E N V I R O N M E N T A L M O N O T O R I N G

ABSTRACT

The level of pollution has increased with times by lot of factors like the increase in population, vehicle use, industrialization and urbanization which

results in harmful effects on human wellbeing by directly affecting health of the people. This project is based on the wireless sensor networks for

collecting information about Environment. In order to monitor, we will develop an IOT Based Environmental Monitoring System, it can monitor the

Air Quality over a web server by using the Wi-Fi Technology. Recent advancements like Internet of Things provide support for the transmission of

huge and accurate amount of data regarding the Environment. In this IOT project, we can

monitor the pollution level from anywhere through

computer or mobile. This system not only calculates the pollutants present in the air, by using this we can forecast to avoid future pollution and can

send the warning message to that particular polluted area.

Keywords: IOT, WIFI

1. INTRODUCTION

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or

other parts, designed to perform a specific function. An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse

physical variables and in diverse environments and sold into a competitive and cost conscious market. An

embedded system is not a computer system that is used primarily for processing, not a software system on PC or

UNIX, not a traditional business or scientific application. High-end embedded & lower end embedded systems.

High-end embedded system - Generally 32, 64 Bit Controllers used with OS. Examples Personal Digital Assistant

and Mobile phones etc. Lower end embedded systems - Generally 8,16 Bit Controllers used with an minimal

operating systems and hardware layout designed for the specific purpose. Examples Small controllers and devices

in our everyday life like Washing Machine, Microwave Ovens, where they are embedded in.

2. LITERATURE SURVEY

In existing model, the Zigbee based wireless Sensor Networks used to monitor the physical and Environmental

conditions. The system consists of a microcontroller, sensors and Zigbee which collects data from different

locations at certain time of a day. [illegible]

averaged in a closed time and space. The Global Positioning System (GPS) module is attached to a system to provide accurate representation of pollution sources in an area. The recorded data is periodically transferred to a computer through a Zigbee receiver and then the data will be displayed on the dedicated website with user acceptance. As a result large number of people can be benefited with the large. Which avoided the use of complex

routing algorithm but local Computations are very minimal.

Due to miscellaneous interactions, limited protocol standardization, security of data storage and complex

identification systems to access data, problems arises in field of monitoring. By using this Zigbee

protocol there must be a one receiver end. It transmits the data over the 10-100m. To overcome these problems we are designing and so on.
, IOT based system monitoring environmental pollution

3. PROPOSED SYSTEM

In this proposed model the climatic changes are frequently monitoring through IOT using sensor nodes. Internet of

Things (IoT) is a recent communication paradigm, in which the objects will be equipped with microcontrollers,

transceivers and suitable protocol stack that will make them to communicate with one another and with user. This

paper designs a prototype of wireless environmental monitoring system to upload information from array of sensors

to the database. This application allows us to observe or measuring the environmental parameters from anywhere in

real time. This system consist of main three modules namely sensor nodes, the wireless communication and the

web server. The sensor nodes in remote location collect the information from surrounding environmental

conditions and send the data wirelessly using Arduino microcontroller and ESP8266 Wi-Fi module to the server.

This paper presents a system that can be used to measure the toxic gases in surrounding area like Industrial area by

using various sensor nodes. All sensors are connected on the arduino microcontroller and the status of the sensors is

send to the control section continuously. The data uploading is done by ESP 8266 Wi-Fi module. The data is

updated on internet. The values of sensors are displayed on LCD. The buzzer is used to make sound, if the sensor

beyond its threshold value for saving the people immediately. The device developed in this project is based

Arduino UNO. The Arduino board connects with Thing Speak platform using ESP8266 Wi-Fi Module. The Thing

Speak is a popular IOT platform which is easy to use and program.

The sensor data is also displayed on a character

LCD interfaced in the monitoring IOT device. The sensing of data and sending it to the Thing Speak server using

Wi-Fi module is managed by the Arduino Sketch. The Arduino sketch is written, compiled and loaded to the

Arduino board using Arduino IDE.

