-span but the sensor could still fail at any time.

According to the 2009 edition of the IRC,<sup>[11]</sup> published by the International Code Council, section R315.1, "For new construction, an approved carbon monoxide alarm shall be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in dwelling units within which fuel-fired appliances are installed and in dwelling units that have attached garages", and section 315.2, "Where work requiring a permit occurs in existing dwellings that have attached garages or in existing dwellings within which fuel-fired appliances exist, carbon monoxide alarms shall be provided in accordance with Section R315.1."

Installation locations vary by manufacturer. Manufacturers' recommendations differ to a certain degree based on research conducted with each one's specific detector. Therefore, make sure to read the provided installation manual for each detector before installing. CO detectors are available as stand-alone models or system-connected, monitored devices.<sup>[12]</sup> System-connected detectors, which can be wired to either a security or fire panel, are monitored by a central station. In case the residence is empty, the residents are sleeping or occupants are already suffering from the effects of CO, the central station can be alerted to the high concentrations of CO gas and can send the proper authorities to investigate.

The gas sensors in CO alarms have a limited and indeterminable life span, typically two to five years. The test button on a CO alarm only tests the battery and circuitry, not the sensor. CO alarms should be tested with an external source of calibrated test gas, as recommended by the latest version of NFPA 720. Alarms over five years old should be replaced but they should be checked on installation and at least annually during the manufacturers warranty period. Most alarm manufacturers now recommend sensor inclusive testing on installation and at least annually.

# CHAPTER 5

## RESULTS AND DISCUSSIONS

Over flow of sewage on roads is been a major problem in many developed and under developed cities as well. Sewage is generally considered as waste water.

The response to the complaints is not properly answered or taken into account. A precautionary system is developed where this issue of sewage overflow can be reduced by early sensing of increase in its level.

The system design comprises of a sensor to sense the level, a controller to command, a communication network to register the complaints on blockage and continues increase in the level of sewage.

A data base is to be maintained to record the data. The system rather simply monitoring the level, it generates alarm signals via complaints to the required departments through mail and SMS regarding prior to overflow.

