

# **ADVANCES IN SMART ENVIRONMENT MONITORING SYSTEMS USING IOT**

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

N.HARSHA VARDHAN (Reg. No.37110491)

E.RAVI TEJA (Reg. No. 37110207)



**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 | 12B Status by UGC |  
Approved by AICTE

**JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI -  
600 119**

**MARCH - 2021**



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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

[www.sathyabama.ac.in](http://www.sathyabama.ac.in)



## **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

### **BONAFIDE CERTIFICATE**

This is to certify that this project report is the bonafide work of **N.HARSHA VARDHAN (Reg. No. 37110491)** and **E. RAVI TEJA (Reg. No.37110207)** who carried out the project entitled "**ADVANCES IN SMART ENVIRONMENT MONITORING SYSTEMS USING IOT**" under my supervision from **August 2019 to March 2020**.

**Internal Guide**

Mr. R. SETHURAMAN B.E.,M.E.,(Ph.D).,

**Head of the Department**

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**Submitted for Viva voce Examination held on**

---

**Internal Examiner**

**External Examiner**

## **DECLARATION**

I **HARSHA VARDHAN** hereby declare that the Project Report entitled **“ADVANCES IN SMART ENVIRONMENT MONITORING SYSTEMS USING IOT”** is done by me under the guidance of **Mr. R. SETHURAMAN, M.E.**, 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.

**DATE:**

**PLACE: CHENNAI**

**SIGNATURE OF THE CANDIDATE**

## ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management** of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. Sasikala, M.E., Ph.D., Dean**, School of Computing, **Dr. S. Vigneswari, M.E., Ph.D.,** and **Dr. L. Lakshmanan, M.E., Ph.D., Heads of the Department** of Computer Science and Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Mr. R. Sethuraman B.E.,M.E.,(Ph.D)., Assistant Professor**, for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering** who were helpful in many ways for the completion of the project.

## **ABSTRACT**

Carbon monoxide, nitrogen oxides, and hydrocarbons are released when fuel is burned in an internal combustion engine and when air/fuel residuals are emitted through the vehicle tailpipe. Gasoline vapors also escape into the atmosphere during refueling and when fuel vaporizes from engines and fuel systems caused by vehicle operation or hot weather.

The pollutants in vehicle emissions are known to damage lung tissue, and can lead to and aggravate respiratory diseases, such as asthma. Motor vehicle pollution also contributes to the formation of acid rain and adds to the greenhouse gases that cause climate change.

Pollutants emitted directly from vehicles are not the only cause for concern. On warm, sunny days, hydrocarbons react with oxides of nitrogen to create a secondary pollutant, ozone. In many urban areas, motor vehicles are the single largest contributor to ground-level ozone which is a common component of smog. Ozone causes coughing, wheezing and shortness of Breath, and can bring on permanent lung damage, making it a cause of crucial public health problem

This problem can be rectify by using some kind of sensor called smoke sensor using this sensor connected to internet it directly Send the data to government

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# **CHAPTER 1**

## **INTRODUCTION**

The current advances in the fields of technology and economy are having a significant impact over the environment, and have led to serious concerns regarding pollution and climate change. In the report released in 2014, the Intergovernmental Panel on Climate Change confirms that human activities are having an unequivocal and continuously increasing influence on the climate system, with recent changes that are unprecedented over decades to millennia.

In this context, environmental monitoring represents a fundamental instrument for gathering relevant information about the ecosystem, leading to new knowledge and understanding, and for ultimately implementing adaptation and mitigation actions that address the degradation of the biosphere.

Another related field currently gaining attention is the monitoring of the ambient in indoor spaces. It has been shown that this is important not only for the comfort and health of building occupants, but also for the reduction of greenhouse gas emissions.

The most common parameters being monitored include the temperature, humidity, rainfall, atmospheric pressure, light intensity, air quality, affected by pollutants such as CO<sub>2</sub>, CO, SO<sub>x</sub>, volatile organic compounds, and many others. One of the immediate benefits brought by the acquisition of such physical properties, like soil moisture, temperature, and salinity, can be seen in agriculture, where significant water resource savings can be achieved.

The majority of monitoring applications rely on WSNs, motivated by the indisputable advantages they bring: lower costs due to the replacement of cables, variable network topologies, scalability, and lower maintenance and commissioning expenses.

## **CHAPTER 2**

### **LITERATURE SURVEY**

#### **1. A Smart Air Pollution Monitoring System**

Author: Kennedy Okokpujie, Etinosa Noma-Osaghae, Modupe Odusami, Samuel John

Air pollution affects our day to day activities and quality of life. It poses a threat to the ecosystem and the quality of life on the planet. The dire need to monitor air quality is very glaring, owing to increased industrial activities over the past years. People need to know the extent to which their activities affect air quality. This project proposes an air pollution monitoring system. The system was developed using the Arduino microcontroller.

#### **2. Air Quality Monitoring System**

Author: Boyanka Nikolova, Marin B. Marinov, Georgi Todorov Nikolov

Detection of low concentration of air pollution, like cigarette smoke, cooking fumes, etc. is possible with the combination of an air quality sensor and data acquisition system. In present paper is presented approach for design and implementation of air quality monitoring system based on tin dioxide gas sensor, integrated temperature and humidity sensors, portable modular data acquisition system and graphical programming language. An interpolation method reducing influence from temperature and humidity is suggested.

#### **3. An air quality monitoring system for urban areas based on the technology of wireless sensor networks**

Author: Jen-Hao Liu, Yu-Fan Chen, Tzu-Shiang Lin, Chia-Pang Chen.

Air pollution is one of environmental issues that cannot be ignored. The heavy transportation and urbanization result in the air pollutants concentrated in certain areas. Inhaling pollutants for a long time causes damages in human health. Traditional air quality monitoring methods, such as building air quality monitoring stations, are typically expensive. In addition, monitoring stations are generally less

densely deployed and provide low resolution sensing data. This paper proposes an urban air quality monitoring system based on the technology of wireless sensor networks (WSNs).

#### 4. IOT BASED AIR QUALITY MONITORING SYSTEM

Author: Ch.V.Saikumar, M.Reji, P.C.Kishoreraja

The main objective of this project is to monitor the air eminence in industrial and urban areas. The proposed outline includes a set of gas sensors (CO, and NO<sub>2</sub>) that are positioned on masses and structure of a IOT (Internet of things) and a dominant server to support both short-range real-time incident management and a continuing deliberate planning. In this Arduino platform is used to communicate the data simply and quickly. WSN (Wireless sensor network) acts as the trans receiver. This provide a real-time low rate monitoring system over the use of low rate, low information rate, and little control wireless communication technology.

## **CHAPTER 3**

### **AIM AND SCOPE**

#### **3.1 AIM :**

This project mainly describes about the continuously monitoring the vehicle pollution in real environment. Many gases carbon monoxide etc, are going to use in exhaust system in vehicle it takes two inputs one from the smoke sensor and other from the threshold value specified by the government. If it reaches the high threshold value the vehicle location can be tracked by the gps module is sent to the government.

#### **3.2 OBJECTIVE :**

In real life scenario pollution checking is the major objective to avoid harmful gases releasing from the some chamber. For this we are using two inputs one input to be given for the smoke chamber and another input is government setted Threshold Temparture. In our daily life situation everytime comparing both inputs and gives alert variable network topologies, scalability, and lower maintenance and commissioning expenses.

#### **3.3 EXISTING SYSTEM:**

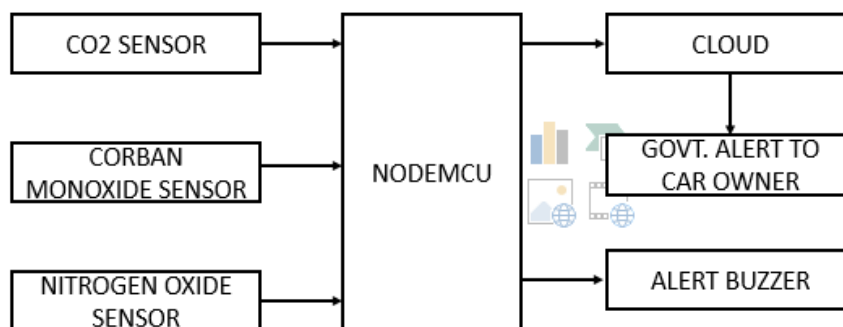
The microcontroller is programmed to do mainly three functions namely: Comparison, timer and triggering.. When the smoke sensor output is more than the threshold value, the microcontroller triggers the timer circuit and an alarm is set on to inform the driver of the pollution in the vehicle and that it will come to the halt state. Semiconductor sensor MQ-2 is used to detect the smoke whose range is 300ppm to 10000ppm. CO Sensor having low conductivity in a clean environment is connected to an PIC microcontroller When this sensor is exposed to the pollutants its conductivity increases generating a signal in the circuit which disables the motor. An automatic SMS is also generated by a gsm module which is connected in the circuit.

### 3.4 PROPOSED SYSTEM:

- The given proposed system is continuously monitoring the vehicle pollution monitoring
- Carbon monoxide sensor, nitrogen oxides sensor are going to use in exhaust system in vehicle It takes two inputs one from the smoke sensor and the other being the pre-defined threshold value specified by the government.
- If it reaches the high threshold value the vehicle location can be traced by GPS module and the location is sent to the government. The government may going to cancel the registration of the car and the message to the car owner.

### 3.5 HARDWARE DESIGN

#### 3.5.1 Block diagram:



#### 3.5.2 Hardware required:

- CO2 SENSOR
- NITROGEN OXIDE SENSOR
- NODEMCU
- CARBON MONOXIDE
- GPS

### **3.5.3 EMBEDDED SYSTEMS**

#### *3.5.3.1 Overview of embedded systems*

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance.

Some embedded systems are mass-produced, benefiting from economies of scale. Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected.