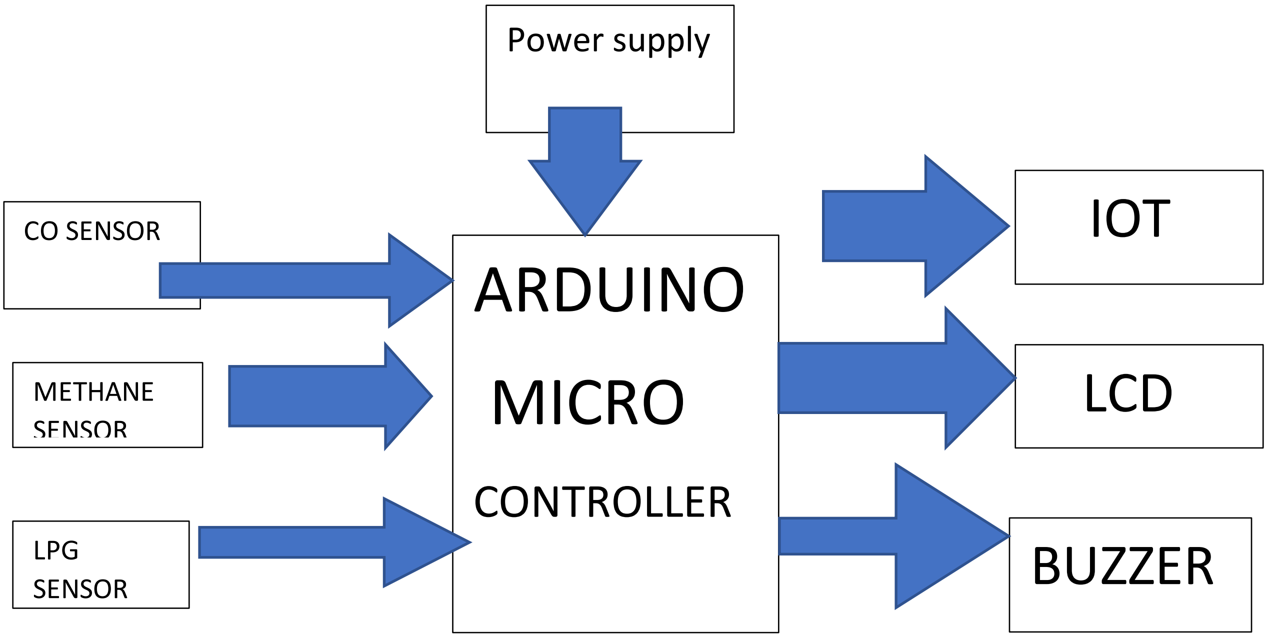


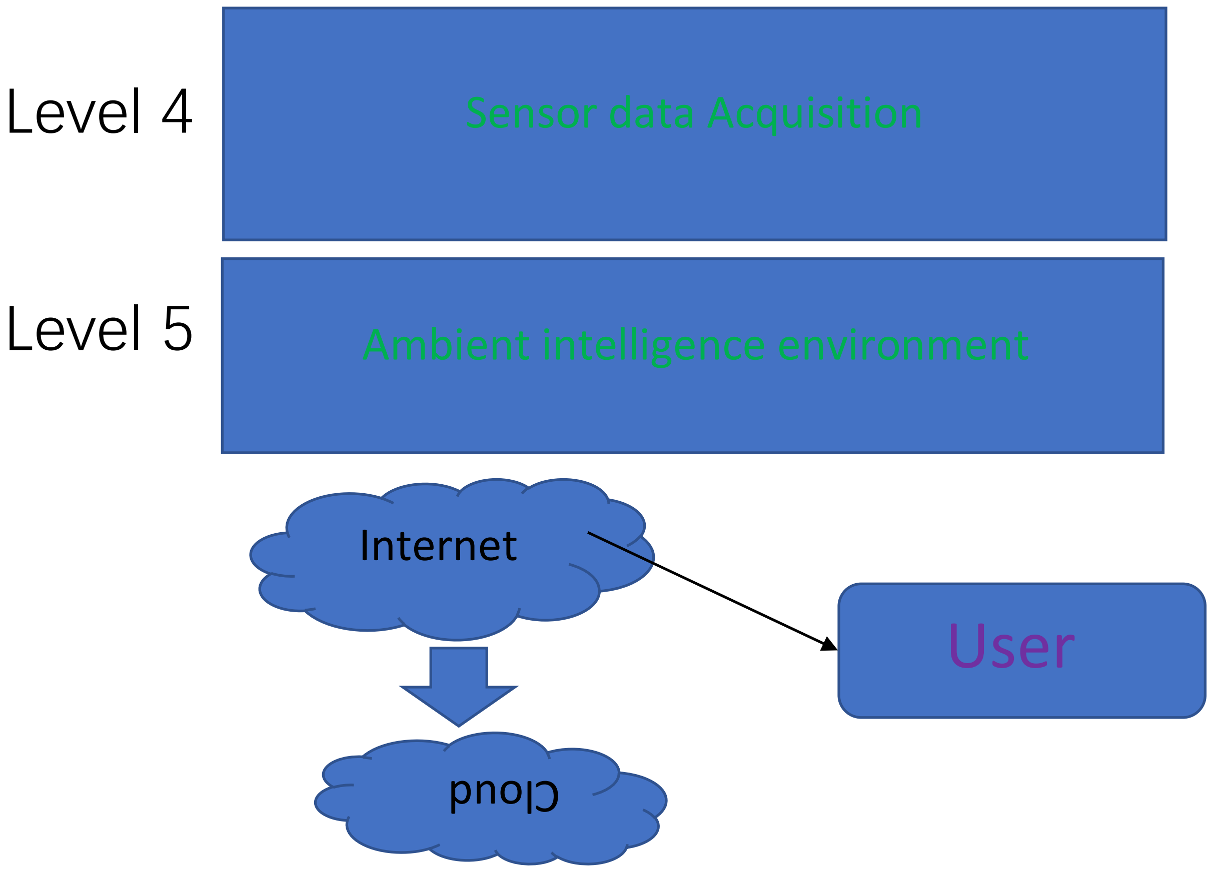
Fig. Block Diagram of Proposed System

SYSTEM MODEL:

Level 1 — ***Introduce environmental parameters to be measured.***

Level 2 — Study the characteristics and features of sensor devices

Level 3 — Decision making on sensor,measuring and fixing the threshold value ,periodicity,timing,space and LED



From the above model, process is divided in 5 layers. The environmental parameters which are to be measured are introduced in layer 1. Study of the characteristics and features of sensor devices is in layer 2. In layer 3, there is decision making on sensing, measuring and fixing the threshold value, periodicity of sensitivity, timing, space and

LED.

Sensor data acquisition is done in layer 4. And layer 5 as ambient intelligence environment. The sensors can be

operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and

updates it to the Internet through Wi-Fi module connected to it. User can monitor the parameters on their smart

