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Vicinity Monitor using Internet of Things

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ABSTRACT

Internet of things is the technology that has been getting very popular lately so much so that it is powering a big translation in the business models and allowing them to drive their way towards Automation. Putting it straight, Internet of things basically is a network of devices like our vehicles and electrical appliances and software and network connectivity that enables these devices to share data about their status. What it enables the developers to do is to control them remotely. By the year 2020, 260 million devices will be IOT enabled according to Gartner. One of the key areas where internet of things is found to be more helpful is Monitoring. Being able to remotely get information about something or the status of something opens the gate for a large number of applications. Motivated by the goal of achieving clean air in our surroundings, this paper discusses the IoT technologies available that enables us to remotely monitor the air quality of a distant place. Furthermore, this paper contributes by introducing Vicinity Monitor, a sensors based air quality, flames and temperature monitoring project that enables its users to get this information on their Android device remotely. And finally putting forward the advantages, challenges and future scope of this project. We aim to make our contribution to the sustainable world with this research.

Keywords: *IoT (Internet of things), Sensors, Gateway, Connectivity, Network, Monitoring, Pollution, Harmful Gases.*

1. INTRODUCTION

Internet of things is changing the way companies interact with customers and business partners like suppliers and it comes as no surprise as Internet has become an integrated part of our everyday lives and has been changing our lifestyle since the 1990s. As we stand today, the developments in the sector of information technology have given rise to a hyper-connected world where mobiles are connected to objects and appliances with internet and can communicate with each other and share data between each other. At the core of this transformation lies the Internet of things which is the driving technology of this change which is making the machine to machine communication possible. IoT can be described in simple words as the ability of network-connected devices to be able to collect and send information across the internet which can then be used to for a practically uncountable purposes because with every mind there will be a new idea. The concept of IoT has been around nearly for more than 20 years. Researchers have been claiming the power of IoT in changing our lifestyle since very long. When things like common electrical appliances including coffee maker, washing machines, geysers etc. or our vehicle are connected to the network they can interact with each other to perform a various task while eliminating your need to control them individually. To put things in perspective let us take an example, you put an alarm of 6:00 am in the morning and go to sleep. Now, the alarm clock is connected to the network shares this information with the devices like a coffee maker and geyser, so, when the alarm is about to ring in the morning the geyser automatically gets switched on to heat up the water which will save your time. Similarly, coffee maker prepares you coffee automatically as it was in sync with the other devices. This is just one example from the sea of applications of IoT.

This project is based on the technology of Internet of things by which we aim to solve the problem of air pollution. Our surroundings are full of harmful effluents that may rise to a toxic level under some circumstances and even lead to fatal consequences. There is no active system in our cars and homes to keep a check on these toxic elements. Hundreds of people die every year due to carbon monoxide poisoning alone. There is no large-scale system to handle this problem so it has to be dealt on a personal level by keeping track of our surroundings.

It might contradict my last line but there are in fact multiple ways available to fight air pollution but the truth is that the best way to tackle this problem is if we reduce the production of air pollution. But this requires people to accept that air pollution is really a problem. In many cities of India, the condition of air is so worse that the numbers set as standards for air pollutants Index in the air seem like very small in comparison to the pollutant index value in the air of this city. And people here seem to be like okay with this as you will find not even 10 people wearing a mask out of 100. So, we feel that if we can make the people realize that air pollution is actually a serious problem then we can really carve our way to fight this problem. We aim to fulfill this task by making the people aware of the quality of the air that they breathe in and out round the clock. It might seem like a foolish idea as newspapers and media have been doing this thing but we are talking about something different.

Before coming to our approach we would like to point out the shortcoming of the awareness that newspaper and media spreads. People take this information from media and newspapers as only applicable to air outside their house and feel that air inside their own house is cleaner. Well, it might be true that air inside the house is cleaner but that comparison would be between something less harmful and more harmful and either way, harm is only to us. So, our approach is to make people aware of the air quality inside their house letting them know how clean or polluted the air is which they breathe every time. We feel that exposure to this information will play a major role in inspiring people to take measures to reduce air pollution. This way all the measures taken by the government at large scale will get active mass support and it has been proven time and again that bigger changes are achieved via mass participation.