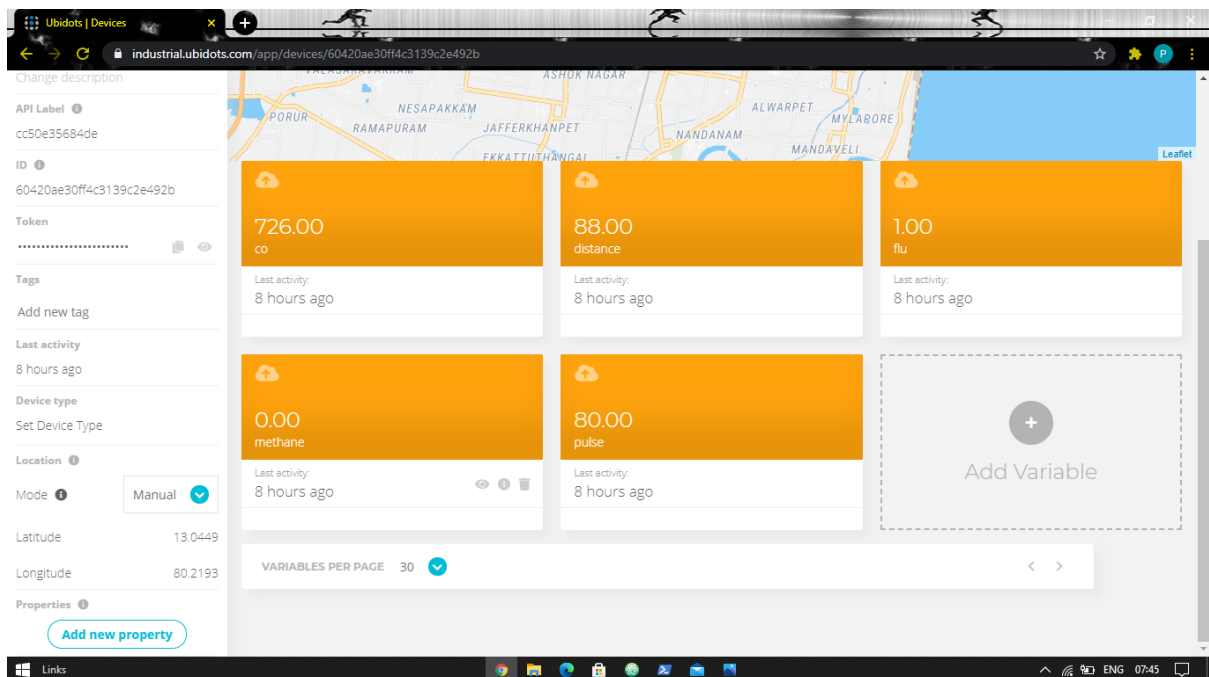


Fig.5.1 This will show all the sensors value in sewage

## **CHAPTER 6**

### **CONCLUSION AND FUTURE WORK**

Underground monitoring is a challenging problem. This project proposes different methods for monitoring and managing underground drainage systems.

It explains various applications like underground drainage and manhole identification in real time. Various parameters like temperature, toxic gases, flow and level of water are being monitored and updated on the internet using the Internet of Things.

This enables the person in-charge to take the necessary actions regarding the same. In this way the unnecessary trips on the manholes are saved and can only be conducted as and when required.

Also, real time update on the internet helps in maintaining the regularity in drainage check thus avoid the hazards.

## REFERENCE PAPERS:

- Lazarescu, M.T., "Design of a WSN Platform for Long-Term Environmental Monitoring for IoT Applications," Emerging and Selected Topics in Circuits And Systems, IEEE Journal on, vol.3, no.1, pp.45, 54, March 2013.
- Prof Muragesh SK1, Santhosha Rao2, "Automated Internet of Things For Underground Drainage and Manhole Monitoring Systems For Metropolitan Cities." International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 4, June 2015.
- Prof Muragesh SK1, Santhosha Rao2, "Automated Internet of Things For Underground Drainage and Manhole Monitoring Systems For Metropolitan Cities." International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 4, June 2015.
- Prof S. A. Shaikh1, Suvama A. Sonawane2, "Monitoring Smart City Application Using Raspberry PI based on IoT" International Journal of Innovative Science, Engineering & Technology, Vol 5 Issue VII, July 2017.
- Dr. Gunasekaran M1, Pavithra S2, Priyanka R2, Reeva M2, Volume: 06 Issue: 03, "IOT enabled underground Drainage monitoring System", Mar 2019 .

## APPENDICES

### A SOURCE CODE

```
#include "UbidotsMicroESP8266.h"
#include <ESP8266WiFi.h>
#define TOKEN "A1E-2mFMC8XRuilHAUJahRreiP418UmTZY" // Put here your Ubidots
TOKEN
#define ID_1 "5c868423c03f972b168167dd" // Put your variable ID here phsensor
#define ID_2 "5c86981dc03f973f855c041a" //buzzer5c86981dc03f973f855c041a
#define ID_3 "5c869764c03f973ee9367729" // motor5c869764c03f973ee9367729
#define WIFISSID "Sewage monitoring" // Put here your Wi-Fi SSID
#define PASSWORD "12345678" // Put here your Wi-Fi password

Ubidots client(TOKEN);
int b= D3;
int m=D5;
void setup()
{
    // initialize serial communication at 9600 bits per second:
    Serial.begin(9600);
    pinMode(b,OUTPUT);
    pinMode(m,OUTPUT);
    digitalWrite(m,LOW);
}

// the loop routine runs over and over again forever:
void loop()
{
    client.wifiConnection(WIFISSID, PASSWORD);

    int Respiratory sensor = random(0,15);
    Serial.println(Respiratory sensor);

    if (phsensor <12)
    {
        digitalWrite(buzzer, HIGH);
        digitalWrite(m, LOW);
    }
    else
    {
        digitalWrite(buzzer, LOW);
        digitalWrite(m, HIGH);
        delay(5000);
    }
    client.add(ID_1, buzzer);
    client.add(ID_2, motor);
    client.add(ID_3,Respiratory sensor);
    client.sendAll(false);
    delay(5000);
}

int cosensor = random(0,15);
Serial.println(cosensor);
if (phsensor <12) {
```

```

        digitalWrite(buzzer, HIGH);
        digitalWrite(m, LOW);
    }
    else
    {
        digitalWrite(buzzer, LOW);
        digitalWrite(m, HIGH);
        delay(5000);
    }
    client.add(ID_1, buzzer);
    client.add(ID_2, motor);
    client.add(ID_3, cosensor);
    client.sendAll(false);
    delay(5000);