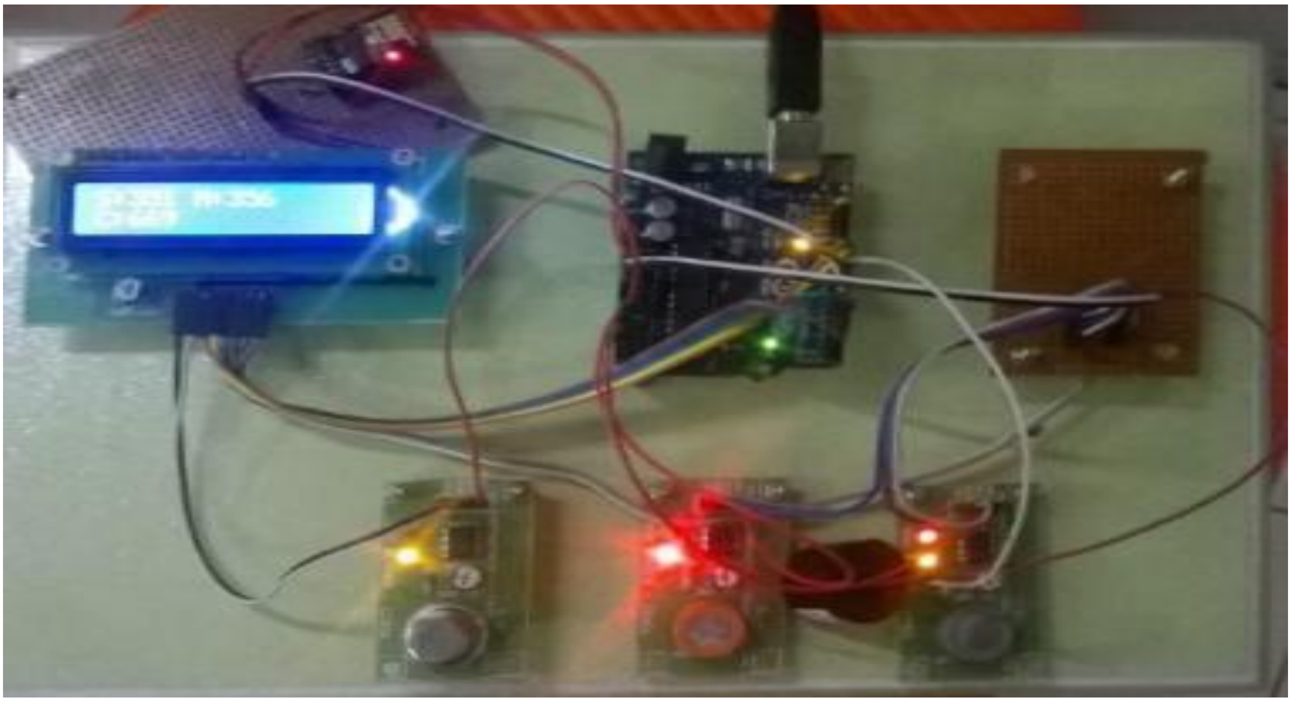
phones as well as pc or laptop.

Fig. Top and Back view of Arduino UNO

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.

4. RESULT AND DISCUSSION

4.1. HARDWARE OUTPUT



It represents the output we have obtained so far. The Hardware components used here includes Arduino

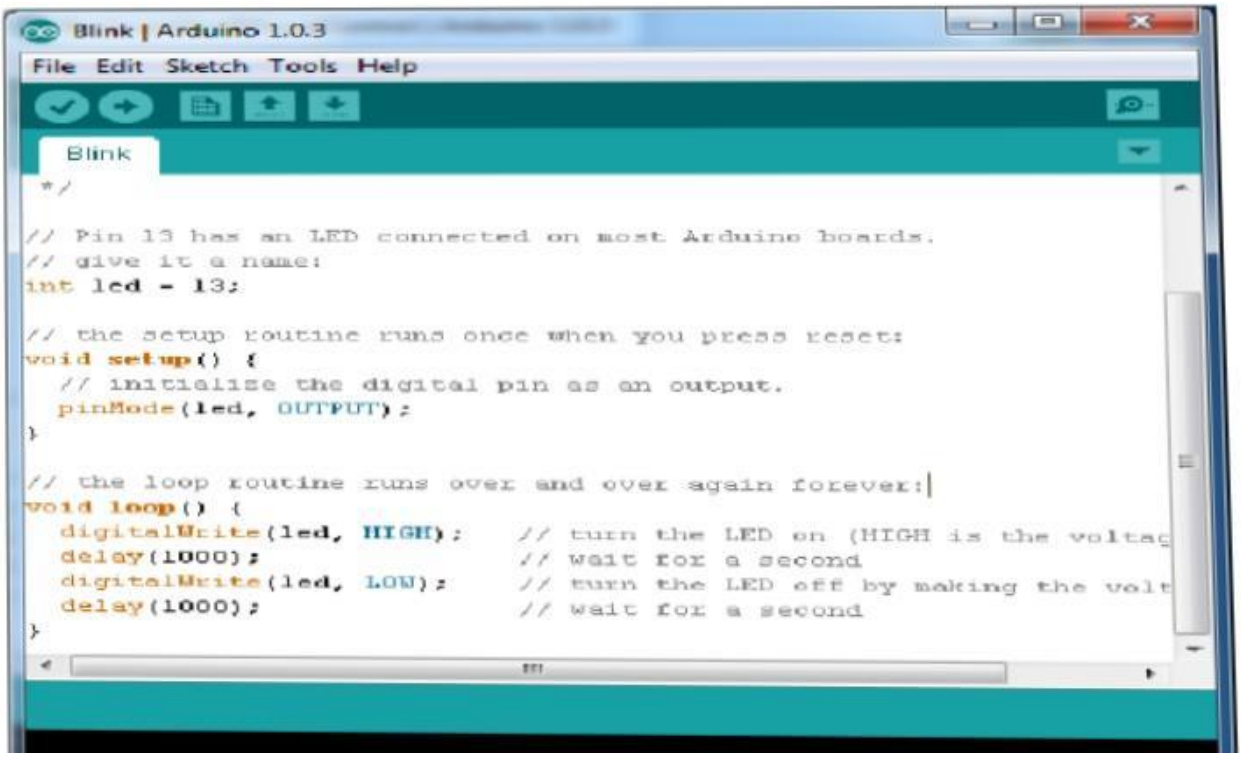
microcontroller, ESP 8266 Wi-Fi module, LCD, Buzzer, CO sensor, SnO2 sensor and LPG sensor. LCD display indicates density of gases in the air. The Buzzer gave alarm when the gas level exceed the threshold value. ESP 8266 Wi-Fi module transmitted the data to the web server.

4.2. ARDUINO IDE

This is the software program of our project. The program was developed

in the Arduino IDE software.
Arduino IDE

is the software used for Arduino applications. Then the program



dumped with our hardware.