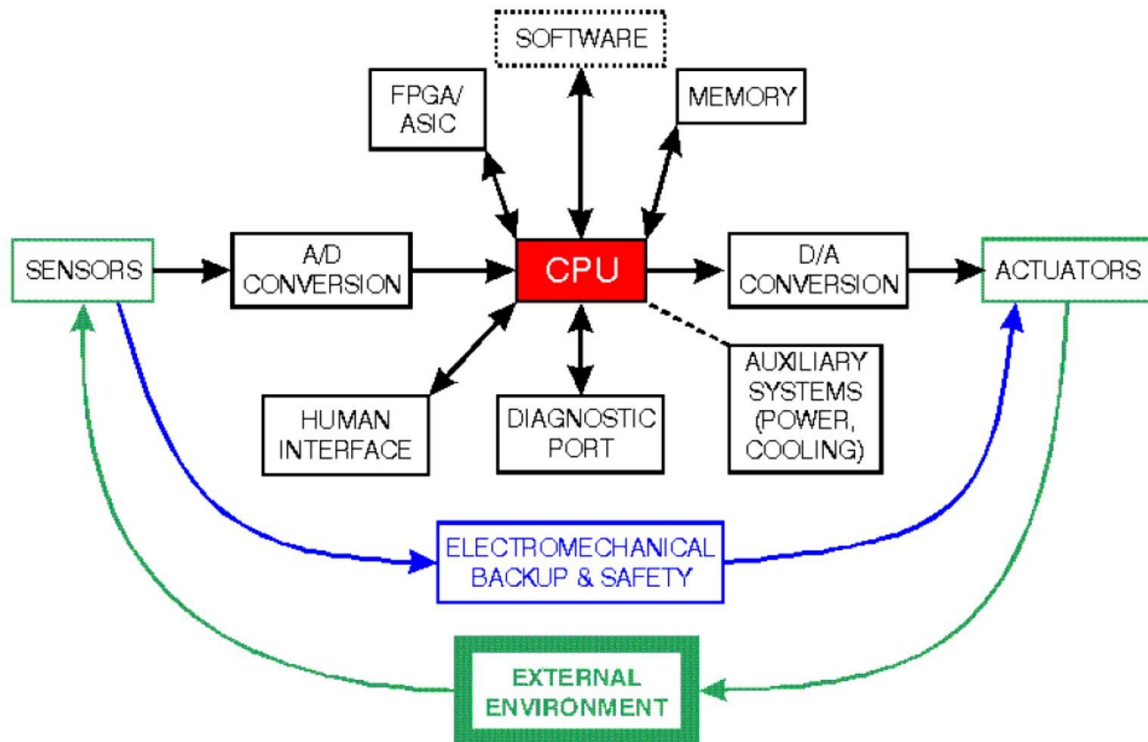
Embedded systems provide several functions

- Monitor the environment; embedded systems read data from input sensors. This data is then processed and the results displayed in some format to a user or users

- Control the environment; embedded systems generate and transmit commands for actuators.
- Transform the information; embedded systems transform the data collected in some meaningful way, such as data compression/decompression
- Although interaction with the external world via sensors and actuators is an important aspect of embedded systems, these systems also provide functionality specific to their applications. Embedded systems typically execute applications such as control laws, finite state machines, and signal processing algorithms. These systems must also detect and react to faults in both the internal computing environment as well as the surrounding electromechanical systems.
- There are many categories of embedded systems, from communication devices to home appliances to control systems. Examples include;
  - Communication devices
    - g.: modems, cellular phones
  - Home Appliances
    - g.: CD player, VCR, microwave oven
  - Control Systems
    - g.: Automobile anti-lock braking systems, robotics, satellite control

#### 3.5.3.2 *Block diagram of an embedded system:*

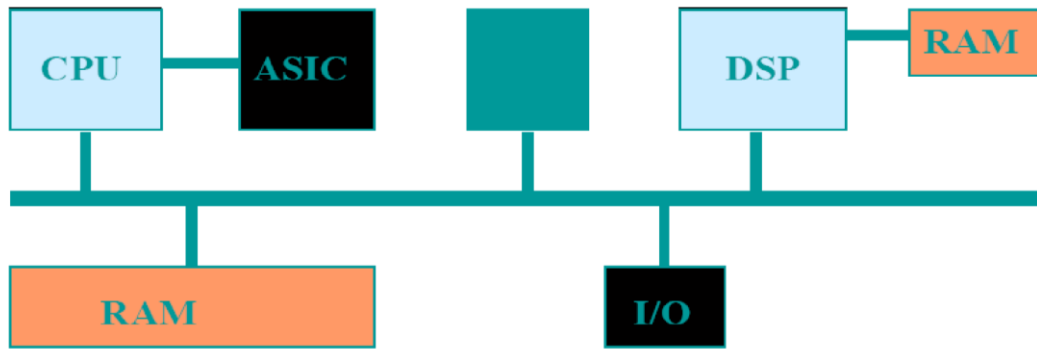
An embedded system usually contains an embedded processor. Many appliances that have a digital interface -- microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system. Others are very specialized resulting in the entire logic being implemented as a single program. These systems are embedded into some device for some specific purpose other than to provide general purpose computing . A typical embedded system is shown in Fig 1.1



**Fig 3.5.3.2.1 Block diagram of a typical embedded system**

### 3.5.3.3 Heterogeneous Architectures

Embedded systems often are composed of heterogeneous architectures (Fig 1.2). They may contain different processors in the same system solution. They may also be mixed signal systems. The combination of I/O interfaces, local and remote memories, and sensors and actuators makes embedded system design truly unique. Embedded systems also have tight design constraints, and heterogeneity provides better design flexibility.



**Fig 3.5.3.3.1 Embedded Systems having Heterogeneous Architectures**

#### *3.5.3.4 Harsh environment*

Many embedded systems do not operate in a controlled environment. Excessive heat is often a problem, especially in applications involving combustion (e.g., many transportation applications). Additional problems can be caused for embedded computing by a need for protection from vibration, shock, lightning, power supply fluctuations, water, corrosion, fire, and general physical abuse.

#### *3.5.3.5 System safety and reliability*

As embedded system complexity and computing power continue to grow, they are starting to control more and more of the safety aspects of the overall system. These safety measures may be in the form of software as well as hardware control. Mechanical safety backups are normally activated when the computer system loses control in order to safely shut down system operation. Software safety and reliability is a bigger issue. Software doesn't normally "break" in the sense of hardware.

However software may be so complex that a set of unexpected circumstances can cause software failures leading to unsafe situations. Discussion of this topic is outside the scope of this book, but the challenges for embedded designers include designing reliable software and building cheap, available systems using unreliable components. The main challenge for embedded system designers is to obtain low-cost reliability with minimal redundancy.

#### *3.5.3.6 Control of physical systems*

One of the main reasons for embedding a computer is to interact with the environment. This is often done by monitoring and controlling external machinery. Embedded computers transform the analog signals from sensors into digital form for processing. Outputs must be transformed back to analog signal levels. When controlling physical equipment, large current loads may need to be switched in order to operate motors and other actuators. To meet these needs, embedded systems may need large computer circuit boards with many non-digital components. Embedded system designers must carefully balance system tradeoffs among analog components, power, mechanical, network, and digital hardware with corresponding software.

#### *3.5.3.7 Small and low weight*

Many embedded computers are physically located within some larger system. The form factor for the embedded system may be dictated by aesthetics. For example, the form factor for a missile may have to fit inside the nose of the missile. One of the challenges for embedded systems designers is to develop non-rectangular geometries for certain solutions. Weight can also be a critical constraint. Embedded automobile control systems, for example, must be light weight for fuel economy. Portable CD players must be light weight for portability purposes.

#### *3.5.3.8 Cost sensitivity*

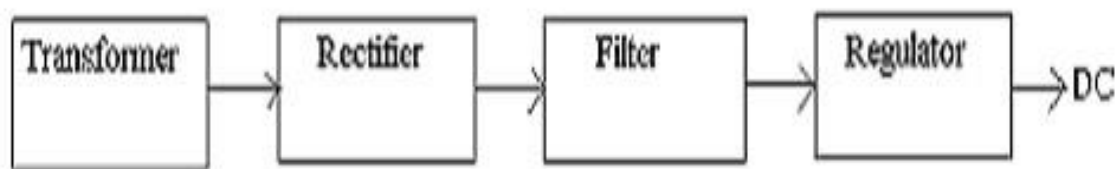
Cost is an issue in most systems, but the sensitivity to cost changes can vary dramatically in embedded systems. This is mainly due to the effect of computer costs have on profitability and is more a function of the proportion of cost changes compared to the total system cost.

#### *3.5.3.9 Power management*

Embedded systems have strict constraints on power. Given the portability requirements of many embedded systems, the need to conserve power is important to maintain battery life as long as possible. Minimization of heat production is another obvious concern for embedded systems.

### 3.6 POWER SUPPLY

All electronic circuits work only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning. This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.



**Fig 3.6.1.General Block Of Power Supply Unit**

### 3.7 TRANSFORMER:

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

### 3.8 RECTIFIER:

A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the

period  $t = 0$  to  $T/2$ . Accordingly for the negative cycle of the input the conducting diodes are D1 & D4. Thus the polarity across the load is the same.

In the bridge rectifier the diodes may be of variable types like 1N4001, 1N4003, 1N4004, 1N4005, 1N4007 etc.... can be used. But here we use 1N4007, because it can withstand up to 1000v.

### **3.9 FILTERS:**

In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output & a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

### **3.10 REGISTERS:**

The controller IC has two 8 bit registers, an instruction register (IR) and a data register (DR). The IR stores the instruction codes and address information for display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written, but not read by the MPU.

The DR temporally stores data to be written to /read from the DD RAM or CG RAM. The data written to DR by the MPU, is automatically written to the DD RAM or CG RAM as an internal operation. When an address code is written to IR, the data is automatically transferred from the DD RAM or CG RAM to the DR. data transfer between the MPU is then completed when the MPU reads the DR. likewise, for the next MPU read of the DR, data in DD RAM or CG RAM at the address is sent to the DR automatically. Similarly, for the MPU write of the DR, the next DD RAM or CG RAM address is selected for the write operation.

The dot-matrix liquid crystal display controller and driver LSI displays alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required

for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver

### **3.11 REGULATORS:**

The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage regulator namely LM7805. The IC LM7805 is a +5v regulator which is used for microcontroller.

### **3.12 FEATURES AND DESCRIPTION OF REGULATORS**

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

#### **3.12.1 NODE MCU**

NodeMCU is an open source IoT platform.<sup>[4][5]</sup> It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.<sup>[6][7]</sup> The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It 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>[8]</sup> and SPIFFS

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems<sup>[6]</sup> began production of the ESP8266.<sup>[10]</sup> The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core,<sup>[citation needed]</sup> widely used in IoT applications (see related projects). NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub.<sup>[11]</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>[12]</sup> Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform,<sup>[13]</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>[14]</sup> to NodeMCU project,<sup>[15]</sup> enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In summer 2015 the creators abandoned the firmware project and a group of independent contributors took over. By summer 2016 the NodeMCU included more than 40 different modules. Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.

s [Arduino.cc](https://www.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>[16]</sup> This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs. IoT platform node MCU is open source .

It is based on the eLua project, and built on the ESP8266 SDK 0.9.5. It uses many open source projects, such as lua-cjson, and spiffs. It includes firmware which runs on the ESP8266 Wi-Fi SoC, and hardware which is based on the ESP-12 module. NodeMCU was created shortly after the ESP8266 came out. In December 30, 2013, Espressif systems began production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. NodeMCU started in 13 Oct 2014, when Hong committed the first file of NodeMCU - firmware to GitHub. 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 1.0. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to Node MCU project, then Node MCU was able to support the MQTT IoT protocol, using Lua to access 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 to NodeMCU project, enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

The main objective of this project is to develop a home automation system using an Node MCU board with Internet being remotely controlled by any Android OS smart phone. As technology is advancing so houses are also getting smarter. Modern houses are gradually shifting from conventional switches to centralized control system, involving remote controlled switches. Presently, conventional wall switches located in different parts of the house makes it difficult for the user to go near them to operate. Even more it becomes more difficult for the elderly or physically handicapped people to do so. Remote controlled home automation system provides a most modern solution with smart phones.

