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A Real-Time Augmented Reality System for Water Distribution System

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Abstract: ***Control of water distribution network by Real-Time Monitoring System (RTMS) can play an inerrant role in its management. RTMS could be used to monitor and analyse hydraulic and water quality parameters in a Water Distribution Network (WDN). Besides, the RTMS warns operators on actions such as to stop pumping, to conserve water, and minimise risks when needed. RTMS can also provide many operational benefits (improve water quality, decrease operational costs, reduce customer complaints, reduce water losses, and modelling capability, etc.). For Quality & Maintenance of the distribution network, the concept of Augmented Reality (AR) can be used as a tool to support maintenance task as the Data from the distribution network can be gathered and parsed in real-time. The useful information will be transmitted to the AR device (PC tablet, smartphone, glasses, watch…) through wireless connectivity. This paper aims to introduce the concept of RTMS and AR technology. It provides a review of some RTMS application in the drinking water sector and shows the benefit of the implementation of AR in that environment. Furthermore, this paper attempts to propose how the RTMS and AR can be merged as system architecture and be applied to enhance the quality of the water within the network, the distribution system management, and maintenance of the distribution network.***

Keywords : ***Real-time monitoring, Augmented Reality, Quality control, Water distribution system.***

I. INTRODUCTION

According to IBM, Real-time monitoring is a technique that allows users to determine the current state of queues and channels within a queue manager. The information returned automatically at the moment the command was issued. That means, data can be assessed in real-time, and a decision can be made. The internet of things (IoT) used the concept of real-time.

The primary use of IoT has been attributed to Kevin Ashton [1] who defined the **IoT** as a network of intelligent, open and comprehensive objects. The network itself is able to organise, share data, resources and information according to any changes in the environment. Modern management of a distribution network is based on economic performance and imposes, the knowledge of the report costs-profits coupled with the necessary control level. New solutions for the efficient functioning of the public water supply implies the existence of an effective monitoring, control and real-time management of installations based on the data gathering from facilities with a proper system based on computational[2].

Research has been funded for the design and the test of various online real-time facilities for monitoring and controls a drinking water system[3][4][5][6]. Real-Time Monitoring (RTM) Ability can be used as a tool for measuring and controlling a Water distribution system[7]. The large volumes of data generated from real-time control, make the Supervisory Control and Data Acquisition (SCADA) system to be suitable for utilization and processing for real-time data acquisition [8]. Epanet hydraulic extension (RTX) module can be used for the integration of network hydraulic and quality model with SCADA[4].

Also, maintenance plays a significant role in every economic sector because it has a direct influence on performance, product quality, and productivity. Maintenance has been improved and perfected over time. The current innovation in maintenance is the concept of augmented reality technology.

Augmented reality, in a nutshell, allows users to enhance their field of view with real-time superimposed digital information. However, more than that, it is a valuable solution for many of the challenges which surround industrial maintenance, repair, and operations for water distribution management. For an overview of the field, the current paper proposes the system architecture and its benefits based on the combination of **Augmented reality** and **SCADA-RTM** system. The paper is subdivided into three sections.

The first section provides an overview of some of the RTM application in water distribution management. The second section provides an introduction of the concept of the augmented reality. Finally, the third section will present the system architecture and its analysis. Conclusion and recommendations will be given to end this paper.

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II. REAL-TIME IOT APPLICATION IN WATER DISTRIBUTION SYSTEM MANAGEMENT

[9] defined the **IoT** as a technological network for monitoring physical objects status, capturing data, and sharing that data to a computer in the cloud for software for real-time analysis and decision making over a wireless network.

[10] State the IoT utility in improving water management, such as:

- Water leakage detection
- More efficient systemic water management
- Water quality and safety monitoring
- Quality control on water reserves
- Transparency on consumption
- Prescriptive maintenance on infrastructure

[11] Used IoT to assimilate water quality data and provide access to the client.The system is based on cloud monitoring.

[12] design a low-cost system for water quality monitoring in real-time. The system measures physical and chemical parameters (temperature, ph, turbidity, the flow of the water) from the sensors and processed by the Arduino model core controller.

[13] provide a smart solution for testing water samples and analyzing water quality data using IoT to.provides an instant alert to the remote user as soon as a deviation appears between the monitor and the pre-defined water quality values.

[14] demonstrate that S:: CAN sensor could be utilized as a part of the SCADA system, for real-time monitoring to detect E.coli cells and intrusion events in drinking water systems.

[15] Combines analytical and neuro-fuzzy decision support systems, with geographical information systems, and wireless sensor through real-time data acquisition and processing for the sustainable management of water pipe networks.