2. IoT AND VICINITY MONITOR

The main characteristic of vicinity monitor of being able to display data about the composition of air with respect to harmful gases like CO, CO_2, Benzene, Butane etc. and other information like temperature and flame emission remotely is delivered by the technology of Internet of things. The working model of this project contains a raspberry pi connected to breadboard circuit. On the breadboard are connected the sensors which are DHT22 temperature and humidity sensor, LM393 flame sensor, MQ2 harmful gases sensor. This circuit along with raspberry pi are provided network connectivity via the home's Wi-Fi. All the readings are stored in the database stored on raspberry pi and are shared via a pipelining along which the data is arranged in the tabular form. All users have to do is to use the android app to register their raspberry on the network and then they can get started. The app will display the data in tabular form. Furthermore, it will also push e-mail notification in case if a flame is detected.

3. RELATED WORK

Below we have put together the list of IoT projects that have been developed and deployed and we drew our inspiration from these ideas and works.

Integrating sensors to the pre-existing Infrastructure

In order to keep a track of air quality, cities have sensors installed in the infrastructure of their key areas. Chicago served as a great example as the city has deployed its array of sensors already since 2014. The sensors are installed citywide on lampposts which are developed by Argonne National Library and the Chicago Department of Innovation and Technology. These sensors are capable of tracking a large number of air pollutants such as ozone, nitrogen dioxide, carbon monoxide, and particulate matter. All this is made possible by the development of a new technology called "waggle chips" and the city is even planning to make it capable of monitoring volatile organic compounds (VOCs) in the future. All this data is available to the public via Chicago's open data portal and has been proven to be of use in predicting air quality incidents.

Mobile sensors

Chicago's implementation had a limitation that its sensors were stationary and the monitoring was done of the same surrounding always with respect to the sensor. This can easily be overcome by installing sensors on the objects and things that move throughout the city. One obvious example is of cars and other vehicles as they travel can map entire city quickly. With Google as a partner, the environmental defense funds (EDF) used the street view cars for measuring the methane levels in eleven cities in total and installed into them the intake tube with methane analyzers. This helped EDF to point out 5500 leaks after creating a methane map. Later in 2014, Google took this project a step further and installed in their street view cars the Aclima's Environmental intelligence mobile platform, which is capable of monitoring the particulate matter, CO_2, NO_2, black carbon and many such harmful gases. With over 750 hours of driving around the Denver city during the test run, the car collected over 150 million data points and thereby creating a street-level air quality map.

Pairing sensors with mobile phone data

So, this particular project was of most help to us as it resembled the similar objective with a large scale implementation. Even though the street level air quality map from google was a great step but it didn't help the citizens to get an insight of how is the bad air quality affecting them. Under this project, anonymously chosen mobile phones were selected to map the common commutes of people around the city and finding out their chances of exposure to the areas of poor air quality. MIT's Senseable City labs in New York took this data to find out which harmful chemicals are the New Yorkers exposed. The study revealed that those living in Manhattan are exposed to the more pollution than the ones who commute to the outer boroughs. These type of studies goes a step further in spreading awareness amongst citizens about the pollution levels around them.

4. IoT ARCHITECTURE

Typically, any IoT solution will consist of three layers. These layers are the edge devices, the gateway, and the cloud. Each of these 3 layers has well-defined roles for them and provides a specific feature and functionality required by the IoT platform. Let us discuss more these layers in detail

Sensors

The word 'Things' in the Internet of things can be any device in our home or our vehicles, basically, anything which is capable of sharing data. What makes these devices IoT enabled are the sensors. They are very small sized microcontrollers with very limited capabilities. There are a variety of sensors each programmed to perform a specific task. But they all can be described with one simple definition, a sensor is a device that detects and responds to a specific type of input or situation from their physical surrounding. Sensors are both digital and analog. An analog sensor is always active while a digital sensor is intentionally made active. But It is not the case that analog sensors are always sending the readings, rather, invoking sensors to get the readings and send the data packet is the responsibility of gateway which is discussed next.

Gateways

Gateways can be considered as the most important part of the IoT architecture. Gateways act as the coordinating point for a group of sensors and edge devices and are responsible for performing mainly two functions which are Telemetry and sending control information. To understand the concept of telemetry, first, we need to understand how the data collection from the sensors is done. No edge device is capable of sending data on its own. It is gateway which sends the command to the sensors which then revert back to the fresh readings. Sensors are passive devices and keep on performing the sensing operation. When they receive the command from the gateway to send the data, the readings are then stored in the data packets which are made according to the messaging protocol and then the gateways receive the data. This is known as telemetry.

Other function performed by the gateways is that they are responsible for controlling these sensors and sharing the control information with these sensors received from the cloud servers.

