An Integrated Web Portal for Water Quality Monitoring through Wireless Sensor Networks

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ABSTRACT

Wireless sensor networks (WSNs) are aiding water quality monitoring with support for real-time and remote quality measurements in terrain. Environmental monitoring portals receiving data from sensors have been a practice since a while among researchers. However, the Web portal introduced here is essentially an integrated portal since it supports modeling and management of both, the observational stream data on water quality coming from wireless sensors – dynamic data, as well as of the data describing the WSN itself, its devices and the corresponding site allocation data – static data. Access is given to a wide range of individuals, from water experts to WSN engineers, to general public. Experts' module infers statistics about water parameters given the experts' data and rules. The portal is further distinguished for its level of scalability: it allows adding with ease new components, like add certain new regulatory documents for water quality, and directly compare data measured by sensors with corresponding quality standards. The aim is to enrich the portal with semantics in future.

Keywords: Statistical Data, Water Expert Rules, Water Quality, Web Portal, Wireless Sensor Networks

1. INTRODUCTION

According to a United Nations report (UN, 2012), around 120 million people in Europe had no access to safe drinking water in 2012. This alarming figure, made the international community react, by making clear that an extra care will be given to the water distribution, its quality and also quantity monitoring. That care would be facilitated by securing an automatic system for the quality monitoring (Zennaro et al. 2009).

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Quality of water is determined through tests which are based on physical, chemical and biological characteristics (Bartram & Ballance, 1996). Throughout time, scientists have measured water temperature, its mineral contents and number of bacteria, which then were compared towards numerical standards and guidelines to determine if water is suitable for usage. Those standards and guidelines are created in order to classify water, whether it can be used for drinking, recreation or even for agricultural purposes. Some of the basic parameters commonly measured are temperature, pH, dissolved oxygen, and turbidity. In most of the developing countries, those measurements are done manually. That incurs considerable delays in the monitoring process, which could fairly be reduced if the monitoring in real-time would have been implemented, at least for some basic parameters, and thus giving an early warning for the necessary measures to be taken (Alkandari, 2011).

Latest technologies, such as wireless sensors (Sohraby, Minoli & Znati, 2007; Garcia et al, 2012), can be used to ensure a constant monitoring of surface water quality. A wireless sensor network (WSN) is composed of compact-size, relatively inexpensive sensor nodes known as motes (Deshpande et al, 2004) which may sense the environment where they are deployed, and also of a base station which gathers sent data from motes for local or in distance processing (Zennaro et al. 2009; Sohraby, Minoli & Znati, 2007; Jiang et al. 2009). With the latest achievements of the micro-electro-mechanical systems (MEMS) technology, sensors are becoming even smaller and versatile (Warneke & Pister, 2002). Tiny sensors support rapid and massive deployment with promising future and involvement in different new fields. WSNs were proposed and are being developed for a variety of environmental applications, but they usage in water quality is still considered a new discipline (Porter et al., 2005). The rationale in favor of WSN technology vs. traditional water sampling has further been elaborated by authors. They conclude with a motivation sentence to interdisciplinary teams towards exploring the implementation of WSNs in different ecological disciplines they showcased via a number of existing example deployments.

In this paper, we propose an integrated Web portal for modeling and management of both, the observational data on water quality coming from wireless sensors, as well as of data describing the WSN itself, its devices and the corresponding site allocation data. Access is given to a wide range of individuals, from water experts to WSN engineers, to general public. Experts may infer statistics about water parameters, or classify water bodies using the intelligent module of the portal.

The paper is organized as follows: Section 2 provides a discussion on related work regarding portals in support of water quality monitoring though wireless sensor networks. Section 3 is an overview of the portal. Section 4 represents data modeling in the portal including modeling of observational data, WSN-related data and experts' data, as well as expert's rules evaluated by the portal. The portal's interface with its four modules each for access by water experts, WSN engineers, wide public, and an administrator is presented in Section 5. Some peculiarities of the portal's implementation are presented in Section 6. Finally, Section 7 concludes the paper and reveals some of the future perspectives of the portal.

2. RELATED WORK

Wireless Sensor Networks represent an active scientific research field due to their importance in development of many applications, including environmental monitoring, healthcare, traffic control, military network systems (Khedo, Perseedoss & Mungur, 2010), and precision agriculture (Baggio, 2005). Moreover, environmental monitoring portals receiving data from sensors have also been a practice since a while among researchers.