[16] Proposed a dynamic hydraulic model framework base on real-time focuses mainly on background leakage detection, pressure management, and water demand forecasting of a recently developed real-time system for water loss reduction.

[17] Monitors and controls hydraulic and water quality with automatically control of pumps and valves coupled with security alarms using the integrated RTM–SCADA system.

[2] Presents the SCADA system to monitor and control technological parameters in the water distribution stations to optimize the administration of the potable water network.

[4] Applied a calibrated Epanet model in an RTM modelling framework using the SCADA system for water supply to study the simulated quality parameters such as water age, traced water source, temperature, pH, hardness, and free chlorine.

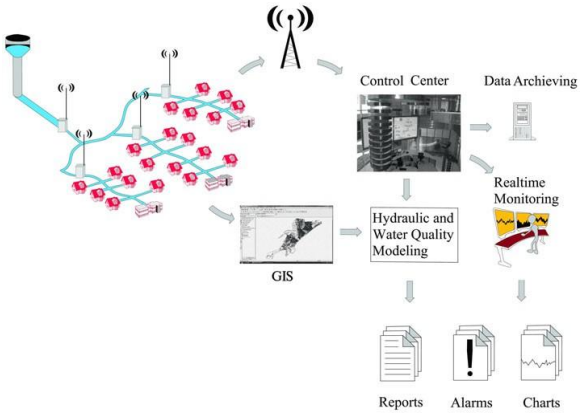

Fig.1. SCADA system schematic presentation [7].

The integrated RTM-SCADA system can provide water quality parameters database for analysis, as shown in fig 2, 3 and 4)[7].

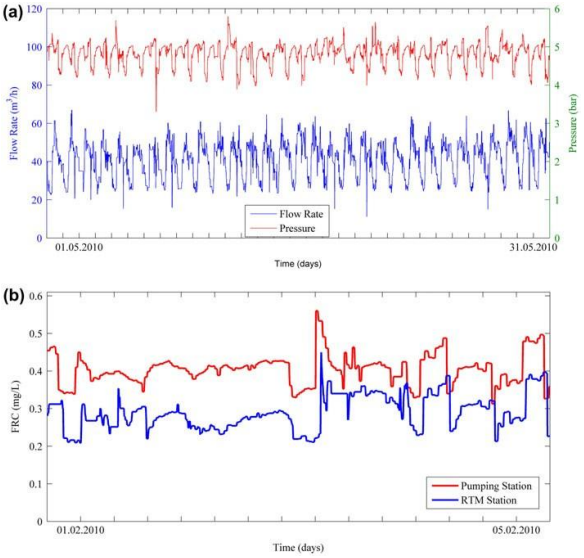

Fig.2. Variation of (a) flow rate and water pressure and (b) FRC concentration measured at a Pumping Station[7].

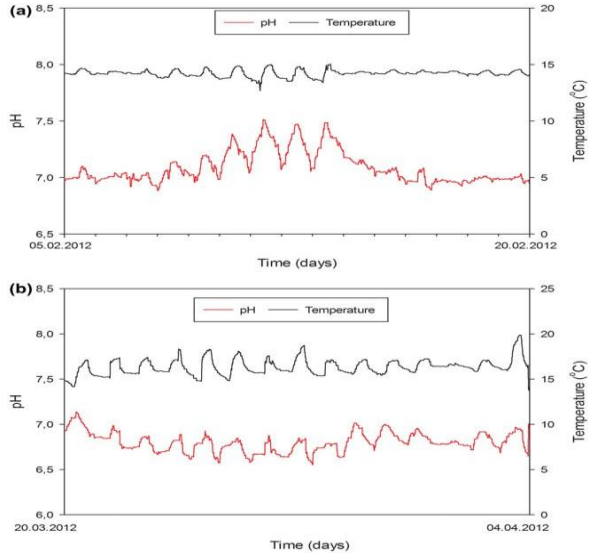

Fig. 3. pH, temperature, conductivity, and turbidity Variation over time [7].

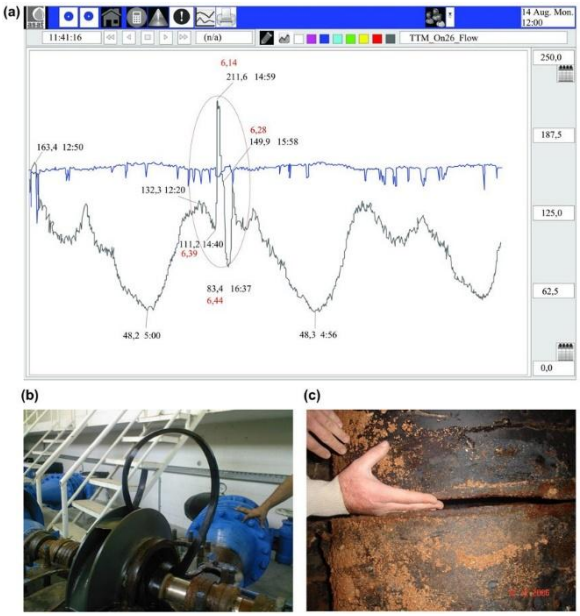

Fig.4. (a) Pipe burst event display, (b) crack in the outlet pipe, and (c) Pumping station capacity reducing by rubber ring [7].