4.3. THINGSPEAK

Thing Speak is the cloud based web server for IOT Applications. It is an open source. In which we created our own

channel for IOT based Environmental monitoring by providing username and password. The output is obtained by

setting the number of field we required for monitoring the Environment parameters. Then the sensors values are

updated to the server using ESP 8266.It provided the graph to show the density of gases in the air.

Fig. ThingSpeak

5.output on the webserver

6. CONCLUSION AND FUTURE WORK

Thus the IOT based Environmental Monitoring System has been designed and implemented. The Environmental

parameters successfully transmitted via ESP 8266 Wi-Fi module. The density of the gases in the remote located

area viewed through the ThingSpeak web server. This project will protect the people from the pollutant gases. It is

more useful for the Industries to control the air pollution in the surrounding area and for the workers safety. In

future we can implement this project with ESP 8266-12E Wi-Fi module and with the sensors which can sense the

gas density in high level. ESP 8266-12E module has inbuilt Arduino microcontroller. It reduces the overall size of

the device and simplifies the working mechanism.

Html

```
<html lang="en">
<head>
  <title>project work</title>
  <meta charset="utf-8">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <link rel="stylesheet"
href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bootstrap.min.css">
  <script
src="https://ajax.googleapis.com/ajax/libs/jquery/3.1.1/jquery.min.js"></script>
  <script
src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"></script>

  <link href="HowItWorks.css" rel="stylesheet">
    <!--IIT Logo Style Link-->
    <link rel="stylesheet" href="Logo.css">
</head>
<body>
<div class="navbar navbar-inverse navbar-fixed-top" role="navigation">
 <div class="container">
  <div class="navbar-header">
    <button type="button" class="navbar-toggle" data-toggle="collapse" data-
target=".navbar-collapse">
           <span class="sr-only">Toggle navigation</span>
           <span class="icon-bar"></span>
           </button>
          </div>
        <div class="collapse navbar-collapse">
      <ul class="nav navbar-nav">
      <li><a href="home.php" class="image_navbar"></a></li>
         <li><a href="#"><font size=5" color="yellow"><b> Air Pollution Monitoring
System</b></font></a></li>
      <li><a href="home.php">Home</a></li>
     <!-- <li><a href="team.html">The Team</a></li>
          <li><a href="export.html">Data</a></li>
      <li><a href="project.html">The Project</a></li>  -->
          <li class="active"><a href="#hiw" rel="m_PageScroll2id">How It Works</a></li>
          </ul>
        <!--  <ul class="nav navbar-nav navbar-right visible-lg">
          <li>
              <a href="http://iitism.ac.in/index.php/home/"><div id="IIT(ISM)-logo-
small" class ="visible-lg"></a>
                         <!-- <a style="width:5px;
height:5px;"href="http://iitism.ac.in/index.php/home/"><img src="C:\Users\Abhishek
Upadhyay\Desktop\bootstrap\ismlogo.png" id="ismlogo"/></a>

         <!--   <div id="divider-large-reversed"></div>
            <a href="http://csesociety.in/"><div id="CSES-logo-web-large"></div></a>
```

```
          </div>
        </li>
      </ul>      -->
    </div>
  </div>
  </div>
  <!-- <div id="logoContainer">
                        <a style="width:auto;
height:10px;"href="http://iitism.ac.in/index.php/home/"><img src="C:\Users\Abhishek
Upadhyay\Desktop\bootstrap\ismlogo.png" id="ismlogo"/></a>
                    </div>       -->

<!-- Photo Header -->
<div class="container">
 <div class="jumbotron">

   <!-- Photo Header -->
<div class="container" style="padding-top:120px">
  <div class="col-md-12 col-sm-12 team-image-display">
    <img id="hiw" src="howitworks_new.jpg">
  </div>

  </div>
  <!-- line divider -->
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break-border"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>

<!-- Information about the System -->

<div class="row featurette" style="padding-left: 20px; padding-right: 20px; padding-
top: 110px">
  <h2 class="featurette-heading">
    <font color="#1560ac">What does each node consist of?</font>
  </h2>
  <br>
  <p class="lead">
   Each node consists of several parts:
 </p>
   <ul>
    <li class="lead">A Dylos system</li>
    <p>Every node has a dylos that consists of a small computer fan, a laser system
that measures particulate matter and a screen that displays the results. This original
setup was modified to also channel air over a RH/Temp Sensor and through a 3D printed
infrastructure that houses the four alphasense sensors.</p>
    <li class="lead">alphasense sensors</li>
    <p>
      Alphasense sensors are electrochemical sensors that measure the concentration of
pollutants. Our sensors include CO, NO and NO<sub>2</sub>  sensors along with a RH
Temperature sensor.
    </p>
    <li class="lead">printed circuit boards</li>
    <p>
      The PCB, or printed circuit board, is a mini computer that serves two purposes.
It distributed power to various components of the node and communicates the data
collected by the alphasense sensors and RH/Temperature sensor to the ADC board.
    </p>
           <li class="lead">an analog to digital converter</li>
    <p>
       The ADC, or analog to Digital converter, received analog input and then converts
it into digital data that the Raspberry Pi can read.
     </p>

    <li class="lead">a raspberry pi</li>
    <p>
```

```
          The Raspberry Pi receives digital data from the ADC board through the ribbon
cable. Ultimately, this information is transferred wirelessly to a database.
</p>
</ul>
</div>

<br><br>
<div>
  <h3 style="text-align: left">
  <font color="#1560ac">A 3D Visualization of the Node</font></h3>
</div>
<div>
  <p class="lead">
 Our sensors include CO, NO and NO<sub>2</sub> sensors along with a RH Temperature
sensor.
  This 3D visualization let's you see what is inside each node's casing. It represents
the Dylos particle sensor, the alphasense sensors, the Raspberry Pi, and the electronic
boards. Feel free to rotate and zoom to get a better look!
</p>
</div>
<!-- line divider -->
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break-border"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>
        <!-- Pollutants Section -->
<div class="row featurette" style="padding-left: 20px; padding-right: 20px; padding-
top: 80px">
  <h2 class="featurette-heading">
    <span class="text-muted">
        <font color="#1560ac">What will we measure?</font></span>
  </h2>
  <br>
  <p class="lead">
We are measuring five pollutants: nitric oxide, nitrogen dioxide, carbon monoxide,
ozone, and particulate matter. The NOx group (nitric oxide and nitrogen dioxide) is
emitted from automobiles, power plants, and turbines. Carbon monoxide comes from
automobile exhaust and burning fuel. Particulate matter is the result of a wide range
of manmade and natural sources, while ozone is the result of reactions between
chemicals already in our air.
Together, these pollutants paint a comprehensive picture of air quality impacts from
the interaction of human activity with natural processes.

  </p>
</div>
        <!-- Pollutant Descriptions -->

<!-- POLLUTANTS SECTIONN -->

<div id="pollutants"></div>
<hr>
<br><br>
<!-- first row of pollutants -->

<!--CARBON MONOXIDE -->
<div class="row">
  <div class="col-sm-6 col-md-4">
   <div class="thumbnail">
    <img src="CO.png">
    <h3>Carbon Monoxide</h3>
    <p>
     <font size="2"> CO is an odorless, colorless gas that is highly toxic in when
encountered in high concentrations! The main contribution of CO is vehicle exhaust but
other sources include fuel combustion, fires, and volcanoes. Harmful health effects of
