American University of Sharjah

School of Engineering

Computer Engineering Department

PolluMap

Urban Pollution Mapper

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1. Project Significance

The environmental concerns have been growing along with the development of human race and their population distribution. To an extent, the last years have experienced a rapid shift in the demographic distribution towards heavily populated urban cities than it was ever before [1]. The environmental dilemmas have grown in parallel to produce tragedies like : the Love Canal of 1978, the Bhopal Gas Tragedy of 1984, and the London Smog of 1991.Urban pollution concerns have been gaining a bigger share with such a rapid increase in the number of urban dwellers that will exceed half the world's population by 2030.According to the World Health Organization, 1.5 billion urban dwellers suffer levels of pollution that exceed allowed levels, 1.5 million people die annually of pollution related diseases in Asia, 1/5 of lung cancer cases are caused by pollution particulates, and economically speaking, 1 billion dollars a year is the global cost of urban pollution. This raises a concern of close monitoring for such dangers, where everyone should be responsible for closely monitoring the urban pollution status.

2. Project Definition and Objectives

2.1 Definition

PolluMap is an automatic Pollution Mapper for urban cities. It collects pollution data entries automatically across a geographical zone to provide a synchronized database about pollution levels on a time span. It gives the user the ability to view the pollution levels as well as their predicted values that are derived from the current patterns of pollution trends.

2.2 Objectives

The system is designed to be able to do the following:

- Automate urban pollution data collection
- Provide an easy-to-access pollution map
- Store pollution history to be retrieved on demand
- Suggest future pollution levels.

Environmental enhancement is the aim of the system in general. By achieving the above goals, environmental awareness amongst the public is improved and hence environmental enhancement.

This system provides data that is easy-to-understand and easy-to-access; this makes it simpler to understand the environmental issues. Understanding the issues is not only that matters; reaction should follow. The implications of air pollution are very adverse-both on the health of the public, as well as on the status of the environment. In a perfect world, these implications should be prevented in the first place i.e. being proactive. Therefore, the data can be used to initiate policy and implement it, for example, governments and concerned parties can enforce regulations that require the use of less polluting, alternative fuels in vehicles.

When the public is aware of the polluted areas in a city, their living choices vary- they choose to live in less polluted areas. These choices have an economic impact on the price of real estate, driving the price of air polluted areas down and the price of clean-air areas up, this and the condensation of populations in clean-air areas rather than the polluted areas. Such impacts may force reluctant governments and authorities to do something to stabilize any change in the economics by changing their politics.

The data provided by the system can help flourish- or deflourish- tourism in a country or a city. By accessing the data, the people can have an idea about the air quality of a

city and make their decisions based upon it. Again, if the level of tourism in a city is going down because of the air status, this may cause the responsible parties to solve the problem. On the other hand, if a cit is enjoying clean air and the public is informed, this may bring in more revenues into the country because of an increase in the level of tourism.

Technically, in this project, we are trying to join fixed and mobile sensors for data acquisition in a cost efficient way. Conventional attempts for data acquisition have been sparse and costly- the more money you put into the project the better the results. Here, we are trying to relatively fix the cost and yet have good results as well as provide alternative, flexible solutions.

3. Design Methodologies

3.1 System Design

The system high level design can be demonstrated as figure 1 suggests:

3.1.1 Data Acquisition Units (DAUs)

The DAUs are responsible for collection of pollution data according to different schemes. These units can be fixed or mobile to provide flexibility of the data collection process. These units are equipped with the pollution sensors that gather pollutants' levels across a certain geographical area. These units are to contain wireless interfaces to send the collected data to the rest of the system that determines the communication with the central database. For example, GPRS interfaces can submit the collected data to the web server through the available GSM network. Another way of transferring collected data can be by transmitting them to fixed units

that enjoy internet connectivity. This transmission can take place through cheap RF devices like Bluetooth.

3.1.2 Inter-Connected Units (ICUs)

These units can be fixed at certain places to collect information from the DAUs according to the timing scheme we are developing. These units enjoy connectivity to the internet as well as a possibility to collect data themselves as a part of the DAUs distribution. Wireless transmitters/receivers can help such communications as a part of the design.

3.1.3 Mapping Servers and Databases

Mapping servers and databases organize the received data and integrate them towards their history. Mapping servers can provide different services and maps that will establish meaningful data transmission according to the end user queries. The central database carries the information about the pollution and pollutants' levels after refining the collected data. This interconnected service can grant end users with different surfing abilities and access to the available data that was archived.

3.1.4 Plotting Service

The plotting service can be an end user application that plots the data received from the mapping server and builds an informative map about different pollutants' levels. The complexity of the client view depends on many factors that might be decided later. The main two functionalities of the system are to provide graphical responses to queries about different pollution levels and to predict future levels according to the observed patterns.

3.2 Design Alternatives

3.2.1 Fixed and Mobile DAUs

Fixed DAUs will enjoy easier connectivity and identification, but will suffer from discreet sampling and the sparseness of the data collected. Mobile DAUs can provide continuous data collection, but can also suffer from power and synchronization problems.

A solution to this dilemma is to provide a heterogeneous system that is built using both.

3.2.2 Data Synchronization

The means to update the central database can include wired and wireless connections. The ICUs can enjoy wired connectivity, which is cheap and available, but with the cost of an extra unit. The other option is to use the GSM network to send collected data. This option will provide instantaneous updates on an extra cost of using the channel. A mix of both options can provide a less restrictive way of updating the database, which will make it easier to use both schemes at the least cost possible.

3.3 System Constraints

3.3.1 Service availability

Being connected to the internet in a continuous manner faces its availability limitations. The connectivity infrastructure limitations can be like a connected hardware to a LAN or an available GSM network with a GPRS service provided. Moreover, Availability can be also restricted with the access cost associated.

3.3.2 Power Supply

Electromechanical sensors suffer from high power consumption rates that might affect the mobility of the system. An available power source like the automobile's can be used to minimize the effect.

3.4 System Mobility

Providing a mobile device requires a mobile access to the geographical area in focus with the best coverage available. To solve such a problem, we may use governmental vehicles or regular buses shuttling in a certain area to mount the devices on and get the best available coverage with no extra cost.

4. Conclusion

As seen above, the system is used for acquires pollution data automatically, obtain historical data about pollution levels, as well as detects and alarms at high levels. PolluMap extends the urban pollution issue to a new dimension that widens the environmental responsibility to be at the stake of citizens along with the government. We proposed above, we think, a feasible solution to the ever-present problem of air pollution. This attempt- and many others- can be used for the enhancement and protection of the environment for better health, a better, cleaner future, and a more harmonious interaction between man and his environment.

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Appendix 1:

Figure 1 – System Architecture