```

```

int ultrasonic = random(0,15);
Serial.println(cosensor);

```

```

    if (ultrasonic <12)
    {
        digitalWrite(buzzer, HIGH);
        digitalWrite(m, LOW);
    }
    else
    {
        digitalWrite(buzzer, LOW);
        digitalWrite(m, HIGH);
        delay(5000); }

```

```

    client.add(ID_1, buzzer);
    client.add(ID_2, motor);
    client.add(ID_3, ultrasonic);
    client.sendAll(false);
    delay(5000);

```

```

int heartbeat = random(0,15);
Serial.println(heartbeat);

```

```

    if (ultrasonic <12)
    {
        digitalWrite(buzzer, HIGH);
        digitalWrite(m, LOW);
    }
    else
    {
        digitalWrite(buzzer, LOW);
        digitalWrite(m, HIGH);
        delay(5000);
    }
    client.add(ID_1, buzzer);
    client.add(ID_2, motor);
    client.add(ID_3, heartbeat);
    client.sendAll(false);
    delay(5000);

```

```

//LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
const int rs = 12, en = 11, d4 = 7, d5 = 8, d6 = 9, d7 = 10;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
int ammonia = A1;
void setup() {
  // put your setup code here, to run once:
  lcd.begin(16, 2);
  Serial.begin(9600);
  pinMode (PH,INPUT);
}
{
  // put your main code here, to run repeatedly:
  Serial.print("*****AMMONIA GAS*****\n");
  int state1=analogRead(ammonia);
  Serial.print("PH3= ");
  Serial.println(state1);
  if(state1==45)
  {
    lcd.setCursor(0, 8);
    lcd.print("co detected");
    Serial.println("co detected");
    delay(1400);
  }
  else
  {
    lcd.setCursor(0, 8);
    lcd.print("œLow heartbeat detected");
    Serial.println("Low heartbeat detected");
    delay(1400);
  }
}
{
  // int pot_value = analogRead(pot);
  // pot_value = map(pot_value,0,1024,0,255);
  //
  //
  // analogWrite(duty_cycle,pot_value);
  // Serial.print("Duty Cycle Value =");
  // Serial.println(pot_value);

  int var=0;
  digitalWrite(8, HIGH); // RECOG MODULE
  digitalWrite(9, LOW);
  digitalWrite(12,LOW);
  digitalWrite(13, HIGH);
  digitalWrite(10,LOW);
  digitalWrite(11, HIGH);
  delay(6.67);
  digitalWrite(10,HIGH);
  digitalWrite(10,LOW);
  while(var==0){
    pot_value = analogRead(pot);
    pot_value = map(pot_value,0,1024,0,255);
    Serial.println(level_value);

    analogWrite(ultrasonic level);
  }
}

```

```

delay(3.33);
digitalWrite(8,LOW);
digitalWrite(9, HIGH);
delay(3.33);
digitalWrite(12,HIGH);
digitalWrite(13,LOW);
delay(3.34);
digitalWrite(10,LOW);
digitalWrite(11, HIGH);
delay(3.33);
digitalWrite(8,HIGH);
digitalWrite(9,LOW);
delay(3.33);
digitalWrite(12,LOW);
digitalWrite(13, HIGH);
delay(3.34);
digitalWrite(10,HIGH);
digitalWrite(11,LOW);
}
}
*****/

void setup() {
  // Setup

  Serial.begin( 9600 );

  pen.attach(penServoPin);
  pen.write(penZUp);
  delay(100);

  // Decrease if necessary
  myX.setSpeed(600);

  myY.setSpeed(600);

  // Set & move to initial default position
  // TBD

  // Notifications!!!
  Serial.print("X range is from ");
  Serial.print(Xmin);
  Serial.print(" to ");
  Serial.print(Xmax);
  Serial.println(" mm.");
  Serial.print("Y range is from ");
  Serial.print(Ymin);
  Serial.print(" to ");
  Serial.print(Ymax);
  Serial.println(" mm.");
}

/*****
* void loop() - Main loop
*****/