CO occur when it enters the bloodstream through the lungs and binds to hemoglobin,
reducing the amount of oxygen that reaches the bodys' tissues and organs.
```

```
    </font> </p>
     <p>
      <a class="btn" data-toggle="modal" data-target="#COModal" href="#">Learn More</a>
    </p>
  </div>
</div>
<!-- CO Modal -->
<div class="modal fade" id="COModal" tabindex="-1" role="dialog" aria-
labelledby="myModalLabel" aria-hidden="true">
  <div class="modal-dialog">
    <div class="modal-content">
      <div class="modal-header">
        <button type="button" class="close" data-dismiss="modal" aria-
hidden="true">&times;</button>
        <h4 class="modal-title" id="myModalLabel">Carbon Monoxide</h4>
      </div>
      <div class="modal-body">
        <p>
          What is it?  Carbon monoxide (CO) is an odorless, colorless, and toxic gas
that is often a byproduct of combustion in gas ranges, automobiles, or unvented
kerosene heaters. CO can also be an important indoor pollution concern, because it is
often produced from indoor heaters, chimneys and furnaces, fireplaces, and water
heaters.
        </p>
        <p>
          Why does it matter?  Because carbon monoxide is difficult to detect and might
be a critical indoor pollution problem, our network is especially useful for CO
detection. At low concentrations, it can cause mild chest pain in people with heart
problems or fatigue in healthy people. CO can be fatal at high concentrations, because
of its ability to limit oxygen intake in blood. Other potential issues include angina,
impaired vision, and reduced brain function.
        </p>

      </div>
      <div class="modal-footer">
        <button type="button" class="btn btn-default" data-
dismiss="modal">Close</button>
      </div>
    </div>
  </div>
</div>
<!-- NITRIC OXIDE -->
<div class="col-sm-6 col-md-4">
 <div class="thumbnail">
   <img src="NO.png">
   <h3>Nitric Oxide</h3>
   <p>
   <font size="2"> Nitric Oxide is colorless and odorless, and of the nitrogen oxides
(NOx) emitted, NO is the primary pollutant. While NO is non-toxic by itself, it quickly
converts to NO2 in the air.
  </font></p>
  <p>
   <a class="btn" data-toggle="modal" data-target="#NOModal" href="#">Learn More</a>
 </p>
</div>
</div>
<!-- NO Modal -->
<div class="modal fade" id="NOModal" tabindex="-1" role="dialog" aria-
labelledby="myModalLabel" aria-hidden="true">
  <div class="modal-dialog">
    <div class="modal-content">
      <div class="modal-header">
        <button type="button" class="close" data-dismiss="modal" aria-
hidden="true">&times;</button>
        <h4 class="modal-title" id="myModalLabel">Nitric Oxide</h4>
      </div>
      <div class="modal-body">
```

```
        <p>
          What is it?  Nitric oxide (NO) is a byproduct of combustion of air in manmade
systems such as automobile engines and fossil fuel power plants, or in natural
processes such as thunderstorms. NO is a free radical (it has one unpaired electron),
which means that it is highly unstable and likely rapidly reacts with surrounding
gases. Usually, NO converts into nitrogen dioxide (NO2), which will enter a complex
chain of reactions that may produce ozone or acid rain.
        </p>
        <p>
          Why does it matter? NO is not included in the Air Quality Index (AQI)
produced by the Environmental Protection Agency. However, it is an important precursor
to nitrogen dioxide (NO2), which is known to have detrimental effects on human
respiratory health. NO2 can also likely produce ozone or acid rain.
        </p>
      </div>
      <div class="modal-footer">
        <button type="button" class="btn btn-default" data-
dismiss="modal">Close</button>
      </div>
    </div>
  </div>
</div>
  </div>
</div>
<!-- NITROGEN DIOXIDE -->
<div class="col-sm-6 col-md-4">
 <div class="thumbnail">
   <img src="NO2.png">
   <h3>Nitrogen Dioxide</h3>
   <p>
  <font size="2">  Nitrogen Dioxide (NO<sub>2</sub>) is strongly tied to the presence
of O3 and particulate matter. The largest sources of NO2 are combustion processes, such
as heating and power generation. Long-term exposure to NO2 has been linked to adverse
respiratory effects.
 </font> </p>
  <p>
   <a class="btn" data-toggle="modal" data-target="#NO2Modal" href="#">Learn More</a>
  </p>
</div>
</div>
<!-- NO2 Modal -->
<div class="modal fade" id="NO2Modal" tabindex="-1" role="dialog" aria-
labelledby="myModalLabel" aria-hidden="true">
  <div class="modal-dialog">
    <div class="modal-content">
      <div class="modal-header">
        <button type="button" class="close" data-dismiss="modal" aria-
hidden="true">&times;</button>
        <h4 class="modal-title" id="myModalLabel">Nitrogen Dioxide</h4>
      </div>
      <div class="modal-body">
        <p>
          What is it? Nitrogen dioxide (NO<sub>2</sub>) is a suffocating, brownish gas
that belongs to a family of highly reactive species known as nitrogen oxides (NOx). NO2
is usually produced after nitric oxide, which is produced from automobiles and
industrial processes, rapidly decomposes to NO2. The NOx gases form when fuel is burned
at high temperatures  as a result of motor vehicle exhaust, electric utilities, and
industrial boilers. NO2 can react with other gases in the atmosphere to form nitric
acid, which leads to acid rain, and ozone.
        </p>
        <p>
          Why does it matter?  At moderate levels, NO2 can cause lung irritation and
make one more susceptible to respiratory illnesses such as influenza. Nitrogen dioxide,
when present for prolonged time periods, can make children more susceptible to acute
respiratory illness. NO2 can increase acid rain and formation of zone. Finally, NO2 can
result in eutrophication in waters, which decreases water oxygen and threatens the
livelihood of aquatic wildlife.
```

```
        </p>

      </div>
      <div class="modal-footer">
        <button type="button" class="btn btn-default" data-
dismiss="modal">Close</button>
      </div>
    </div>
  </div>
  </div>
  </div>
<br><br><br>

<!-- line divider -->
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break-border"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>

<!-- CALIBRATION SECTION -->

<div class="row featurette" style="padding-left: 20px; padding-right: 20px; padding-
top: 110px">
  <h2 class="featurette-heading">
    <font color="#1560ac">How have we calibrated our sensors?</font>
  </h2>
  <br>

  <p class="lead">
    Every node is outfitted with 4 electrochemical sensors, which output millivolt
readings. The goal of the calibration process was to provide a precise conversion of
the electrochemical sensor millivolt readings to a parts per billion unit of
measurement for the individual gas species. Using an airtight metal chamber which fit
two nodes at a time, we created a system where air was pumped in through tubing to the
nodes and out through tubing to the equipment, so that both the nodes and the equipment
could measure the same gas pulses. Using a linear regression, the relationship between
the millivolt readings from the sensors and the ppb concentrations from the instruments
created.
  </p>
</div>

<!-- line divider -->
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break-border"></div>
    <div class="col-md-12 line-break"></div>
    <div class="col-md-12 line-break"></div>

      <!-- CONTACT SECTION -->

<div class="row featurette" style="padding-left: 2%; padding-right: 2%">
  <h2 class="featurette-heading">
    <font color="#000">Contact Us</font>
    <span class="text-muted"></span>
  </h2>
  <br>
  <p class="lead">
  </p>
</div>

<div class="col-md-12 line-break"></div>
<div class="col-md-12 line-break-border"></div>
<div class="col-md-12 line-break"></div>

</div>
<!--</div>
```

```
</div>
</div>  -->

</div>
</div>
</body>
</html>
```