On the topography of a typical IoT architecture, Gateways are placed between sensors and cloud servers and have specifications capable of monitoring hundreds of edge devices.

Cloud

This is where all the analytics and processing of an IoT solution takes place. Each IoT platform has a number of cloud server each performing a specific task. Different types of cloud servers can be Data management, Software update management, message routing, and analytics. Cloud servers in the IoT architecture topography are in control of all the gateways i.e. they are placed at the top of the hierarchy.

IoT Platform

The three layers of an IoT solution that has been discussed yet are the hardware layers. IoT platform is the combination of all the software that connects these hardware layers with each other. Each IoT platform has software dedicated to performing each of the function of each layer discussed above. IoT platforms are basically of two types, one which provides the end-to-end solution in a single software while the second type consists of open source software that performs a specific function for an IoT solution and can be made to work in integration with other open source tools.

Key characteristics of an IoT Platform

Scalability

Thousands of devices are connected to a single IoT solution implementation to provide data sharing for multiple purposes via a network. Scalability is the feature that allows an IoT platform to better adapt to specific hardware and software need when it rises. It helps to make an IoT platform futureproof. An IoT platform should be scalable both vertically and horizontally. Vertical scaling refers to when more resources are provided to the existing hardware like increasing processing power. While horizontal scalability refers to the case when hardware devices are added to the architecture. Scalability is an important characteristic of an IoT platform due to the fundamental nature of this technology and a large number of devices that will become IoT enables eventually.

Device authentication and Asset modeling

A lot of devices are connected to a single IoT solution implementation. It is the responsibility of the IoT solution software to authorize every device that connects to the platform and should be uniquely identifiable from all the other nodes on the network. Asset modeling refers to making digital twins of the physical nodes on the platform software.

Modularity and Loose coupling

The three layers of the IoT architecture should be loosely coupled with each other in order to be used independently rather than heavily relying on gateway or cloud. Furthermore, the tools used in an IoT platform should be modular. Modularity and loose

coupling make way for having options to use gateway software from one company and messaging broker and client from another supplier. Not only this the software tools should be device independent and this can be achieved by going for open source standards.

Open Standards

Internet of things is not a product or service that can be used individually, instead, it is the new standard which will change the business models for many organizations. Therefore, IoT is a fundamental and necessary step forward in the Industry. To make this change easy to adapt, the tools and platforms for Internet of things should be Open source so that companies can be more flexible with them.

5. APPLICATIONS

Vicinity monitor can be used in many different domains, from environment protection (forests trees protecting, air monitoring...), energy (wind turbines, electricity meters...), public safety (bridges, buildings, vehicles...), health (baby monitors, elderly monitors…), to agriculture, especially in greenhouses where it can be used for:

a. Security

There are many ways where IoT can be used for security: infrared radiation for fire or intrusion detection, Video surveillance, equipment tracking.

b. Environmental monitoring

Some applications can be related to the continuous and long-term monitoring of gas concentration in air, soil humidity, lighting conditions.

c. Climate control

Temperature, humidity and soil moisture can be monitored through various sensors. These can then be linked to systems to trigger alerts or automate processes such as water and air control.

d. Room Allotment in Hospitals

Rooms in a hospital can be issued to a patient by predetermining the composition of air of a particular room and only the best medically suited room is allotted to a patient.

6. CONCLUSION

In conclusion, the Internet of Things is closer to being implemented than the average person would think. Most of the necessary technological advances needed for it have already been made, and some manufacturers and agencies have already begun implementing a small-scale version of it. The main reasons why it has not truly been implemented is the impact it will have on the legal, ethical, security and social fields. Workers could potentially abuse it, hackers could potentially access it, corporations may not want to share their data, and individual people may not like the complete absence of privacy. For these reasons, the Internet of Things may very well be pushed back longer than it truly needs to be.

Vicinity Monitor is an IoT Open Source / Open Technology initiative which tracks the concentration of elements in the air that surrounds us. Sensors consistently measure the levels of specific elements and send data to the gateway which uploads the data to a web-based browser that can be used and analyzed to be shown to the end user.

Our surroundings are full of harmful effluents that may rise to a toxic level under some circumstances and even lead to fatal consequences. There is no active system in our cars and homes to keep a check on these toxic elements. Hundreds of people die every year due to carbon monoxide poisoning alone.

Some of the benefits of this system are:

• Convenient monitoring of the surroundings

• Safety from the sudden increase of toxic gases in the car or home

• Safety from fire by detecting the presence of flames or toxic gas levels

• Temperature tracking