```

```

void loop()
{

    delay(100);
    char line[ LINE_BUFFER_LENGTH ];
    char c;
    int lineIndex;
    bool lineIsComment, lineSemiColon;

    lineIndex = 0;
    lineSemiColon = false;
    lineIsComment = false;

    while (1) {

        // Serial reception - Mostly from Grbl, added semicolon support
        while ( Serial.available()>0 ) {
            c = Serial.read();
            if (( c == '\n' ) || ( c == '\r' ) ) {          // End of line reached
                if ( lineIndex > 0 ) {                    // Line is complete. Then execute!
                    line[ lineIndex ] = '\0';            // Terminate string
                    if (verbose) {
                        Serial.print( "Received : ");
                        Serial.println( line );
                    }
                    processIncomingLine( line, lineIndex );
                    lineIndex = 0;
                }
            }
            else {
                // Empty or comment line. Skip block.
            }
            lineIsComment = false;
            lineSemiColon = false;
            Serial.println("ok");
        }
        else {
            if ( (lineIsComment) || (lineSemiColon) ) { // Throw away all comment characters
                if ( c == ')' ) lineIsComment = false; // End of comment. Resume line.
            }
            else {
                if ( c <= ' ' ) {                        // Throw away whitespace and control characters
                }
                else if ( c == '/' ) {                    // Block delete not supported. Ignore character.
                }
                else if ( c == '(' ) {                    // Enable comments flag and ignore all characters until
                    // ')' or EOL.
                    lineIsComment = true;
                }
            }
            else if ( c == ';' ) {
                lineSemiColon = true;
            }
        }
    }
}