In order to achieve this, a relay module is interfaced to the Node MCU board at the receiver end while on the transmitter end, a GUI application on the cell phone sends ON/OFF commands to the receiver where loads are connected. By touching the specified location on the GUI, the loads can be turned ON/OFF remotely through this technology. The loads are operated by IOT board through Relay Module.

NODEMCU (esp8266) has been selected as the controller for this system due to its compact size, compatibility, easy interfacing over several other type of controller including Programmable Integrated Circuit (PIC), Programmable Logic Controller (PLC) and others. ESP8266 is an open source firmware that is built on top of the chip manufacturer's proprietary SDK. The firmware provides a simple programming environment, which is a very simple and fast scripting language. The ESP8266 chip incorporates on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board..Figure-3 shows the diagram of NODEMCU (ESP8266). It has

Processor called L106 32bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz and has a memory of 32 Kbit instruction RAM ,32 Kbit instruction cache RAM, 80 Kbit user data RAM&16 KbitETS system data RAM. It has inbuilt Wi-Fi module of IEEE 802.11 b/g/n Wi-Fi.

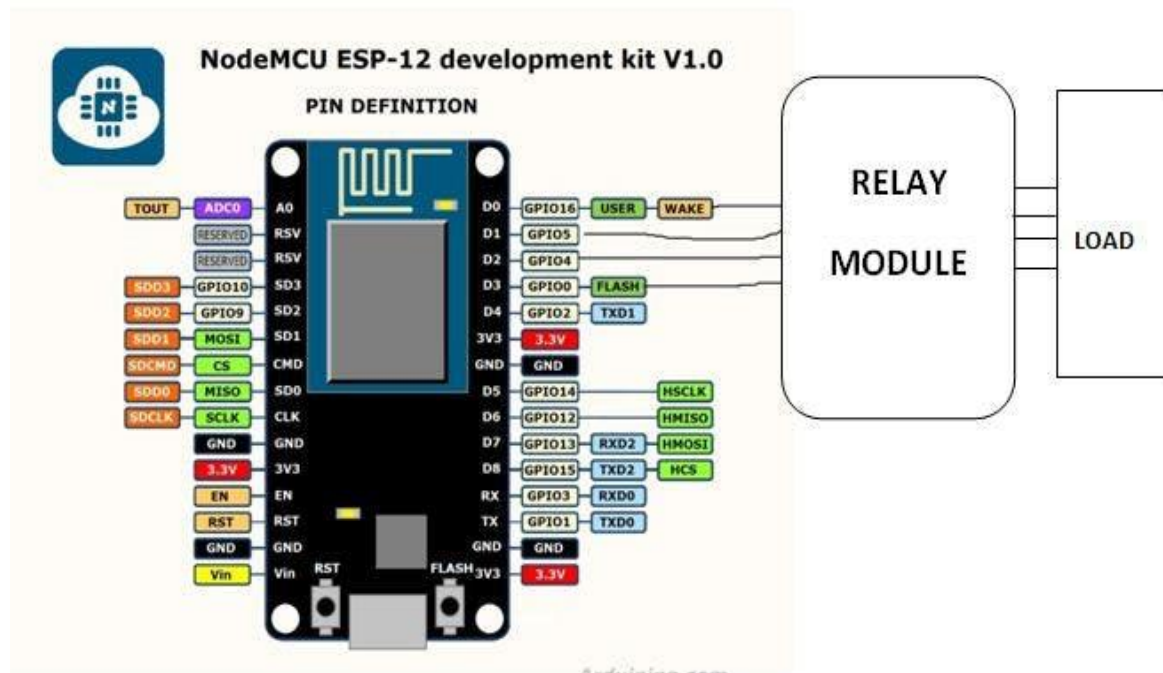
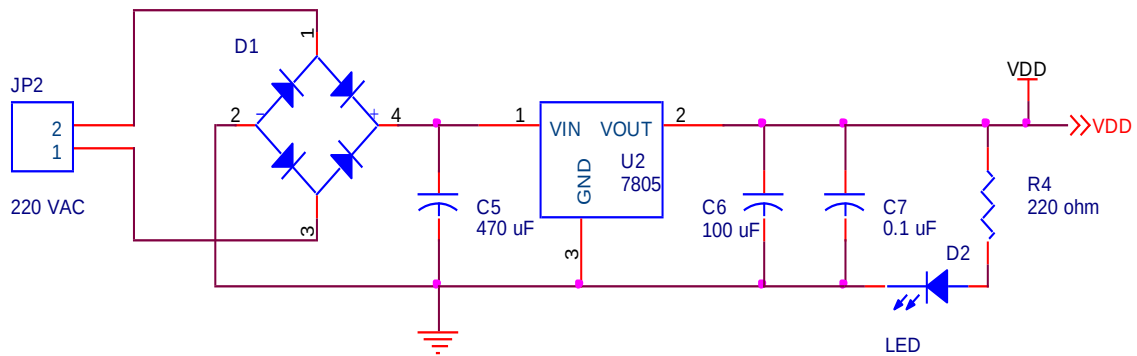


FIG. 3.12.1.1 NODE ESP-12 DEVELOPMENT KIT V1.0

### 3.12.2 CIRCUIT DIAGRAM DESCRIPTION

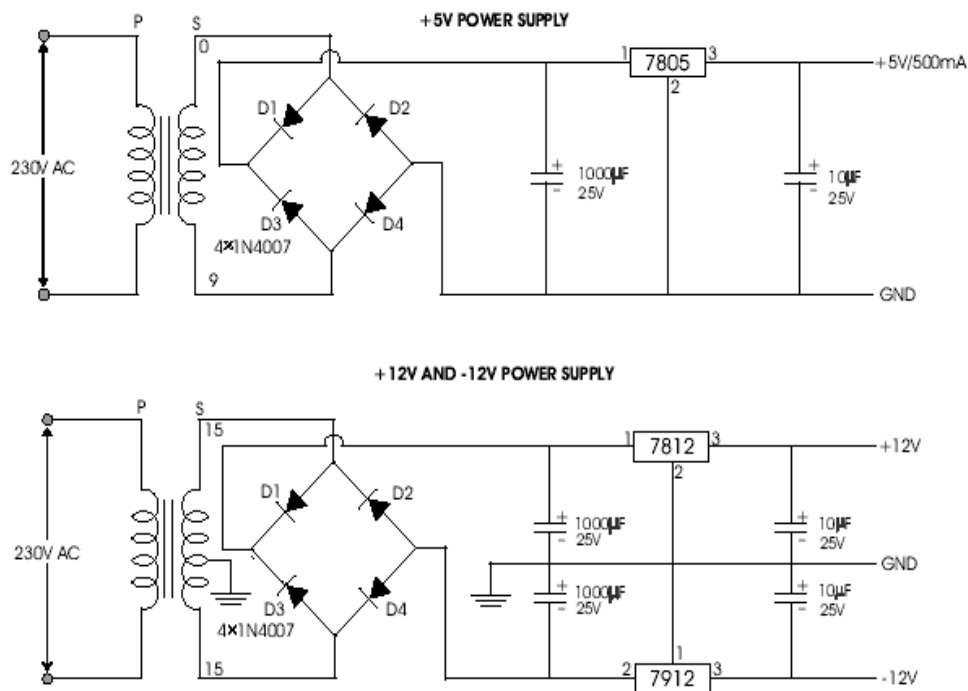
The operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an AC voltage, a steady DC voltage is obtained by rectifying the AC voltage, Then filtering to a DC level, and finally, regulating to obtain a desired fixed DC voltage. The regulation is usually obtained from an IC voltage regulator Unit, which takes a DC voltage and provides a somewhat lower DC voltage, Which remains the same even if the input DC voltage varies, or the output Load connected to the DC voltage changes.

### 3.12.2.1 POWER SUPPLY UNIT:



## 3.13 CIRCUIT DIAGRAM OF POWER SUPPLY

### 3.13.1 WORKING PRINCIPLE:



The AC voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired DC output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains

the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes.

### **3.13.2 TRANSFORMER:**

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op-amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

### **3.13.3 BRIDGE RECTIFIER:**

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3. One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to the shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier. One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice

that of the conventional full-wave circuit. This may be shown by assigning values to some of the components shown in views A and B. Assume that the same transformer is used in both circuits. The peak voltage developed between points X and Y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts. The maximum voltage that appears across the load resistor is nearly—but never exceeds—500 volts, as a result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

### **3.13.4 IC VOLTAGE REGULATORS:**

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage,  $V_i$ , applied to one input terminal, a regulated dc output voltage,  $V_o$ , from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

#### **3.13.4.1 Gas sensor module :**

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:

Filtering out the suspended particles so that only gaseous elements are able to pass to insides of the sensor.

- 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. 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.

#### *3.13.4.1.1 CO<sub>2</sub> SENSOR:*

A carbon dioxide sensor or CO<sub>2</sub> sensor is an instrument for the measurement of carbon-di-oxide gas

The most common principles for CO<sub>2</sub> sensors are infrared gas sensors (NDIR) and chemical gas sensors

Measuring carbon dioxide is important in monitoring indoor air quality, the function of the lungs in the form of a capnograph device, and many industrial processes



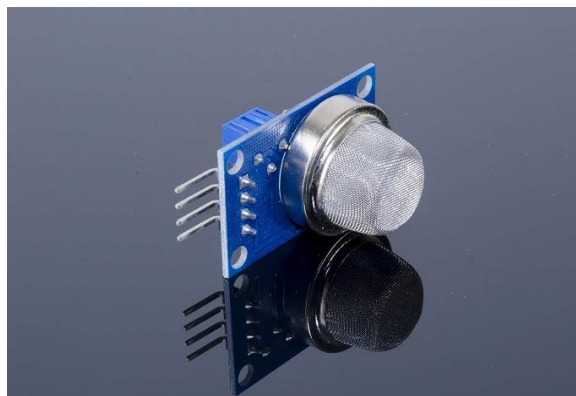
#### *3.13.4.1.2 Methane gas sensor:*

- Methane gas sensor detects the concentration of methane gas in the sewage and outputs its reading as an analog voltage.
- MQ-4 gas sensor has high sensitivity to Methane, also to Propane and Butane.
- The sensor could be used to detect different combustible gas, especially Methane, it is with low cost and suitable for different application.