Css

```
/*.graph{

}*/


/*#map{

   Height: 100%;

   Width: 100%;

   Position: absolute;

   z-index: -1;

}*/


#valuesTable{

            Background-color: #6699FF;

            Background: rgba(0, 0, 0, 0.7);

            Position: fixed;

            Left: 1%;

            Top: 50px;

            Height: 100%;

            Width: 23%;

            Color: white;

            z-index: 1;

            overflow: auto;

}


#lastupdated{

            Position: relative;

            Left: 10px;

            Font-size: 10px;

}
```

```
#locationheader{
	Font-family: “Helvetica Neue”, Helvetica, Arial, sans-serif;
	Font-style: bold;
	Font-size: 25px;
	Position: relative;
}

/*#legend{
	Position: relative;
	Left: 77%;
	Top: 60%;
	Width: 20%;

	Background-color: #6699FF;
	Background: rgba(0, 0, 0, 0.7);
	Color: white;
	Font-family: “Helvetica Neue”, Helvetica, Arial, sans-serif;
	Font-style: bold;
}

.sublegend{
	Display: inline-block;

}

#legend_container{
	Position: absolute;
	Margin-left: 5px;
}

#legendtable{
	Position: absolute;
	Bottom: 70px;
}

#graphContainer{
	z-index: -10;
```

```
        position: fixed;
        top: 90px;
        width: 100%;
}


#toGraph{
        Color: black;
        Position: relative;
        Top: 10px;
}

#graphButton{
        Position: relative;
}

#logo{
        Height: 25%;
        Width: 25%;
}

#backToMap{
        Float: right;
        Position: relative;
        Right: 1%;
        Background-color: white;
        Height: 30px;
        Width: 40px;
        z-index: 5;
        color: gray;
        font-size: x-small;
        line-height: 10px;
        text-align: center;
        cursor: hand;
}
*/
```

```
.values{
        Font-size: 22px;
}

/*#contactLink {
        Font-size: 10px;
}
*/
Table{
        Border-collapse:separate;
        Border-spacing:0px 0px;
        Font-style: bold;
}



Table.table#temprh > tbody > tr > td {
        Border: 0;
}

/*.leaflet-google-layer{
        z-index: 0;
}

.leaflet-map-pane{
        z-index: 100;
}

.image_navbar {
        Padding: 10px 5px;
}*/

#temprh {
        Padding-top: 10px;
        Font-size: 12px;
}

.table>tbody>tr>td.pollutantName {
```

```
    Border-top: 0px;

}

.table-condensed>tbody>tr>td {
    Padding: 0.5px;
}

.table-condensed>tbody>tr>td.pollutantFull {
    Padding-bottom: 5px;
    Font-size: 10px;
}

.pollutantValue {
    Text-align: right;
}

/*#xButton {
    Line-height: 30px;
}

.unitlabel {
    Text-align: right;
    Font-size: 10px;
}

#dylos{
    Color: white;
}*/
```