```

## B.SCREENSHOT

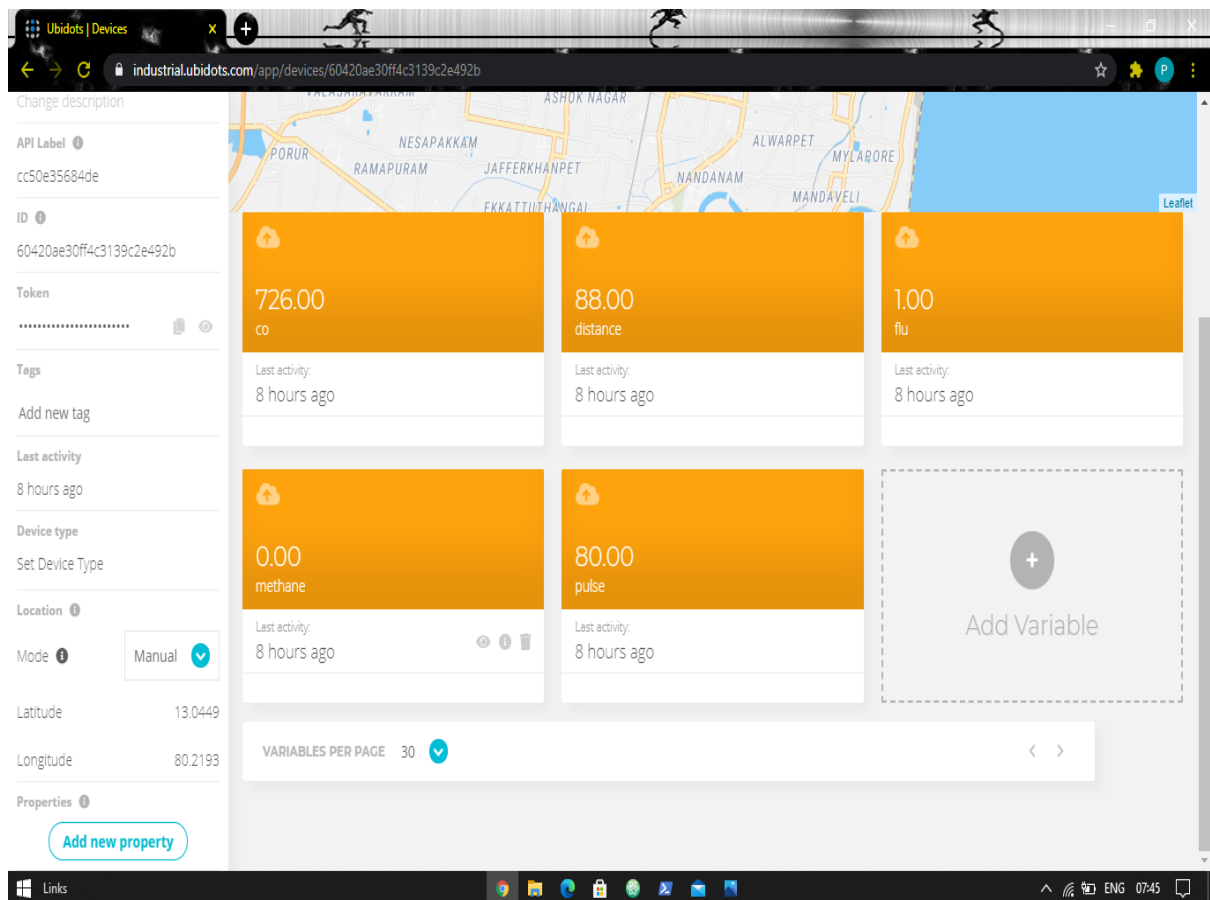


Fig.1 This shows the change level of wastage

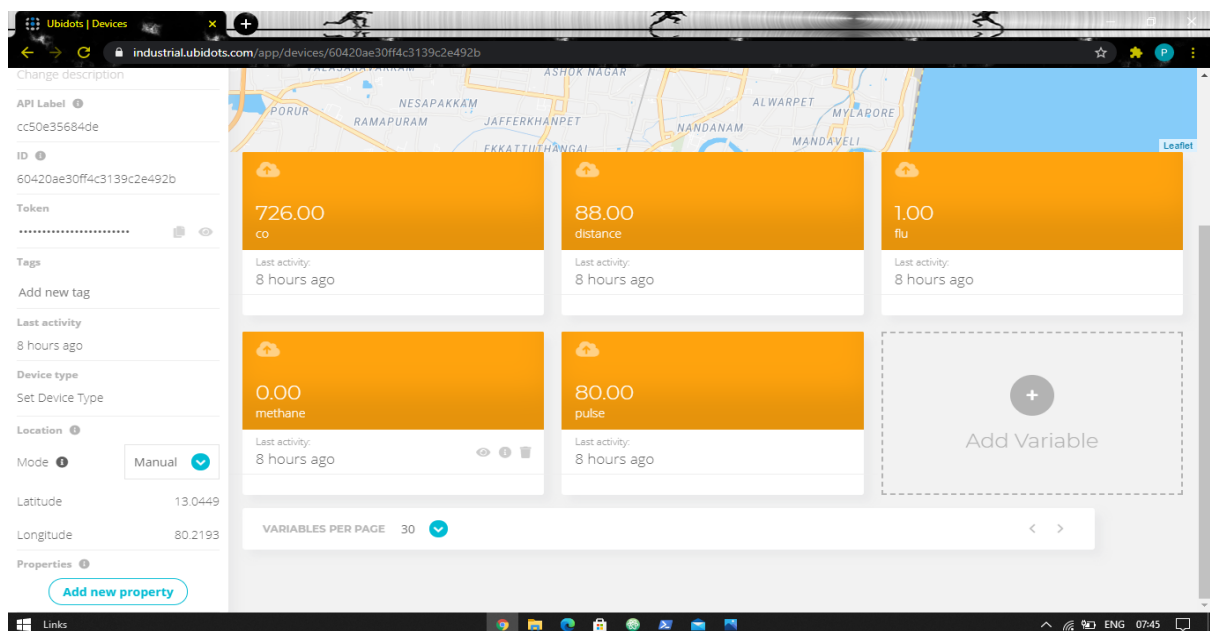