#### 3.13.4.1.3 Propane sensor:

- If a flaming wooden splint or piece of paper is inserted into a tube of **gas** and the flame immediately goes out, then the **gas** is **propane** versus oxygen (oxygen would feed the flame). If a wet piece of pH paper is inserted into a tube of **gas** and shows no change, then the **gas** is **propane** versus carbon dioxide.
- **Propane** is a colorless, odorless, tasteless, diatomic and generally inert gas at standard temperature and pressure.
- Propane **sensor** designed to measure low ambient levels of propane associated with the irritation of the eyes, nose, throat, and lungs



## CHAPTER 4

### SOFTWARE DEVELOPMENT METHODOLOGY

#### 4.1 GENERAL INTRODUCTION OF INTERNET OF THINGS

##### 4.1.1 INTERNET OF THINGS:

The Internet of things (IOT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IOT-GSI) defined the 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" and for these purposes a "thing" is "an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks". The IOT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IOT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IOT will consist of about 30 billion objects by 2020. Typically, IOT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid, and expanding to areas such as smart cities. "Things", in the IOT sense, can refer to a wide variety of devices such as heart monitoring implants,

biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices that assist fire fighters in search and rescue operations. Legal scholars suggest regarding "Things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens, or refrigerators/freezers that use Wi-Fi for remote monitoring. As well as the expansion of Internet-connected automation into a plethora of new application areas, IOT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IOT is one of the platforms of today's Smart City, and Smart Energy Management Systems

#### **4.1.2 APPLICATIONS:**

According to Gartner, Inc. (a technology research and advisory corporation), there will be nearly 20.8 billion devices on the Internet of things by 2020. ABI Research estimates that more than 30 billion devices will be wirelessly connected to the Internet of things by 2020. As per a 2014 survey and study done by Pew Research Internet Project, a large majority of the technology experts and engaged Internet users who responded—83 percent—agreed with the notion that the Internet/Cloud of Things, embedded and wearable computing (and the corresponding dynamic systems) will have widespread and beneficial effects by 2025. As such, it is clear that the IOT will consist of a very large number of devices being connected to the Internet. In an active move to accommodate new and emerging technological innovation, the UK Government, in their 2015 budget, allocated £40,000,000 towards research into the Internet of things. The former British Chancellor of the Exchequer George Osborne, posited that the Internet of things is the next stage of the information revolution and referenced the inter-connectivity of everything from urban transport to medical devices to household appliances. The ability to network

embedded devices with limited CPU, memory and power resources means that IOT finds applications in nearly every field. [48] Such systems could be in charge of collecting information in settings ranging from natural ecosystems to buildings and factories, thereby finding applications in fields of environmental sensing and urban planning. On the other hand, IOT systems could also be responsible for performing actions, not just sensing things. Intelligent shopping systems, for example, could monitor specific users' purchasing habits in a store by tracking their specific mobile phones. These users could then be provided with special offers on their favourite products, or even location of items that they need, which their fridge has automatically conveyed to the phone. Additional examples of sensing and actuating are reflected in applications that deal with heat, water, electricity and energy management, as well as cruise-assisting transportation systems. Other applications that the Internet of things can provide is enabling extended home security features and home automation. The concept of an "Internet of living things" has been proposed to describe networks of biological sensors that could use cloud-based analyses to allow users to study DNA or other molecules. However, the application of the IOT is not only restricted to these areas. Other specialized use cases of the IOT may also exist. An overview of some of the most prominent application areas is provided here.

#### **4.1.3 ENVIRONMENTAL MONITORING :**

Environmental monitoring applications of the IOT typically use sensors to assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even include areas like monitoring the movements of wildlife and their habitats. Development of resource constrained devices connected to the Internet also means that other applications like earthquake or tsunami early-warning systems can also be used by emergency services to provide more effective aid. IOT devices in this application typically span a large geographic area and can also be mobile. It has been argued that the standardization IOT brings to wireless sensing will revolutionize this area.

#### **4.1.4 MANUFACTURING NETWORK:**

Control and management of manufacturing equipment, asset and situation management, or manufacturing process control bring the IOT within the realm of industrial applications and smart manufacturing as well. The IOT intelligent systems enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing production and supply chain networks, by networking machinery, sensors and control systems together. Digital control systems to automate process controls, operator tools and service information systems to optimize plant safety and security are within the purview of the IOT. But it also extends itself to asset management via predictive maintenance, statistical evaluation, and measurements to maximize reliability. Smart industrial management systems can also be integrated with the Smart Grid, thereby enabling real-time energy optimization. Measurements, automated controls, plant optimization, health and safety management, and other functions are provided by a large number of networked sensors. The National Science Foundation established an Industry/University Cooperative Research Centre on intelligent maintenance systems (IMS) in 2001 with a research focus to use IOT-based predictive analytics technologies to monitor connected machines and to predict machine degradation, and further to prevent potential failures. The vision to achieve near-zero breakdown using IOT-based predictive analytics led the future development of e-manufacturing and e-maintenance activities. The term IIOT (Industrial Internet of Things) is often encountered in the manufacturing industries, referring to the industrial subset of the IOT. IIOT in manufacturing could generate so much business value that it will eventually lead to the fourth industrial revolution, so the so-called Industry 4.0. It is estimated that in the future, successful companies will be able to increase their revenue through Internet of things by creating new business models and improve productivity, exploit analytics for innovation, and transform workforce. The potential of growth by implementing IIOT will generate \$12 trillion of global GDP by 2030 while connectivity and data acquisition are imperative for IIOT, they should not be the purpose, rather the foundation and path to something bigger. Among all the technologies, predictive maintenance is probably a relatively "easier win" since it is applicable to existing assets and management systems. The objective of intelligent

maintenance systems is to reduce unexpected downtime and increase productivity. And to realize that alone would generate around up to 30% over total maintenance costs. Industrial big data analytics will play a vital role in manufacturing asset predictive maintenance, although that is not the only capability of industrial big data. Cyber-physical systems (CPS) is the core technology of industrial big data and it will be an interface between human and the cyber world. Cyber-physical systems can be designed by following the 5C (connection, conversion, cyber, cognition, configuration, architecture), and it will transform the collected data into actionable information, and eventually interfere with the physical assets to optimize processes. An IOT-enabled intelligent system of such cases has been demonstrated by the NSF Industry/University Collaborative Research Centre for Intelligent Maintenance Systems (IMS) at University of Cincinnati on a band saw machine in IMTS 2014 in Chicago. Band saw machines are not necessarily expensive, but the band saw belt expenses are enormous since they degrade much faster. However, without sensing and intelligent analytics, it can be only determined by experience when the band saw belt will actually break. The developed prognostics system will be able to recognize and monitor the degradation of band saw belts even if the condition is changing, so that users will know in near real time when is the best time to replace band saw. This will significantly improve user experience and operator safety, and save costs on replacing band saw belts before they actually break. The developed analytical algorithms were realized on a cloud server, and was made accessible via the Internet and on mobile devices.

#### **4.1.5 TRANSPORTATION:**

The IOT can assist in integration of communications, control, and information processing across various transportation systems. Application of the IOT extends to all aspects of transportation systems (i.e. the vehicle, the infrastructure, and the driver or user). Dynamic interaction between these components of a transport system enables inter and intra vehicular communication, smart traffic control, smart parking, electronic toll collection systems, logistic and fleet management.

#### **4.6 ARCHITECTURE:**

The system will likely be an example of event-driven architecture, bottom-up made (based on the context of processes and operations, in real-time) and will consider any subsidiary level. Therefore, model driven and functional approaches will coexist with new ones able to treat exceptions and unusual evolution of processes (multi-agent systems, B-ADSC, etc.). In an Internet of things, the meaning of an event will not necessarily be based on a deterministic or syntactic model but would instead be based on the context of the event itself: this will also be a semantic web. Consequently, it will not necessarily need common standards that would not be able to address every context or use: some actors (services, components, avatars) will accordingly be self-referenced and, if ever needed, adaptive to existing common standards (predicting everything would be no more than defining a "global finality" for everything that is just not possible with any of the current top-down approaches and standardizations). Building on top of the Internet of things, the web of things is an architecture for the application layer of the Internet of things looking at the convergence of data from IOT devices into Web applications to create innovative use-cases. In order to program and control the flow of information in the Internet of things, a predicted architectural direction is being called BPM Everywhere which is a blending of traditional process management with process mining and special capabilities to automate the control of large numbers of coordinated devices.

##### **4.6.1 NETWORK ARCHITECTURE:**

The Internet of things requires huge scalability in the network space to handle the surge of devices. IETF 6LoWPAN would be used to connect devices to IP networks. With billions of devices being added to the Internet space, IPv6 will play a major role in handling the network layer scalability. IETF's Constrained Application Protocol, Zero MQ, and MQTT would provide lightweight data transport. "MQ" in "MQTT" came from IBM's MQ Series message queuing product line. Fog computing is a viable alternative to prevent such large burst of data flow through Internet. The edge devices' computation power can be used to analyse and process data, thus providing easy real time scalability.

#### **4.7 COMPLEXITY:**

In semi-open or closed loops (i.e. value chains, whenever a global finality can be settled) IOT will often be considered and studied as a complex system due to the huge number of different links, interactions between autonomous actors, and its capacity to integrate new actors. At the overall stage (full open loop) it will likely be seen as a chaotic environment (since systems always have finality). As a practical approach, not all elements in the Internet of things run in a global, public space. Subsystems are often implemented to mitigate the risks of privacy, control and reliability. For example, Domestic Robotics (Domotics) running inside a smart home might only share data within and be available via a local network.

#### **4.8 FRAMEWORKS**

IOT frameworks might help support the interaction between "things" and allow for more complex structures like distributed computing and the development of distributed applications. Currently, some IOT frameworks seem to focus on real-time data logging solutions, offering some basis to work with many "things" and have them interact. Future developments might lead to specific software-development environments to create the software to work with the hardware used in the Internet of things. Companies are developing technology platforms to provide this type of functionality for the Internet of things. Newer platforms are being developed, which add more intelligence. REST is a scalable architecture that allows things to communicate over Hypertext Transfer Protocol and is easily adopted for IOT applications to provide communication from a thing to a central web server. MQTT is a publish-subscribe architecture on top of TCP/IP that allows bidirectional communication between a thing and an MQTT broker.

#### **4.9 ENABLING TECHNOLOGIES FOR IOT:**

There are many technologies that enable IOT. Crucial to the field is the network used to communicate between devices of an IOT installation, a role that several wireless or wired technologies may full fill:

##### **4.9.1 SHORT-RANGE WIRELESS:**

- Bluetooth low energy (BLE) – Specification providing a low power variant to classic Bluetooth with a comparable communication range.