Java script

```
var serverURL = "http://clairity.mit.edu/latest/all/";

var sensors = [];
var new_sensor;
var nodesDrawn = false;
var firstUpdate = false;
```

```
var update_int = 11000; //milliseconds, 11 seconds;

var mapBig = true;

var alpha1_thresholds = [0, 4500, 9500]; //CO
var alpha2_thresholds = [100000, 500000, 900000, 1300000, 1500000]; //NO
var alpha3_thresholds = [100000, 500000, 900000, 1300000, 1500000]; //NO2
var alpha4_thresholds = [0, 2000, 3000]; //O3
var pm25_thresholds = [0, 600, 2100];
var pm10_thresholds = [10000, 50000, 90000, 130000, 150000];
var alpha_thresholds = [alpha1_thresholds, alpha2_thresholds, alpha3_thresholds,
alpha4_thresholds, pm25_thresholds, pm10_thresholds];

var drawNodes;

function sensor(lat,lon,location,id,in_out,offline) {
	this.node_id = id;
	this.lat = lat;
	this.lon = lon;
	this.location = location;
	this.indoor = in_out;
	this.alpha1 = null;
	this.alpha2 = null;
	this.alpha3 = null;
	this.alpha4 = null;
	this.color = [0,0,0,0,0,0,0];
	//Overall color, alpha1 color, alpha2 color, alpha3 color, alpha4 color, pm2.5
color, pm10 color
	// 0 = green, 1 = yellow, 2 = red
	this.pm25 = null;
	this.pm10 = null;
	this.functioning = true;
	this.alphaFunctioning = true;
	this.dylosFunctioning = true;
	this.alpha1Functioning = true;
	this.alpha2Functioning = true;
	this.alpha3Functioning = true;
	this.alpha4Functioning = true;
	this.offline = offline;
}

function RequestNodes(sidebarNode) {
	$.getJSON(serverURL, function (data) {
		if(!nodesDrawn){
			for(i=0; i<data.length; i++){
				new_sensor = new
sensor(data[i]["latitude"],data[i]["longitude"],data[i]["name"],data[i]["node_id"],data
[i]["indoor"],data[i]["offline"]);
			sensors.push(new_sensor);
				if(sensors[i].offline){
					sensors[i].alphaFunctioning = false;
					sensors[i].dylosFunctioning = false;
					console.log(sensors[i].location+"
"+sensors[i].offline);
				}
			}
			drawNodes();
			nodesDrawn=true;
			console.log(sensors[3].location+"
"+sensors[3].alphaFunctioning);
		}
		if(nodesDrawn){
			for(i=0; i<sensors.length; i++){
				sensors[i].color = [0,0,0,0,0,0,0];
				for(j=1; j<7; j++){
					addAlphasenseData(i,j,data);
				}
```

```
                                sensors[i].temp = data[i]["temperature"];
                                sensors[i].rh = data[i]["rh"];
                                var tempDate = data[i]["last_modified"].split(/[\s*\-
\s*,":"]/,5);
                                sensors[i].lastUpdated =
tempDate[1]+"/"+tempDate[2]+"/"+tempDate[0]+" "+tempDate[3]+":"+tempDate[4];
                                if(!sensors[i].alpha1Functioning &&
!sensors[i].alpha2Functioning && !sensors[i].alpha3Functioning &&
!sensors[i].alpha4Functioning){
                                        sensors[i].alphaFunctioning = false;
                                }
                                if(!sensors[i].alphaFunctioning &&
!sensors[i].dylosFunctioning){
                                        sensors[i].functioning = false;
                                }
                                setColor(i);
                        }
                        displaySidebar(sidebarNode);
                        if(firstUpdate){
                                sensors[sidebarNode].circ.setStyle({fillOpacity: "1"});
                                firstUpdate = false;
                        }
                }
        });
}

function addAlphasenseData(i,j,data){
        if(j==1){
                var toAdd = data[i]["co"];
                sensors[i].alpha1 = toAdd;
                if(toAdd < 1 && toAdd > -1 || toAdd > 5000 || toAdd < -500){
                        sensors[i].alpha1Functioning = false;
                }
                findColor(i,1,toAdd);
        }
        else if(j==2){
                 var toAdd = data[i]["no"];
                 sensors[i].alpha2 = toAdd;
                 if(toAdd < 1 && toAdd > -1 || toAdd > 1000 || toAdd < -500){
                        sensors[i].alpha2Functioning = false;
                }
                        findColor(i,2,toAdd);
        }
        else if(j==3){
                var toAdd = data[i]["no2"];
                sensors[i].alpha3 = toAdd;
                if(toAdd < 1 && toAdd > -1 || toAdd > 5000 || toAdd < -500){
                        sensors[i].alpha3Functioning = false;
                }
                findColor(i,3,toAdd);
        }
        else if(j==4){
                var toAdd = data[i]["o3"];
                sensors[i].alpha4 = toAdd;
                if(toAdd < 1 && toAdd > -1 || toAdd > 5000 || toAdd < -500){
                        sensors[i].alpha4Functioning = false;
                }
                findColor(i,4,toAdd);
        }
        else if(j==5){
                        var toAdd = data[i]["small_particles"];
                        sensors[i].pm25 = toAdd;
                        findColor(i,5,toAdd);
                        if(toAdd < 1 ){
                                sensors[i].dylosFunctioning = false;
                        }
        }
```

```
        else{
                if(data[i]["big_particles"]){
                        var toAdd = data[i]["big_particles"];
                        sensors[i].pm10 = toAdd;
                }
        }
}

function findColor(i, j, value) {
        if(value > alpha_thresholds[j-1][2]){
                sensors[i].color[j] = 2;
        }
        else if(value > alpha_thresholds[j-1][1]){
                sensors[i].color[j] = 1;
        }
}

function setColor(i){
        var circColor = null;
        if(sensors[i].lat){
                if(sensors[i].dylosFunctioning && sensors[i].alphaFunctioning){
                        index = [1,4,5];
                        for(k=1;k<4;k++){
                                z = index[k-1];
                                if(sensors[i].color[z]>sensors[i].color[0]){
                                        sensors[i].color[0]=sensors[i].color[z];
                                }
                        }
                        if(sensors[i].color[0] == 0){ circColor = "green"; }
                        else if(sensors[i].color[0] == 1){ circColor = "yellow"; }
                        else{ circColor = "red"; }
                }
                else{
                        circColor = "grey";
                }