Fig.2 It detects methane gas present in sewage

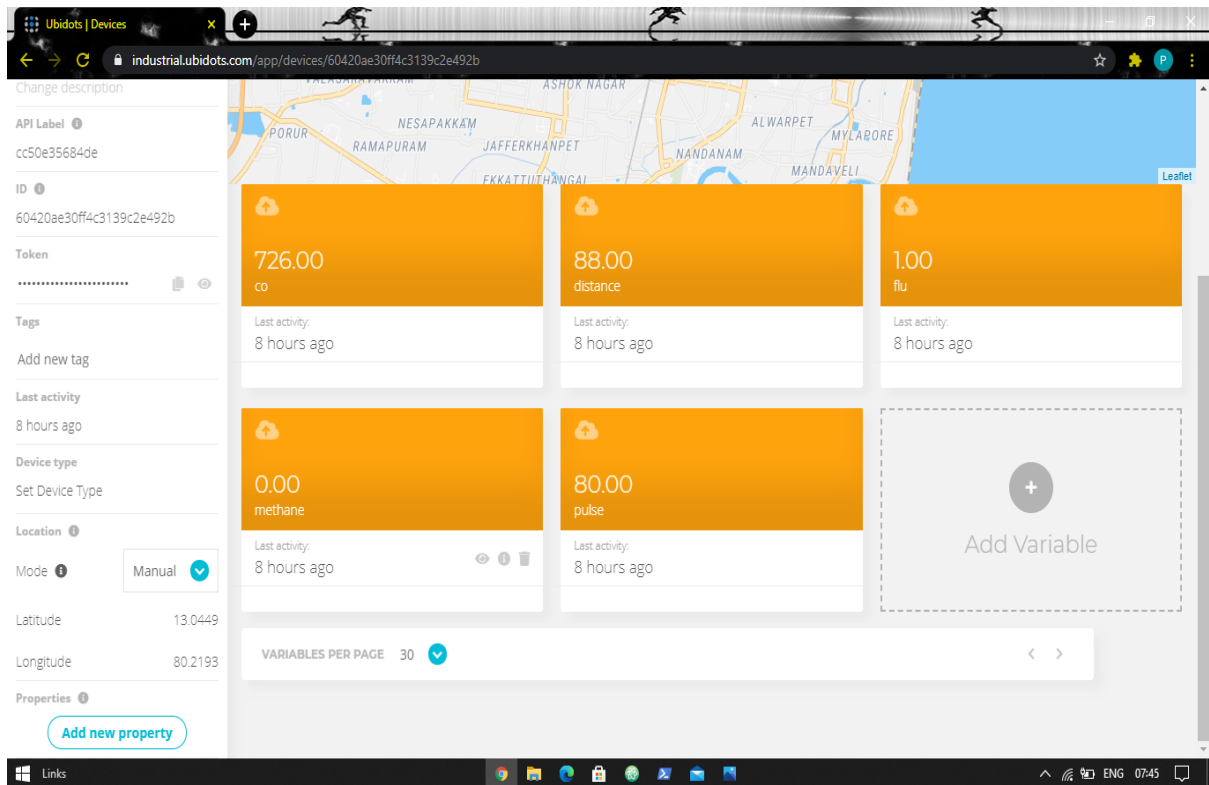


Fig.3 It detects CO gas present in sewage

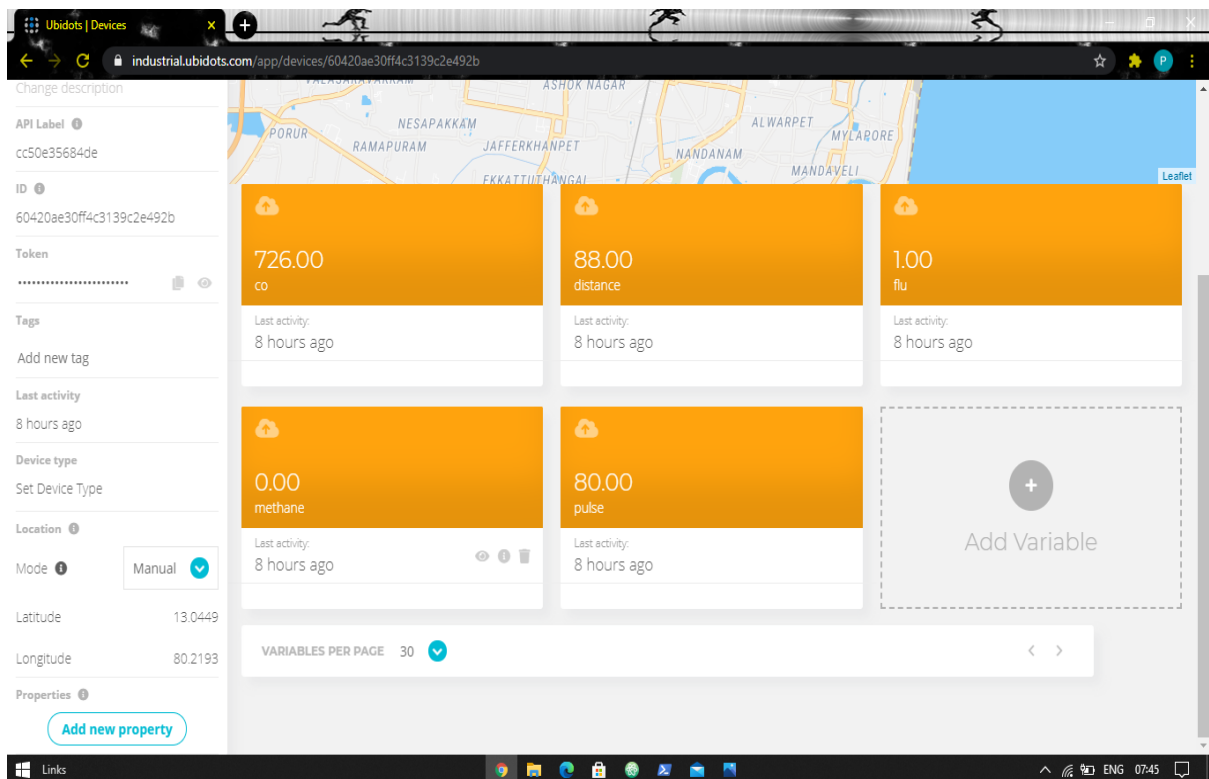