- Light-Fidelity (Li-Fi) – Wireless communication technology similar to the Wi-Fi standard, but using visible light communication for increased bandwidth.
- Near-field communication (NFC) – Communication protocols enabling two electronic devices to communicate within a 4 cm range.
- QR codes and barcodes – Machine-readable optical tags that store information about the item to which they are attached.
- Radio-frequency identification (RFID) – Technology using electromagnetic fields to read data stored in tags embedded in other items.
- Thread – Network protocol based on the IEEE 802.15.4 standard, similar to Zigbee, providing IPv6 addressing.
- Transport Layer Security (network protocol) | TLS – Network security protocol.
- Wi-Fi – Widely used technology for local area networking based on the IEEE 802.11 standard, where devices may communicate through a shared access point.
- Wi-Fi Direct – Variant of the Wi-Fi standard for peer-to-peer communication, eliminating the need for an access point.
- Z-Wave – Communication protocol providing short-range, low-latency data transfer at rates and power consumption lower than Wi-Fi. Used primarily for home automation.
- Zigbee – Communication protocols for personal area networking based on the IEEE 802.15.4 standard, providing low power consumption, low data rate, low cost, and high throughput.

#### **4.9.2 MEDIUM-RANGE WIRELESS:**

- Hallow – Variant of the Wi-Fi standard providing extended range for low-power communication at a lower data rate.
- LTE-Advanced – High-speed communication specification for mobile networks. Provides enhancements to the LTE standard with extended coverage, higher throughput, and lower latency.

#### **4.9.3 LONG-RANGE WIRELESS:**

- Low-power wide-area networking (LPWAN) – Wireless networks designed to allow long-range communication at a low data rate, reducing power and cost.

- Very small aperture terminal (VSAT) – Satellite communication technology using small dish antennas for narrowband and broadband data.

#### **4.10 WIRED:**

- Ethernet – General purpose networking standard using twisted pair and fibre optic links in conjunction with hubs or switches.
- Multimedia over Coax Alliance (MOCA) – Specification enabling whole-home distribution of high definition video and content over existing coaxial cabling.
- Power-line communication (PLC) – Communication technology using electrical wiring to carry power and data. Specifications such as Home Plug utilize PLC for networking IOT devices.

#### **4.11 SIMULATION:**

IOT modelling and simulation (and emulation) is typically carried out at the design stage before deployment of the network. Network simulators like OPNET, Net Sim and NS2 can be used to simulate IOT networks. Digital Twins may also be implemented to produce updates on the status and health of an asset, based upon sensor readings integrated with a computational model of the asset.

#### **4.12 PLATFORM FRAGMENTATION:**

IOT suffers from platform fragmentation and lack of technical standards a situation where the variety of IOT devices, in terms of both hardware variations and differences in the software running on them, makes the task of developing applications that work consistently between different inconsistent technology ecosystems hard. Customers may be hesitant to bet their IOT future on a proprietary software or hardware devices that uses proprietary protocols that may fade or become difficult to customize and interconnect. IOT amorphous computing nature is also a problem for security, since patches to bugs found in the core operating system often do not reach users of older and lower-price devices. One set of researchers say that the failure of vendors to support older devices with patches and updates leaves more than 87% of active devices vulnerable.

#### **4.13 PRIVACY, AUTONOMY, AND CONTROL:**

Philip N. Howard, a professor and author, writes that the Internet of things offers

immense potential for empowering citizens, making government transparent, and broadening information access. Howard cautions, however, that privacy threats are enormous, as is the potential for social control and political manipulation. Concerns about privacy have led many to consider the possibility that big data infrastructures such as the Internet of things and Data Mining are inherently incompatible with privacy. Writer Adam Greenfield claims that these technologies are not only an invasion of public space but are also being used to perpetuate normative behaviour, citing an instance of billboards with hidden cameras that tracked the demographics of passers-by who stopped to read the advertisement. The Internet of Things Council compared the increased prevalence of digital surveillance due to the Internet of things to the conceptual panopticon described by Jeremy Bentham in the 18th Century. The assertion was defended by the works of French philosophers Michel Foucault and Gilles Deleuze. In *Discipline and Punish: The Birth of the Prison* Foucault asserts that the panopticon was a central element of the discipline society developed during the Industrial Era. Foucault also argued that the discipline systems established in factories and schools reflected Bentham's vision of panopticism. In his 1992 paper "Postscripts on the Societies of Control," Deleuze wrote that the discipline society had transitioned into a control society, with the computer replacing the panopticon as an instrument of discipline and control while still maintaining the qualities similar to that of panopticism.

The privacy of households could be compromised by solely analyzing smart home network traffic patterns without dissecting the contents of encrypted application data, yet a synthetic packet injection scheme can be used to safely overcome such invasion of privacy. Peter-Paul Verbeek, a professor of philosophy of technology at the University of Twente, Netherlands, writes that technology already influences our moral decision making, which in turn affects human agency, privacy and autonomy. He cautions against viewing technology merely as a human tool and advocates instead to consider it as an active agent. Justin Brookman, of the Centre for Democracy and Technology, expressed concern regarding the impact of IOT on consumer privacy, saying that "There are some people in the commercial space who say, 'Oh, big data — well, let's collect everything, keep it around forever, we'll pay for somebody to think about security later.'" The question is whether we want to have

some sort of policy framework in place to limit that." Tim O'Reilly believes that the way companies sell the IOT devices on consumers are misplaced, disputing the notion that the IOT is about gaining efficiency from putting all kinds of devices online and postulating that "IOT is really about human augmentation. The applications are profoundly different when you have sensors and data driving the decision-making." Editorials at WIRED have also expressed concern, one stating "What you're about to lose is your privacy. Actually, it's worse than that. You aren't just going to lose your privacy, you're going to have to watch the very concept of privacy be rewritten under your nose." The American Civil Liberties Union (ACLU) expressed concern regarding the ability of IOT to erode people's control over their own lives. The ACLU wrote that "There's simply no way to forecast how these immense powers – disproportionately accumulating in the hands of corporations seeking financial advantage and governments craving ever more control – will be used. Chances are big data and the Internet of Things will make it harder for us to control our own lives, as we grow increasingly transparent to powerful corporations and government institutions that are becoming more opaque to us." In response to rising concerns about privacy and smart technology, in 2007 the British Government stated it would follow formal Privacy by Design principles when implementing their smart metering program. The program would lead to replacement of traditional power meters with smart power meters, which could track and manage energy usage more accurately. However the British Computer Society is doubtful these principles were ever actually implemented. In 2009 the Dutch Parliament rejected a similar smart metering program, basing their decision on privacy concerns. The Dutch program later revised and passed in 2011.

#### **4.14 DATA STORAGE AND ANALYTICS:**

A challenge for producers of IOT applications is to clean, process and interpret the vast amount of data which is gathered by the sensors. There is a solution proposed for the analytics of the information referred to as Wireless Sensor Networks. These networks share data among sensor nodes that are send to a distributed system for the analytics of the sensory data. Another challenge is the storage of this bulk data. Depending on the application there could be high data acquisition requirements which in turn lead to high storage requirements. Currently the internet is already

responsible for 5% of the total energy generated and this consumption will increase significantly when we start utilizing applications with multiple embedded sensors.

#### **4.15 SECURITY:**

Concerns have been raised that the Internet of things is being developed rapidly without appropriate consideration of the profound security challenges involved and the regulatory changes that might be necessary. Most of the technical security issues are similar to those of conventional servers, workstations and smartphones, but the firewall, security update and anti-malware systems used for those are generally unsuitable for the much smaller, less capable, IOT devices. According to the Business Insider Intelligence Survey conducted in the last quarter of 2014, 39% of the respondents said that security is the biggest concern in adopting Internet of things technology. In particular, as the Internet of things spreads widely, cyber-attacks are likely to become an increasingly physical (rather than simply virtual) threat. In a January 2014 article in Forbes, cyber-security columnist Joseph Steinberg listed many Internet-connected appliances that can already "spy on people in their own homes" including televisions, kitchen appliances, cameras, and thermostats. Computer-controlled devices in automobiles such as brakes, engine, locks, hood and trunk releases, horn, heat, and dashboard have been shown to be vulnerable to attackers who have access to the on-board network. In some cases, vehicle computer systems are Internet-connected, allowing them to be exploited remotely. By 2008 security researchers had shown the ability to remotely control pacemakers without authority. Later hackers demonstrated remote control of insulin pumps and implantable cardioverter defibrillators. David Pogue wrote that some recently published reports about hackers remotely controlling certain functions of automobiles were not as serious as one might otherwise guess because of various mitigating circumstances; such as the bug that allowed the hack having been fixed before the report was published, or that the hack required security researchers having physical access to the car prior to the hack to prepare for it. The U.S. National Intelligence Council in an unclassified report maintains that it would be hard to deny "access to networks of sensors and remotely-controlled objects by enemies of the United States, criminals, and mischief makers... An open market for aggregated sensor data could serve the interests of commerce and security no less than it helps

criminals and spies identify vulnerable targets. Thus, massively parallel sensor fusion may undermine social cohesion, if it proves to be fundamentally incompatible with Fourth-Amendment guarantees against unreasonable search." In general, the intelligence community views the Internet of things as a rich source of data. As a response to increasing concerns over security, the Internet of Things Security Foundation (IOTSF) was launched on 23 September 2015. IOTSF has a mission to secure the Internet of things by promoting knowledge and best practice. Its founding board is made from technology providers and telecommunications companies including BT, Vodafone, Imagination Technologies and Pen Test Partners. In addition, large IT companies are continuously developing innovative solutions to ensure the security for IOT devices. As per the estimates from KBV Research, the overall IOT security market would grow at 27.9% rate during 2016-2022 as a result of growing infrastructural concerns and diversified usage of Internet of things. In 2016, a distributed denial of service attack powered by Internet of things devices running the Mirai malware took down a DNS provider and major web sites.

#### **4.16 DESIGN:**

Given widespread recognition of the evolving nature of the design and management of the Internet of things, sustainable and secure deployment of IOT solutions must design for "anarchic scalability." Application of the concept of anarchic scalability can be extended to physical systems (i.e. controlled real-world objects), by virtue of those systems being designed to account for uncertain management futures. This "hard anarchic scalability" thus provides a pathway forward to fully realize the potential of Internet of things solutions by selectively constraining physical systems to allow for all management regimes without risking physical failure. Brown University computer scientist Michael Littman has argued that successful execution of the Internet of things requires consideration of the interface's usability as well as the technology itself. These interfaces need to be not only more user-friendly but also better integrated: "If users need to learn different interfaces for their vacuums, their locks, their sprinklers, their lights, and their coffeemakers, it's tough to say that their lives have been made any easier."

#### **4.16.1 PRIVACY AND SECURITY CONCERNS:**

According to a recent study by Noura Aleisa and Karen Renaud at the University of Glasgow, "the Internet of Things' potential for major privacy invasion is a concern" with much of research "disproportionally focused on the security concerns of IOT." Among the "proposed solutions in terms of the techniques they deployed and the extent to which they satisfied core privacy principles", only very few turned out to be fully satisfactory. Louis Basenese, investment director at Wall Street Daily, has criticized the industry's lack of attention to security issues: "Despite high-profile and alarming hacks, device manufacturers remain undeterred, focusing on profitability over security. Consumers need to have ultimate control over collected data, including the option to delete it if they choose...Without privacy assurances, wide-scale consumer adoption simply won't happen." In a post-Snowden world of global surveillance disclosures, consumers take a more active interest in protecting their privacy and demand IOT devices to be screened for potential security vulnerabilities and privacy violations before purchasing them. According to the 2016 Accenture Digital Consumer Survey, in which 28000 consumers in 28 countries were polled on their use of consumer technology, security "has moved from being a nagging problem to a top barrier as consumers are now choosing to abandon IoT devices and services over security concerns." The survey revealed that "out of the consumers aware of hacker attacks and owning or planning to own IoT devices in the next five years, 18 percent decided to terminate the use of the services and related services until they get safety guarantees." This suggests that consumers increasingly perceive privacy risks and security concerns to outweigh the value propositions of IoT devices and opt to postpone planned purchases or service subscriptions.