III. AUGMENTED REALITY & WDS

In recent year, technological improvements have led to better management of the drinking water industry. Aware of this challenge, commendable works have been performed in WDS in term of quality of water and reduction of water losses. In the same momentum, it is again worthy of research to assist the WDS with adequate maintenance system. The new technological trends give good insight into AR technology due to the high potential it offers. AR has made a significant contribution to a wide range of industry and still heading in the right direction. GIS Data in Augmented Reality is used to display and holograms overlaid on the user's view of a physical job site, as shown in the figure below.

Fig.5. Combined GIS data with augmented reality to display a water distribution network[1].

The use of such a system increases situational awareness of user surrounding, saving time, and assist in avoiding costly mistakes[1]. Along in the same idea, AR is also used to optimise operations. Holograms of a water facility can be created that function as real workspaces, using a set of AR devices (PC tablet, smartphone, glasses, watch, etc.). Based on the SCADA system, the operator can have access to the facilities information wherever they are or go. In short, AR helps to monitor in a real-time situation and helps the operator physically present at the field to receive remote assistance, from the experts who can provide advice based on what the operator is seeing [2]. According to the current state-of-the-art of AR application, this paper attempts to propose a structural system that combines RTM & AR technology.

IV. STRUCTURE OF RT-AR SYSTEM

This proposed structure makes up with RTM–SCADA systems (GIS, hydraulic Model), and AR technology. From the literature, some structures have been proposed using each system mentioned above or of their combination either. The figure below shows the proposed architecture in this paper.

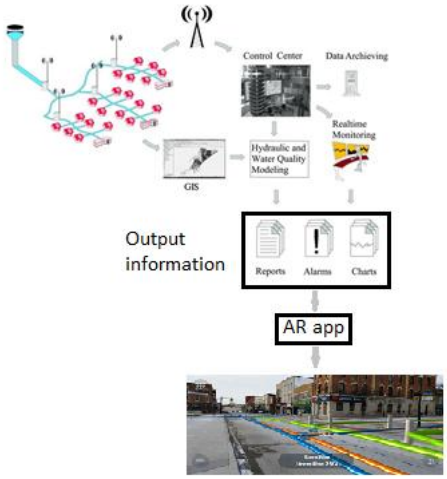

Figure 6. Combined RTM–SCADA with augmented reality to display a water distribution network.

Based on the proposed architecture in [7], we build the RTM-SCADA-AR system. The output information from the previous architecture will be used as integrated parts to the AR application in order to visualise it in a real-time situation. The integrated RTM–SCADA–AR system, will offer the usual benefits of RTM–SCADA system:

- The visualisation of the trends for analysing spatial and temporal variations of the monitored parameters;
- The remote control of all reservoirs, pumps, and valves;
- Providing energy efficiency in operation;
- Detection and approximate localisation of leaks and pipe bursts and,
- Integration of monitoring and modelling of hydraulic and water quality parameters.

Apart from the usual benefit cited above the RTM–SCADA–AR will provide:

- Boost first-time fix
- Reduce technician error and increase their productivity.
- Allow remote expert assistance.
- Reduce costly downtime
- Process improvement.

The implementation of the RTM-SCADA-AR system will assist a lot the water industry in the management of the water distribution system in that the whole distribution network will be monitored in real-time. Variation within the network in terms of water quality parameters, and others such as pressure, throughput, flow, etc. shall be visualised thanks to AR technology and action to be taken in the event of need shall also be displayed through AR device.

V. CONCLUSION

The integrated RTM–SCADA–AR system can be reliable at 100% for a proper water distribution system control and management. However, its implementation still very expensive, the payback period is estimated to be less than one year when all the other benefits are considered[7]; the Developing country cannot afford the implementation due to the cost. The present paper strongly recommends more founded study for developing a low-cost real-time system to facilitate the implementation in the developing country. Our further study witch is ongoing actually with the collaboration of Ruiru Juja water and sewerage company (RUJWASCO) located in central Kenya is designing and implementing a low-cost RTM monitoring coupled with the AR system to assist the company for proper background leakages detection and management.

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