Fig.4 It measures the heartbeat of manual scavenger

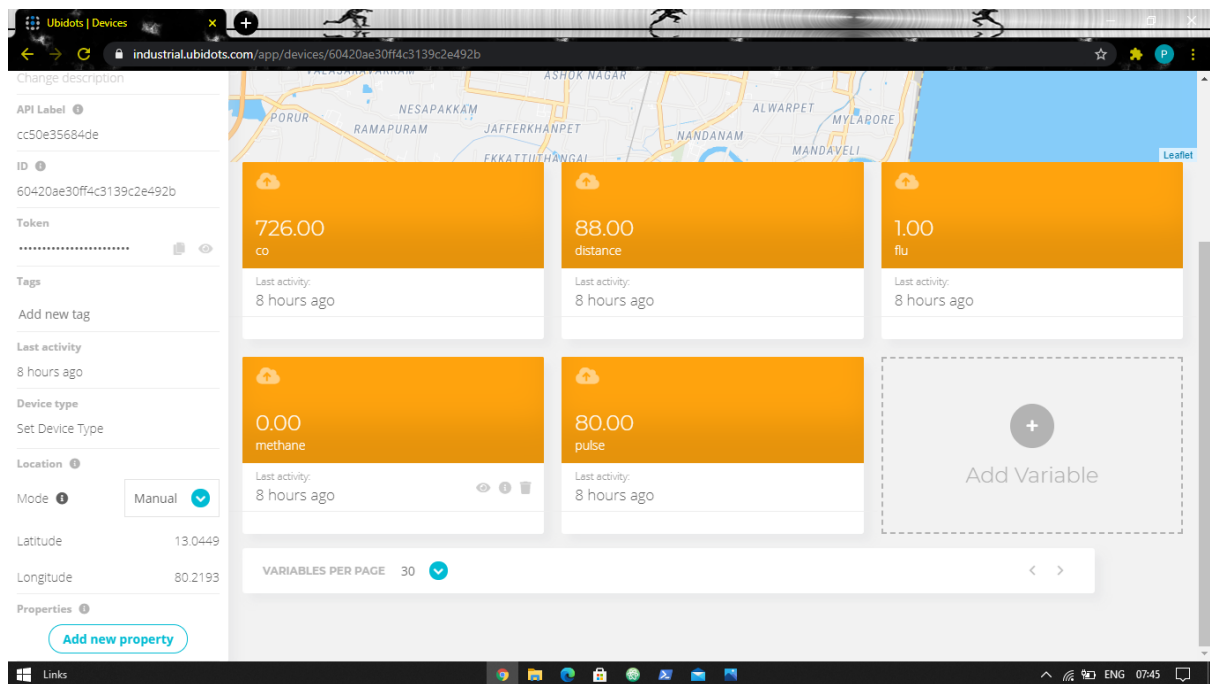


Fig 6 It sense the breathing rate of the scavengers