A Mobile Environmental Air Quality Information System as a Support for m-Health

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Abstract. Considering mobile device limitations, such as storage, computing power and bandwidth, we propose a mobile cloud computing in order to provide the necessary resources and for delivery of any multimedia data like maps, alarms or messages to the mobile user devices.

The main contribution of this paper is the scalability of our mCloud-based pollution monitoring system. The system can be extended to the entire territory of the country and it integrates all sensor pollution data with patient databases. By using mobile technologies, users/patients receive alerts concerning the air quality levels through user-friendly messages.

Keywords: Air Quality Index, Cloud Computing, m-Health, Lung Disease, Prevention, Alerts.

1 Introduction

In this paper, as a part of our e-Health system, we focus on patients with lung diseases. The database of radiological images is used as a ground level for diagnostics and cloud computing is used to connect this system with data from the Airpointer system. The Airpointer system gathers raw data through various sensors for which GIS technology can be used to make visualization from the air pollution parameters.

In the sections that follow, we present several related works that depict some important topics concerning our system (Section 2). Afterwards, the Architecture of the Air Quality Monitoring System is presented (Section 3). The experimental results present the outcome of the different systems and their interaction (Section 4). Section 5 concludes the paper and presents some possible future upgrades of the system.

2 Related Work

Many authors (see [1] for example) try to find various ways to measure air pollution, to increase public awareness and eventually to prevent medical conditions that are in direct correlation with this environmental problem.

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The framework in [4] uses location-based technologies such as GPS/GSM modules, wireless sensor networks and mobile device technology to enable real-time patient monitoring and communication through alerts for potential environmental dangers to prevent asthma patients more accurately and develop care plans for the patients.

Throughout the world, patient data including their pictures are already stored in clouds. One solution uses the cloud to store patients data, gathered from the sensors attached to existing medical equipment that are interconnected to exchange service for later processing by expert system and fast data delivery to medical staff [7].

Another solution provides patient images in a cloud to save storage capacity, to promote energy savings and to use less paper and film for printing reports. Moreover, data would be accessed independently, using adequate security measures [8].

In [3], the cloud computing (CC) paradigm and WSN are used for the data process ability and as a service model. In the framework, the data from WSN are efficiently utilized and managed, depending on which, information services are well provided to the users.

A similar air pollution monitoring system with GIS modeling is used in the work where Nanotechnology Based Solid State Gas Sensors are used to detect pollution levels in some industrialized areas in Thailand [2].

Our system uses mobile technologies to spread more rapidly and provide the system with greater flexibility and urgency, since it deals with patients known to have a lung disease. Patients receive alerts with air quality levels through user-friendly messages. The web service providing the alerts is in mCloud. An Airpointer [5] that contains various sensors that measure air pollution parameters is connected to the mCloud where GIS technology is used to visualize this gathered data.

3 Architecture of the Air Quality Monitoring System

The main components of our Air Quality Monitoring System are shown on Fig.1. All pollution measurement data are provided by the Airpointer and other sensor stations and transmitted to the pollution database (PDB) in the mCloud. The patient database containing lung radiology images and other patient data is also located in the mCloud. Users connect to the mCloud through mobile devices like smart phones, tablets etc. By using mobile technologies, these patients receive alerts for the air quality levels given from the web service.

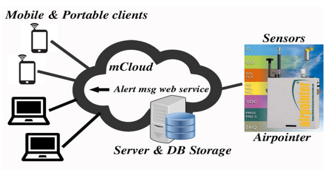

Fig. 1. Architecture of the Air Quality Monitoring System

The pollution data is continuously renewed, approximately in real time. Publishing of this data is regulated every hour. The six steps procedure of the Air Quality Monitoring System is presented in Table 1.

Table 1. Six steps of the Air Quality Monitoring System

Steps	Actions
1	Acquisition of data from the measurement stations.
2	Pollution data are enriched with spatial coordinates (using Python PL) for every measuring point.
3	Building GIS layers from PDB with the use of interpolation module (IDW from ESRI software).
4	Presentation of layers on the map for each parameter.
5	Visualization by different colors of the parameters concentration as a new layer over a map of the city of Skopje.
6	Sending of messages for air quality levels in Skopje to alert mobile users in categories with lung diseases.

As a result of the above procedure, the visualized pollution state can be presented as shown on Fig. 2.

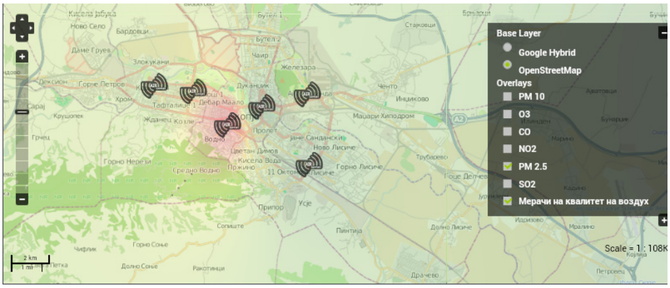

Fig. 2. The position of the sensors and visualized pollution state of the city of Skopje (http://www.skopjefinki.ekoinformatika.mk)

One concrete parameter rarely determines the current air pollution. Usually, it is the combination of parameters and their density, calculated with a formula [6] that retrieves the "Air Quality Index-AQI" for a given area (the measurement point).

Finally, as has been mentioned before, we keep the patient database with the corresponding lung radiological images in the mCloud.

4 Experiment Results

The alert output messages to the users (patients) involved in the category with lung diseases, depending of the AQI range are presented on Table 2.

Table 2. Alert outputs according to the AQI

Alert (Low to High)	AQI Range	Output Message
1	0-50	No risk.
2	51-100	Low risk for health sensitive people.
3	101-150	Medium risk for children and people with lung problems.
4	151-200	High risk for children and people with lung problems. Medium risk for the rest.
5	201-300	Very high risk for children and people with lung problems. High risk for the rest.
6	301+	Extremely high risk for everyone.

AQI (Air Quality Index) calculated from these pollution parameters is used as a basis for the following web pollution service:
{"EcoMethodResult":"Time; AQI_all_avg1\u000a2013-07-13 22:17:00; 58,44 \u00a"}

On Fig.4 the results of the above Web pollution service is shown, as well as the Android mobile application where patients receive alert messages.

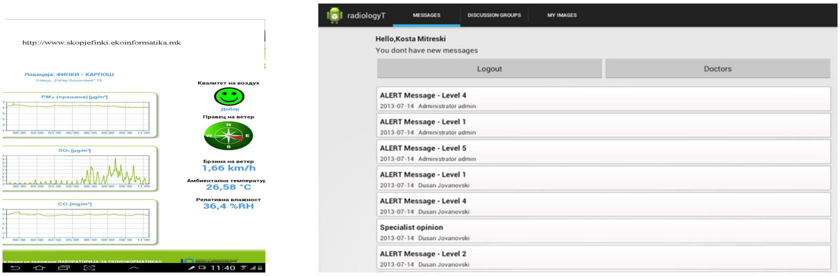

Fig. 3. Screenshot of alert messages for the air quality levels (right) and corresponding links

5 Conclusion

Future improvements and upgrades of the system would be to directly connect the tracking system to the m-Health Radiology Consultation and Alerting System. We plan to extend this system on the entire territory of the country and to all lung diseases patient especially asthma patients as a service connected to the Ministry of Health.

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