##### **4.16.1.1 Software required:**

Arduino ide

Embedded C

## **4.16.2 SOFTWARE DESIGN**

### *4.16.2.1 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.

### *4.16.2.2 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 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.

#### **4.16.3 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

#### ***4.16.4 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.

14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` 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 functions:

- **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 `attachInterrupt()` function for details.

- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the `analogWrite()` 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 `analogReference()` function. Additionally, some pins have specialized functionality:

- **I2C: A4 or SDA pin and A5 or SCL pin.** Support I2C communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with `analogReference()`.
- **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.

#### **4.16.5 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).

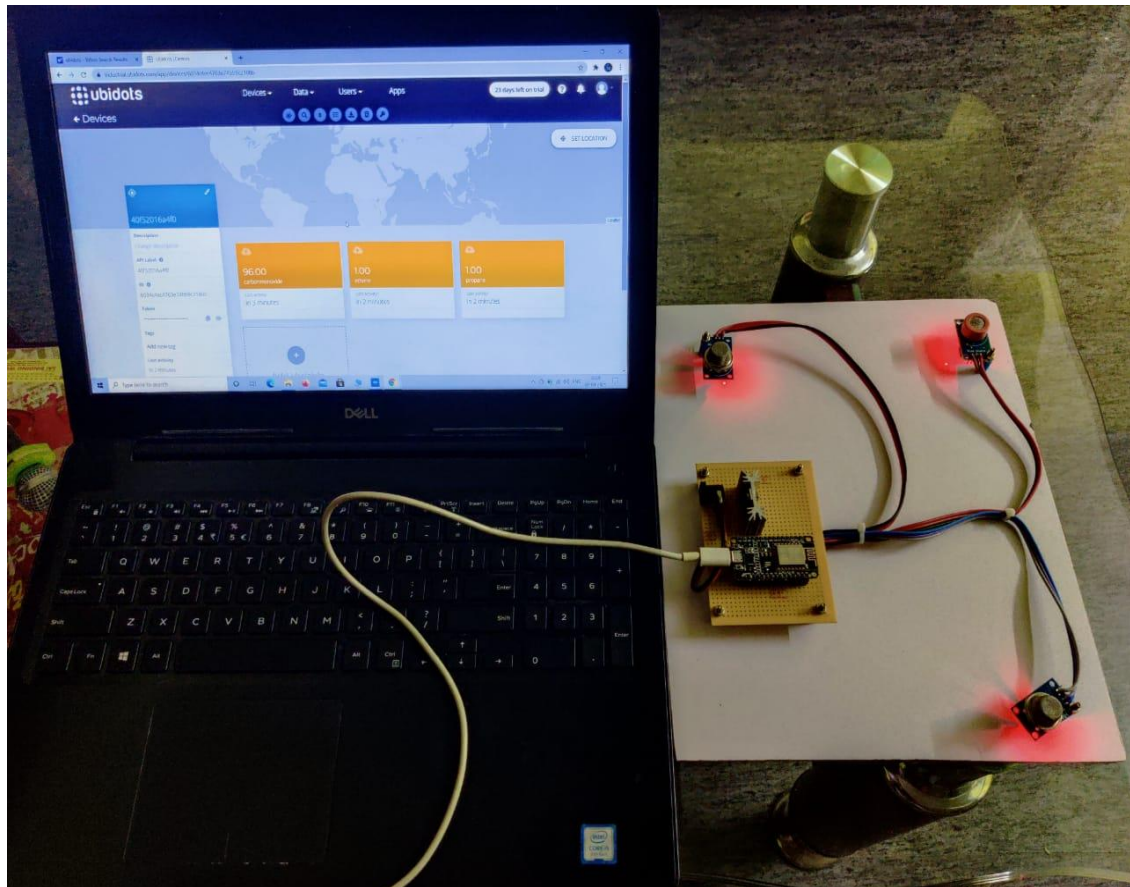
A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

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.

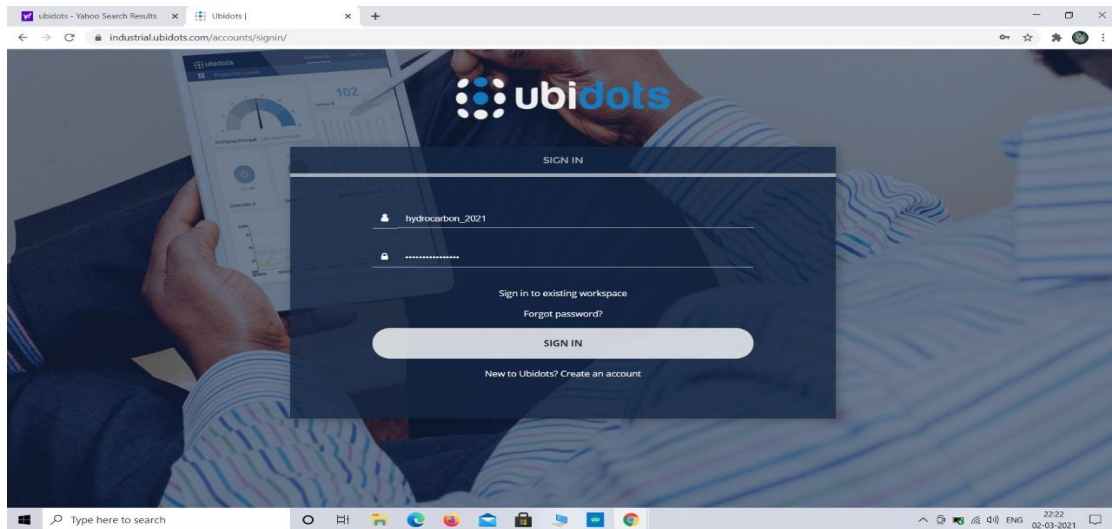
## CHAPTER 5

### RESULTS

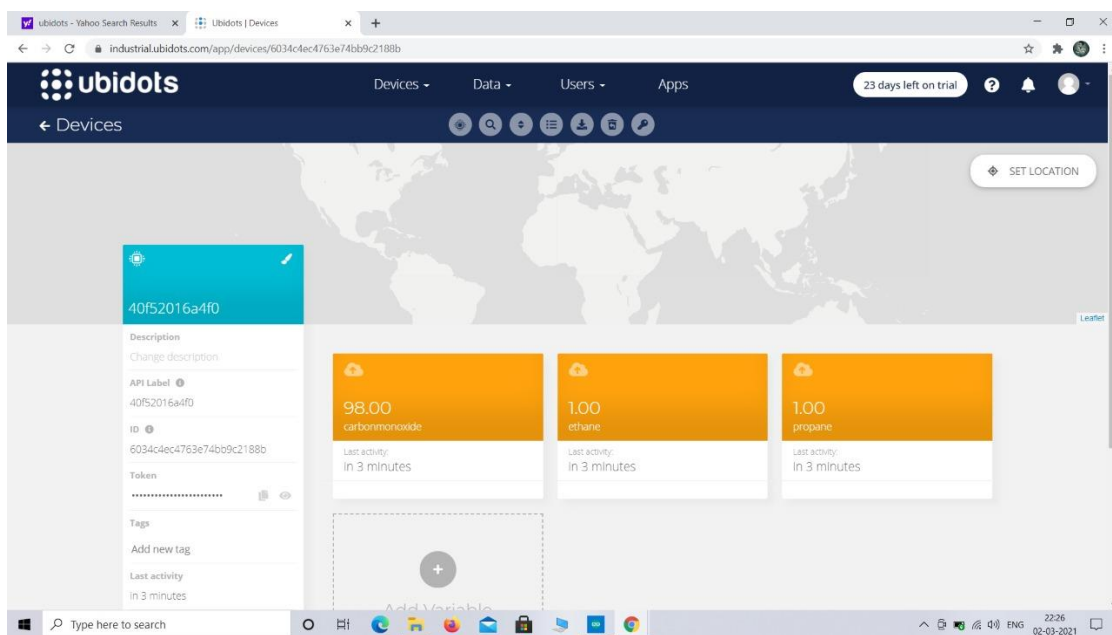
#### 5.1 Screenshots :



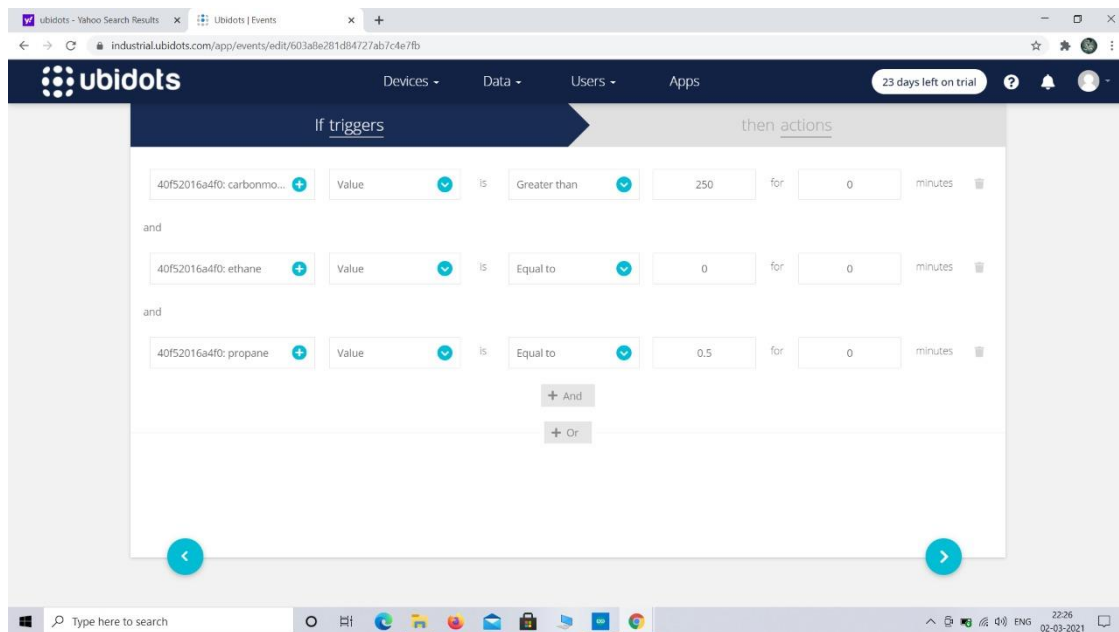
This screenshot describes about the connection work given to the smoke sensors and also power supply to the node mcu. After completion of this connection work we should connect to the system where our arduino ide program compilation done successfully then we will redirect to the ubidots login page. Before sign up into the ubidots app we should give our hotspot connection to the device which is connected to the vehicle. Then the smoke sensors predict the corresponding smoke sensor values monitored by the gps module.