                sensors[i].circ.setStyle({color: circColor, fillColor: circColor});
        }
}

function displaySidebar(i){
        $("#locationheader").html(String(sensors[i].location));
        if(!sensors[i].alphaFunctioning){
                var alpha_color = "grey";
                co_color = "grey";
                $(".alpha1").html("--");
                $(".alpha2").html("--");
                $(".alpha3").html("--");
                $(".alpha4").html("--");
        }
        else{
                alpha_color = "white";
                $(".alpha1").html(String(Math.round(sensors[i].alpha1)));
                $(".alpha2").html(String(Math.round(sensors[i].alpha2)));
                $(".alpha3").html(String(Math.round(sensors[i].alpha3)));
                $(".alpha4").html(String(Math.round(sensors[i].alpha4)));
                if(sensors[i].color[1]==1){
                        co_color = "yellow";
                }
                else if(sensors[i].color[1]==2){
                        co_color = "red";
                }
                else{
                        co_color = "green";
                }
        }
        doc = document.getElementById("no2a").style.color=alpha_color;
        doc = document.getElementById("no2b").style.color=alpha_color;
```

```
        doc = document.getElementById("o3a").style.color="grey";
        doc = document.getElementById("o3b").style.color="grey";

        doc = document.getElementById("coa").style.color=co_color;
        doc = document.getElementById("cob").style.color=co_color;

        doc = document.getElementById("noa").style.color=alpha_color;
        doc = document.getElementById("nob").style.color=alpha_color;

        if(!sensors[i].dylosFunctioning){
                doc = document.getElementById("dylos1").style.color="grey";
                doc = document.getElementById("dylos2").style.color="grey";
                doc = document.getElementById("dylosa").style.color="grey";
                doc = document.getElementById("dylosb").style.color="grey";
                $(".pm25").html("--");
                $(".pm10").html("--");
        }
        else{
                if(sensors[i].color[5]==1){
                        doc = document.getElementById("dylos1").style.color="yellow";
                        doc = document.getElementById("dylosa").style.color="yellow";
                }
                else if(sensors[i].color[5]==2){
                        doc = document.getElementById("dylos1").style.color="red";
                        doc = document.getElementById("dylosa").style.color="red";
                }
                else{
                        doc = document.getElementById("dylos1").style.color="green";
                        doc = document.getElementById("dylosa").style.color="green";
                }


                doc = document.getElementById("dylos2").style.color="white";
                doc = document.getElementById("dylosb").style.color="white";
                $(".pm25").html(String(Math.round(sensors[i].pm25)));
                $(".pm10").html(String(Math.round(sensors[i].pm10)));
        }
        $("#lastupdated").html("Last Updated: "+sensors[i].lastUpdated + " UTC");
};


$(document).ready(function(){
    //Leaflet Map
        var googleLayer = new L.Google('ROADMAP',mapStylesArray);

        var sWBound = L.latLng(42.336976,-71.153984);
        var nEBound = L.latLng(42.381880,-71.052017);
        var map = new L.Map('map', {center: [42.3590000, -71.095500], zoom: 16,
minZoom: 14, maxBounds:[sWBound,nEBound], zoomControl: false, attributionControl:
false, layers: [googleLayer] });

        map.addLayer(googleLayer);
        var zoomBar = L.control.zoom({ position: 'topright' }).addTo(map);
        var attribution = L.control.attribution({position: 'topright'}).addTo(map);

        map.doubleClickZoom.disable();
        map.scrollWheelZoom.disable();

        var sidebarNode = 14;

        drawNodes = function(){
        for(var i=0; i<sensors.length; i++){
                if(sensors[i].lat){
                        var delt_lat = 0.00015;
                        var delt_lon = 0.00028;
                        if(sensors[i].indoor){
```

```
                                sensors[i].circ = 
L.polygon([[sensors[i].lat+delt_lat,sensors[i].lon],[sensors[i].lat-
delt_lat,sensors[i].lon+delt_lon],[sensors[i].lat-delt_lat,sensors[i].lon-delt_lon]],{
                                color: 'red',
                                fillColor: "#f03",
                                fillOpacity: 0.5
                                }).addTo(map);
                                sensors[i].circ.bindPopup(sensors[i].location, 
{closeButton: false,'offset': L.point(-12,-15)});
                        }
                        else{
                                sensors[i].circ = 
L.circle([sensors[i].lat,sensors[i].lon], 16, {
                                color: 'red',
                                fillColor: "#f03",
                                fillOpacity: 0.5
                                }).addTo(map);
                                sensors[i].circ.bindPopup(sensors[i].location, 
{closeButton: false,'offset': L.point(0,-5)});
                        }

                        sensors[i].circ.number = i;

                        sensors[i].circ.on('mouseover', function(evt) {
                                evt.target.openPopup();
                        });
                        sensors[i].circ.on('mouseout', function(evt){
                                evt.target.closePopup();
                        });

                        sensors[i].circ.on('click', function(evt){
                                displaySidebar(this.number);
                                sidebarNode = this.number;
                                for(var i=0; i<sensors.length; i++){
                                        if(sensors[i].lat){
                                        sensors[i].circ.setStyle({fillOpacity: "0.5"});
                                        }
                                }
                                this.setStyle({fillOpacity: "1"});
                        });

                };
        };
}

        RequestNodes(sidebarNode);
        var reset = setInterval(function() {RequestNodes(sidebarNode)}, update_int);

});
```

Submitted by

A.jebastin