Projet PPE: Air pollution monitoring system using LoRa communication

19 mai 2019

1 Introduction

Collecting data from sensors is an important task as it allows users to understand their environment better. We propose Web Sensor Data Processing Engine, that allows to collect and process sensor data.

The sensors attached with a micro controller in the LoRa module will communicate to the cloud environment through the LoRa gateway. A web page provides the interface to the residents and to the authorities to gauge the air quality after analyzing the data using the prediction algorithm.

Furthermore, it provides a solution for handling the locks that have been employed in and around the village to control the flow of pollution in a timely manner.

The system should also provides an alert mechanism which notifies the different level of authorities through email and SMS in case of any issues.

As the world population increases at a steady rate, providing clean water to the masses in an efficient manner is one of the biggest challenges faced in the modern era. Controlling the flow of water so that it doesn't go to waste is another challenge. Water flow is generally managed through locks and manually controlling these gates often turn out to be a long-winding process. Due to recent technological progress and increased connectivity in rural areas, a system of IoT devices proved to be alternative for managing the water grid. A new Low Power Wide Area Network (LPWAN) technology called LoRa is explored in our study for the communication of these IoT devices. The LoRa devices can communicate within a range of 2-4 KMs while running on batteries that last for years. As a pilot project, we implemented a smart water grid management system in Mori, a village in the eastern Godavari district in Andhra Pradesh situated near to Bay of Bengal.

The water grid management system proposed in this paper involves different sensors deployed at various strategically chosen locations to measure the air quality by generating real time data.

While Twitter and other Online Social Networks (OSNs) or microblogs are considered as a source of information for breaking news or uproarious and unexpected events, they could also be exploited as a dense worldwide sensors network for physical measurements. The corpus of geotagged posts from OSNs includes people's feedbacks about a wide range of topics, with precise temporal and geographical metadata, that can be used as a support or an improvement to hardware sensors. For instance, if collocated people, independently and at the same time, write posts complaining about high temperatures, it could effectively denote a raise of heat in that place. In this paper, we explore the feasibility to use a geographical search on social networks, that is, a geosocial search, about air pollution related posts, as effective air impureness measurements. We evaluate our assumption in large cities over three continents of the planet, where a minimum increment about the number of air pollution related posts in an area, indeed corresponds to a raise of minimum pollution values in such area. Such a correlation can be exploited to integrate and extend existing air pollution monitoring networks. At the end of the manuscript we propose to further employ the time series of posts returned by the geosocial search to predict next pollution values.

Air pollution monitoring has become an essential requirement for cities worldwide. Currently, the most extended way to monitor air pollution is via fixed monitoring stations, which are expensive and hard to install. To solve this problem, we have developed EcoSensor, a solution to monitor air pollution through mobile sensors. It is deployed with off-the-shelf hardware such as Waspmote (based on the Arduino platform), low-end sensors, and Raspberry Pi devices. EcoSensor collects air pollution using embedded sensors and transfers the captured data to an Android-based device, which displays to the user the air pollution levels in real time. EcoSensor also stores the different pollution traces to a Cloud-based server to analyze the pollution distribution. The cloud server uses the uploaded data, together with highly-accurate data made available by the existing air monitoring infrastructure, to create detailed pollution distribution maps using kriging-based spatial prediction techniques. To optimize the usage of our system, we analyze the impact of sensor orientation in the presence of mobility. Also, we analyze the best time and space sampling strategies to determine the most effective data capturing strategy. Experimental results show that the sensor orientation and the sampling period have a lot less impact on created maps than the actual path taken.

Mobile sensing is becoming the best option to monitor our environment due to its ease of use, high flexibility, and low price. In this paper, we present a mobile sensing architecture able to monitor different pollutants using low-end sensors. Although the proposed solution can be deployed everywhere, it becomes especially meaningful in crowded cities where pollution values are often high, being of great concern to both population and authorities. Our architecture is composed of three different modules: a mobile sensor for monitoring environment pollutants, an Android-based device for transferring the gathered data to a central server, and a central processing server for analyzing the pollution distribution. Moreover, we analyze different issues related to the monitoring process: (i) filtering captured data to reduce the variability of consecutive measurements; (ii) converting the sensor output to actual pollution levels; (iii) reducing the temporal variations produced by mobile sensing process; and (iv) applying interpolation techniques for creating detailed pollution maps. In addition, we study the best strategy to use mobile sensors by first determining the influence of sensor orientation on the captured values and then analyzing the influence of time and space sampling in the interpolation process.

The clean air is the most important part of human living [1, 2]. Based on WHO data, in 2014 nearly half of the world's urban population is exposed to air pollution 2.5 times above WHO safety standards [3]. The clean air will support human healthy, the type of air that directly affects human healthy are CO 2 , NO 2 and H 2 S [4], accordingly the level intensity of that must be considered. Increasing the number of motor vehicles in a city has contributed considerably to the decrease of air quality in a city, especially if coupled with the burning of the forest, the community activities of a city will be disrupted [5]. In addition, air pollution will also directly interfere with environmental conditions and indirectly can disrupt the global economy [6]. Because of these problems, it is necessary to do an air quality monitoring in real time to prevent the level of air pollution is getting worse [1], [7]. The rapid development of network and internet technology has supported the growth of the Internet of Things in the World. With the Internet of Things, every sensor and actuator will connect to an object, so that information from each object can be communicated to third parties through internet network technology. And for the future the performance of the Internet of Things (IoT) will depend on the efficiency of the device's power usage and the maximum distance between transmitter and receiver. This caused a lot of research using IoT technology in order to monitor air quality so that the measured air intensity value can be accessed by various parties [8]. Several studies have discussed the process of direct air monitoring. The air monitoring process utilizes an array of gas sensors comprising eight sensors, an Arduino board device, an ATMega 2560 microcontroller successfully measuring changes in Hydrogen gas, butane gas, CO gas and H2S gas on a highway [9]. But in that research, the measured data can not be sent to the third partyes. Other research about air monitoring is the process of air monitoring using Arduino and gadgets as data transmission medium [10]. In this research, the measurable data can be directly observed through the gadget. Due to the data transmission process using Bluetooth technology, the observation distance is less than 10 meters from the data center. The other research is using wireless sensor networks (WSN) technology in the process of air pollution data transmission [11]. In this technology, the system consists of target, node sensors and base station controller (BSC). With parameters measured CO 2 , CO, temperature and humidity. Using the JN139 microcontroller as the sensor node controller, which is integrated with an IEEE 802.15.4 and Zigbee applications, so that data is sent to the receiver is capable of traveling long distances through the addition of repeaters. And the other reseach about air monitoring system is air monitoring system based on wireless sensor network (WSN) with Tree-like Mesh topology using Zigbee device and General Packet Radio Services (GPRS) as data transfer protocol [12]. In this research, the system can measure the intensity of CO and the delivery of test data with a good performance because have low of delay and low packet loss. Because this system uses the GPRS protocol in its data transmission then the system must be connected to the internet network that provides additional fee in the data connection. From some of these studies indicate that the distance between transmitter and receiver and the need for internet conection are the major problem in the data communication system, so it takes a new technology that can transmit measurement data in a long distance without connecting to the internet to improve performancy system. So the use of Low Power Wide Area Network (LPWAN) technology