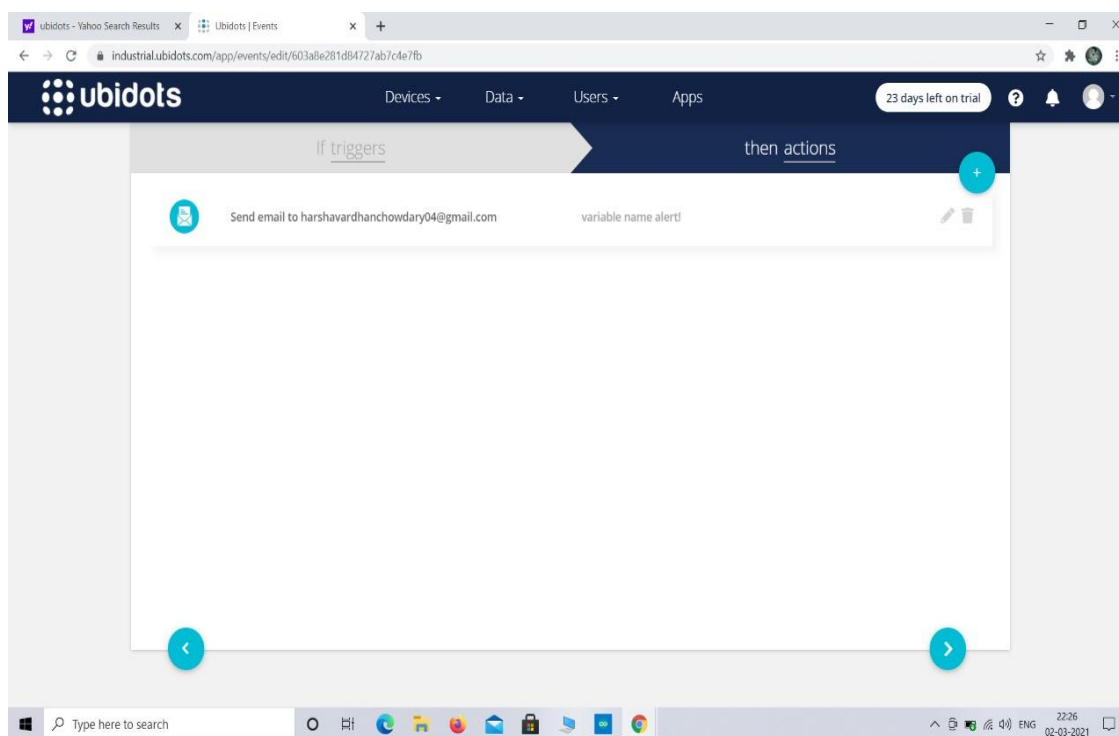
This describes about the ubidots login page where we enter with our login details to monitor our vehicle pollution.



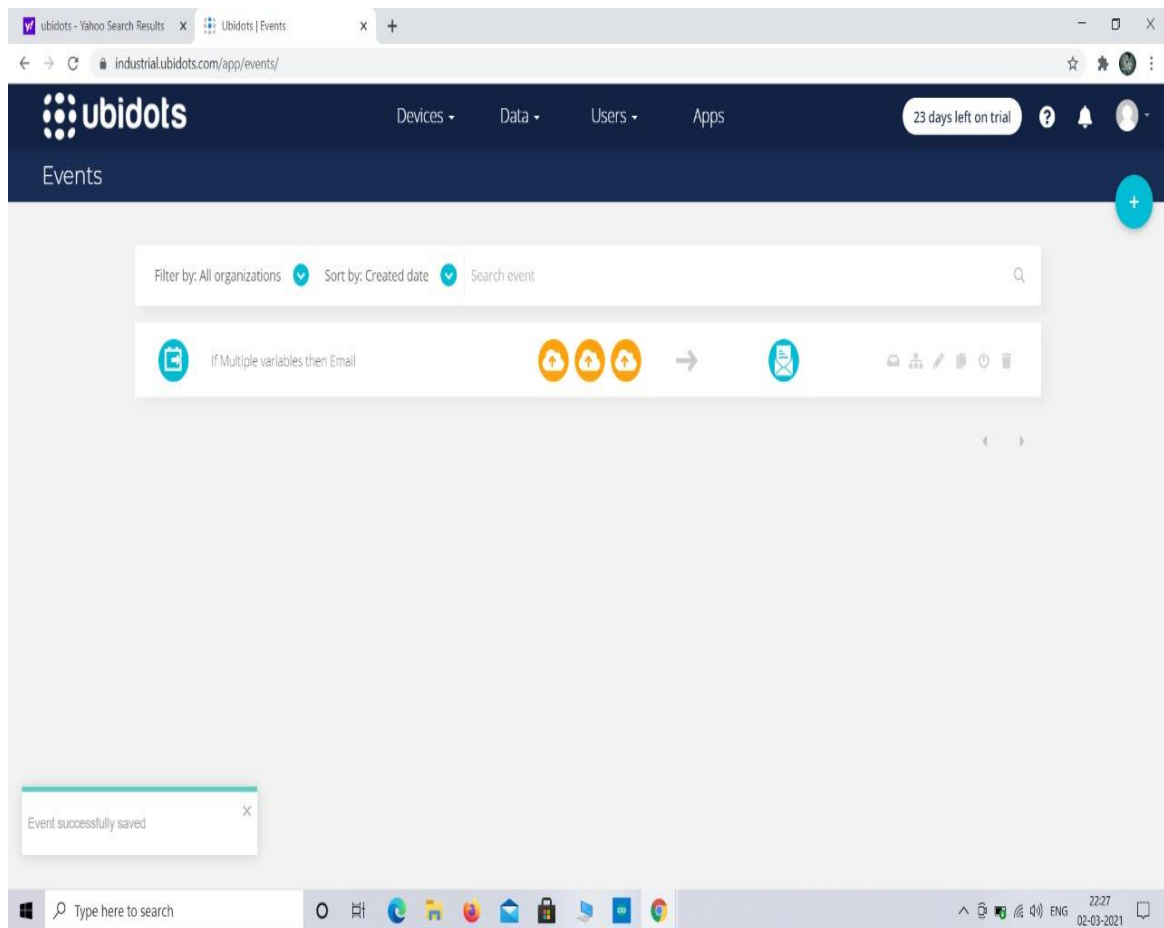
This describes about the ubidots app layout which consists our device data in this app. This device contains one wifi gps tracking system connected to nodemcu which automatically connect to our mobile hotspot. After the completion of all the process we discussed above the corresponding smoke sensor values will be shown in this app layout.



This describes about the government setted threshold value for every smoke sensor.



This describes about the intimation message alert will be directed to the government official mail id when the smoke sensors identifies the pollution increase.



This describes about the pollution check process events where the government setted threshold values and message alerts are successfully saved in this ubidots app.

## **CHAPTER 6**

### **SUMMARY AND CONCLUSION**

#### **6.1 Conclusion:**

Previously the issue has been discussed among various places but solutions were quite expensive that led to difficulties in implementations. This time we have also introduced the concept with the inclusion of the Internet of Things and LTE-M modules that are low cost and more efficient system for M2M devices, which will be helpful for many other aspects and can be supportive enough to propagate other technologies for several other applications in making the smart cities. So as discussed, one major concern of optimal deployment of sensor node power is addressed and planned solution and endeavour was to introduce new way of collecting data of air pollution by the help of Public Transport vehicles to save time and energy, also reducing the handing out of every sensor nodes. We suggested a method where these sensor nodes can directly communicate with the moving nodes deployed on the public vehicles in this paper. Thus, it will diminish the requirement and processing (routing algorithm) for special connectivity. As a consequence, it results in long-term and increasing reliability and durability of each of the sensor nodes and data security. Extension of this work for better communication mechanism between coordinator nodes will be effective one. Scheme of base station for better pollution calculation for cluster will help to make technology environment friendly.

## 6.2 References:

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- [2] U. Roland, F. Holzer, and F.-D. Kopinke, "Improved oxidation of air pollutants in a nonthermal plasma," *Catal. Today*, vol. 73, no. 3/4, pp. 315– 323, Apr. 2002.
  
- [3] M. Higashi and K. Fujii, "Treatment of exhaust gas from vehicles by discharge plasma reactors," *Elect. Eng. Jpn.*, vol. 120, no. 2, pp. 1–7, Jul. 1998.
  
- [4] C. H. Tsai, Y. F. Wang, H. H. Yang, and C. N. Liao, "Effects of ethylene on NO conversion and product distributions in an rf discharge reactor," *J. Hazardous Mater.*, vol. 150, no. 2, pp. 401–407, Jan. 2008.
  
- [5] Q. Yu, H. M. Yang, K. S. Zeng, Z. W. Zhang, and G. Yu, "Simultaneous removal of NO and SO<sub>2</sub> from dry gas stream using nonthermal plasma," *J. Environ. Sci.*, vol. 19, no. 11, pp. 1393–1397, 2007.

