Chapter 15
Water Management for Rural Environments and IoT

José Jasnau Caeiro
https://orcid.org/0000-0002-4760-726X
Instituto Politécnico de Beja, Portugal

João Carlos Martins
Instituto Politécnico de Beja, Portugal

ABSTRACT

Internet of Things (IoT) systems are starting to be developed for applications in the management of water quality monitoring systems. The chapter presents some of the work done in this area and also shows some systems being developed by the authors for the Alentejo region. A general architecture for water quality monitoring systems is discussed. The important issue of computer security is mentioned and connected to recent publications related to the blockchain technology. Web services, data transmission technology, micro web frameworks, and cloud IoT services are also discussed.

INTRODUCTION

Water is the main component of Earth's oceans, rivers and lakes. It is found in liquid, solid and gaseous states and is the major constituent of most living organisms. It is vital for all forms of life that are known to humanity.

The Alentejo region in Portugal is home to one of the largest dams and artificial lakes in western Europe---the Alqueva dam---, that constitutes a strategic water reserve. It guarantees the water supply to the population, agriculture and industry. It is a very important component of the irrigation system network of the Alentejo. Water is a critical resource and will become even more important because of the pressure exerted by climate change.

Water management systems may benefit from Internet of Things (IoT) systems in several ways. This chapter will describe how IoT can be used for several aspects of water management, namely starting from sensor networks dedicated to the acquisition of data related to water quality and quantity, to aggregator

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microcomputer systems, security issues and centralization of the information with further high-level processing. The importance of novel technologies such as the blockchain and machine intelligence for the IoT area is also addressed.

The definition of IoT can be found across a large number of publications and Internet sites. The Institute of Electrical and Electronics Engineers created a dedicated site to the theme (https://iot.ieee.org) and in 2015 published a report trying to define what IoT is (IEEE Internet Initiative, 2015).

A short definition attributed to IEEE in March 2014, and mentioned in the report, is that IoT is "A network of items, each embedded with sensors, which are connected to the Internet". It can be included under the broader definition of ubiquitous computing and sometimes we may consider the definitions indistinguishable.

The water quality and resources monitoring systems described are limited to those that mention themselves as IoT proposals. The engineering aspects are favored in the chapter and the system proposals reflect such a choice.

The chapter starts with this introduction followed by a section with an overview of water management IoT applications described in the literature. Based upon the approaches in the literature a general water quality monitoring architecture is presented in the section with this title. The types of sensors, the communication network, the data storage and data processing subsystems are shown in a systems diagram and discussed.

After the general water quality monitoring architecture presentation some general relevant additional topics are discussed, namely: computer security; data transmission protocols; micro web frameworks; cloud IoT platforms and machine intelligence. These are very short sections destined only to give the reader some sense of the importance of these topics for the design of real world IoT systems.

Before the final conclusion two sections present two examples: a water quality monitoring system and an irrigation and drainage network monitoring system. Each is designed using an IoT approach including: low cost sensors and hardware; some sort of Internet connection and data storage.

The chapter ends with a short conclusion collecting some of the main aspects of the sections.

WATER MANAGEMENT IOT APPLICATIONS

IoT applications for water management in rural environments address two questions: irrigation water quality management and water resources management.

In Portugal, information about the water quality and water resources is presented online at the (http://snirh.pt/) Internet site. This data is collected using traditional chemical and physical analysis from samples collected in the field. Unfortunately, due to cost issues, the data at many sites is not collected anymore. IoT systems are typically low cost and could present an alternative for the problem of updating old networks of water quality monitoring systems.

During the last few years some proposals for IoT based water quality monitoring systems have appeared in scientific literature. A short review follows.

An architecture using web services for real time water quality data acquisition is presented by Wong and Kerkez (2016). The proposal is centered around the web services concept, namely tackling the transmission of data collected by the hardware developed by the authors--- a water quality sensor node using the NeoMote wireless sensing platform. A set of three different web services were implemented on