## APPENDIX

### Source Code :

```
// This example sends data to multiple variables to
// Ubidots through HTTP protocol.

/*****
 * Include Libraries
 *****/

#include "Ubidots.h"

/*****
 * Define Instances and Constants
 *****/

const char* UBIDOTS_TOKEN = "BBFF-8OqEuljxxtAqe4oOSrmoOvP6MXLwJQ";
// Put here your Ubidots TOKEN
const char* WIFI_SSID = "hydrocarbon"; // Put here your Wi-Fi SSID
const char* WIFI_PASS = "12345678"; // Put here your Wi-Fi password
Ubidots ubidots(UBIDOTS_TOKEN, UBI_HTTP);

/*****
 * Auxiliar Functions
 *****/

// Put here your auxiliar functions

/*****
 * Main Functions
 *****/

void setup() {
  Serial.begin(115200);
  ubidots.wifiConnect(WIFI_SSID, WIFI_PASS);
  pinMode(D0, INPUT);
  pinMode(D1, INPUT);
  // ubidots.setDebug(true); // Uncomment this line for printing debug messages
}

void loop() {
  float propane = digitalRead(D0);
  float ethane = digitalRead(D0);
  float carbonmonoxide = analogRead(A0);
  ubidots.add("Propane", propane); // Change for your variable name
  ubidots.add("Ethane", ethane);
```

```
ubidots.add("Carbonmonoxide", carbonmonoxide);

bool bufferSent = false;
bufferSent = ubidots.send(); // Will send data to a device label that matches the
device Id

if (bufferSent) {
    // Do something if values were sent properly
    Serial.println("Values sent by the device");
}

delay(5000);
```

---

### **ADVANCES IN SMART ENVIRONMENT MONITORING SYSTEMS USING IOT**

N. HARSHA VARDHAN [1], E. RAVI TEJA [2], R. SETHURAMAN [3]

[1][2]UG Student, Dept. of CSE, Sathyabama Institute of Science and Technology, Chennai

[3] Associate Professor, Dept. of CSE, Sathyabama Institute of Science and Technology, Chennai

#### **ABSTRACT:**

- Carbon monoxide, nitrogen oxides, and hydrocarbons are released when fuel is burned in an internal combustion engine and when air/fuel residuals are emitted through the vehicle tailpipe. Gasoline vapours also escape into the atmosphere during refueling and when fuel vaporizes from engines and fuel systems caused by vehicle operation or hot weather.
- The pollutants in vehicle emissions are known to damage lung tissue, and can lead to and aggravate respiratory diseases, such as asthma. Motor vehicle pollution also contributes to the formation of acid rain and adds to the greenhouse gases that cause climate change.
- Pollutants emitted directly from vehicles are not the only cause for concern. On warm, sunny days, hydrocarbons react with oxides of nitrogen to create a secondary pollutant, ozone. In many urban areas, motor vehicles are the single largest contributor to ground-level ozone which is a common component of smog. Ozone causes coughing, wheezing and shortness of Breath, and can bring on permanent lung damage, making it a cause of crucial public health problem
- This problem can be rectify by using some kind of sensor called smoke sensor using this sensor connected to internet it directly Send the data to government

## INTRODUCTION:

- The most common parameters being monitored include the temperature, humidity, rainfall, atmospheric pressure, light intensity, air quality, affected by pollutants such as CO<sub>2</sub>, CO, SO<sub>x</sub>, volatile organic compounds, and many others.
- One of the immediate benefits brought by the acquisition of such physical properties, like soil moisture, temperature, and salinity, can be seen in agriculture, where significant water resource savings can be achieved.
- Another related field currently gaining attention is the monitoring of the ambient in indoor spaces. It has been shown that this is important not only for the comfort and health of building occupants, but also for the reduction of greenhouse gas emissions.
- The majority of monitoring applications rely on WSNs, motivated by the indisputable advantages they bring: lower costs due to the replacement of cables,

## OBJECTIVES

- In real life scenario pollution checking is the major objective to avoid harmful gases releasing from the some chamber.
- For this we are using two inputs one input to be given for the smoke chamber and another input is government settled Threshold Tempature.
- In our daily life situation everytime comparing both inputs and gives alert

variable network topologies, scalability, and lower maintenance and commissioning expenses.

## EXISTING SYSTEM:

- The microcontroller is programmed to do mainly three functions namely: Comparison, timer and triggering.. When the smoke sensor output is more than the threshold value, the microcontroller triggers the timer circuit and an alarm is set on to inform the driver of the pollution in the vehicle and that it will come to the halt state. Semiconductor sensor MQ-2 is used to detect the smoke whose range is 300ppm to 10000ppm.
- CO Sensor having low conductivity in a clean environment is connected to an PIC microcontroller When this sensor is exposed to the pollutants its conductivity increases generating a signal in the circuit which disables the motor. An automatic SMS is also generated by a gsm module which is connected in the circuit.

message to the government to seize the vehicle.

## PROPOSED SYSTEM:

- The given proposed system is continuously monitoring the vehicle pollution monitoring
- Carbon monoxide sensor, nitrogen oxides sensor are going to use in exhaust system in vehicle It takes two inputs one from the smoke sensor and the other being the pre-

defined threshold value specified by the government.

- If it reaches the high threshold value the vehicle location can be traced by GPS module and the location is sent to the government. The government may going to cancel the registration of the car and the message to the car owner

#### **LITERATURE SURVEY:**

##### **A Smart Air Pollution Monitoring System**

Kennedy Okokpujie, Etinosa Noma-Osaghae, Modupe Odusami, Samuel John

Air pollution affects our day-to-day activities and quality of life. It poses a threat to the ecosystem and the quality of life on the planet. The dire need to monitor air quality is very glaring, owing to increased industrial activities over the past years. People need to know the extent to which their activities affect air quality. This project proposes an air pollution monitoring system. The system was developed using the Arduino microcontroller.

##### **Air Quality Monitoring System**

Boyanka Nikolova, Marin B. Marinov, Georgi Todorov Nikolov

Detection of low concentration of air pollution, like cigarette smoke, cooking fumes, etc. is possible with the combination of an air quality sensor and data acquisition system. In present paper is presented approach for design and implementation of air quality monitoring system based on tin dioxide gas sensor, integrated temperature and humidity sensors, portable modular data acquisition system and graphical programming language. An interpolation method reducing

influence from temperature and humidity is suggested.

##### **An air quality monitoring system for urban areas based on the technology of wireless sensor networks**

Jen-Hao Liu, Yu-Fan Chen, Tzu-Shiang Lin, Chia-Pang Chen.

Air pollution is one of environmental issues that cannot be ignored. The heavy transportation and urbanization result in the air pollutants concentrated in certain areas. Inhaling pollutants for a long time causes damages in human health. Traditional air quality monitoring methods, such as building air quality monitoring stations, are typically expensive. In addition, monitoring stations are generally less densely deployed and provide low resolution sensing data. This paper proposes an urban air quality monitoring system based on the technology of wireless sensor networks (WSNs).

##### **IOT BASED AIR QUALITY MONITORING SYSTEM**

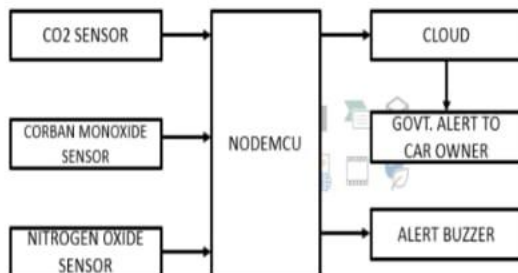
Ch.V.Saikumar, M.Reji, P.C.Kishoreraja

The main objective of this project is to monitor the air eminence in industrial and urban areas. The proposed outline includes a set of gas sensors (CO, and NO<sub>2</sub>) that are positioned on masses and structure of a IOT (Internet of things) and a dominant server to support both short-range real-time incident management and a continuing deliberate planning. In this Arduino platform is used to communicate the data simply and quickly. WSN (Wireless sensor network) acts as the trans receiver. This provide a real-time low rate monitoring system over the use of low rate, low

information rate, and little control wireless communication technology.

## METHODOLOGY

### BLOCK DIAGRAM



### HARDWARE USED:

- CO2 SENSOR
- NITROGEN OXIDE SENSOR
- NODEMCU
- CARBON MONOXIDE
- GPS

#### NodeMCU:

- **NodeMCU** is an open source IoT platform.
- It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.



- The term "NodeMCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266

#### Propane sensor:

- This MQ-5 Methane LPG Liquid Propane Gas Sensor Module is widely used in gas leakage detecting pieces of equipment in family and industry, are suitable for detecting of LPG, natural gas, town gas, avoid the noise of alcohol and cooking fumes and cigarette smoke
- The MQ5 ( MQ-5 ) is used in gas leakage detecting equipment in consumer and industry applications, this sensor is suitable for detecting LPG, natural gas, coal gas. Avoid the noise of alcohol, cooking fumes, and cigarette smoke. The sensitivity can be adjusted by the potentiometer.
- Sensitive material of MQ-5 gas sensor is SnO<sub>2</sub>, which with lower conductivity in clean air. When the target combustible gas exists, The sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to the corresponding output signal of gas concentration.



- MQ-5 gas sensor has high sensitivity to Methane, Propane, and Butane, and could be used to detect both Methane and Propane. The sensor could be used to detect different combustible gas especially Methane, it is with low cost and suitable for different application

#### CARBON-MONOOXIDE SENSOR:

- Methane gas sensor detects the concentration of methane gas in the sewage and outputs its reading as an analog voltage.
- MQ-4 gas sensor has high sensitivity to Methane, also to Propane and Butane.



- The sensor could be used to detect different combustible gas, especially Methane, it is with low cost and suitable for different application.

#### Ethane sensor:

- **Ethylene** is the most produce compound in organic chemistry. **Ethylene** (also called **Ethane**;  $C_2H_4$ ), the simplest Alkene, is an organic compound containing a  $C=C$  double bond. **Ethylene** is a coplanary unsaturated hydrocarbon (also called olefin) which is the most produced for industrial use.



- **Ethylene** ( $H_2C=CH_2$ ), the simplest of the organic compounds known as alkenes, which contain carbon-carbon double bonds. It is a colorless, flammable **gas** having a sweet taste and odour.
- **Ethylene** gas can affect you when breathed in. \* Skin contact with liquid **Ethylene** can cause frostbite. \* Exposure to **Ethylene** can cause headache, dizziness, fatigue, lightheadedness, confusion and unconsciousness. \* **Ethylene** is a HIGHLY FLAMMABLE and REACTIVE chemical and a **DANGEROUS FIRE** and EXPLOSION HAZARD.

#### SOFTWARE USED:

- ARDUINO IDE
- EMBEDDED C

#### CONCLUSION AND FRAME WORK

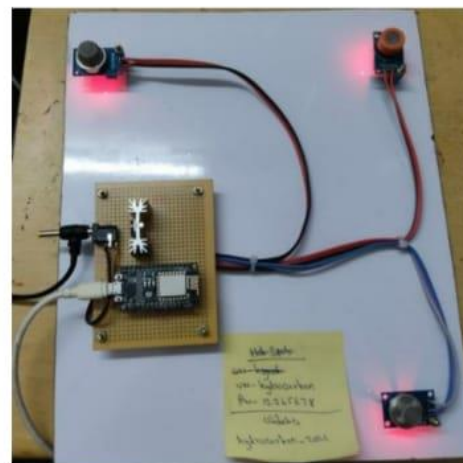
Previously the issue has been discussed among various places but solutions were quite expensive that led to difficulties in implementations. This time we have also introduced the concept with the inclusion of the Internet of Things and LTE-M modules that are low cost and more efficient system for M2M devices, which will be helpful for many other aspects and can be supportive enough to propagate other technologies for several other applications in making the smart cities. So as discussed, one major concern of optimal deployment of sensor node power is addressed and

planned solution and endeavour was to introduce new way of collecting data of air pollution by the help of Public Transport vehicles to save time and energy, also reducing the handing out of every sensor nodes. We suggested a method where these sensor nodes can directly communicate with the moving nodes deployed on the public vehicles in this paper. Thus, it will diminish the requirement and processing (routing algorithm) for special connectivity. As a consequence, it results in long-term and increasing reliability and durability of each of the sensor nodes and data security. Extension of this work for better communication mechanism between coordinator nodes will be effective one. Scheme of base station for better pollution calculation for cluster will help to make technology environment friendly

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