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Development of a low-cost System for Water Quality Monitoring: Bibliographic Review

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Abstract *— This work presents a practical application of a water monitoring system using the internet concept of things - Iot. The integrated water quality monitoring system for decision support, this proposal is a theoretical study for use in the Federal Institute of Tocantins by professors and researchers in the area of Agronomic Engineering. This new development paradigm allows us to integrate low-cost sensors into embedded systems, thus creating a clustering of interconnected physical objects, embedded in electronics, software, sensors, and network connectivity, coupled with its low cost, this implementation demonstrates the feasibility of monitoring using low-cost systems. In summary, the initial application will be carried out in hydroponics and fish-culture systems, thus, we can gauge the integrated monitoring and decision support system, demonstrating the viability of the use to support the producer, researcher or even the environmentalist in the collection and analysis of efficient decision-making. The second step will be the development of the prototype.*

Keywords *— **Internet of Things, Water Monitoring, Automation, Multiparameter.***

I. INTRODUCTION

There are several methods and tools used to test water quality. The conventional method commonly used to carry out the tests is to manually collect samples by sending them to a laboratory, or performing tests in situ, with devices, manually or automatically annotating the collected data. As a result, we implemented a system that measures the quality of water in real time through electronic sensors, and this data is stored and sent to an online system for decision making.

Several physical-chemical variables are necessary to monitor water quality for agricultural production purposes, as shown by the work of [1, p. 58]. The development of new technologies for monitoring and control of the aquatic environment, has become an important tool to aid decision making. Our work aims to develop a mobile, multi-parameter system that provides real-time information of the environment for decision making.

Embedded systems are taking more and more space in academic productions. Due to their cost-effectiveness and the high variety of sensors available in the market, these systems are in increasing demand by researchers and technology enthusiasts. As a result, this ecosystem of embedded hardware and software received the Internet nickname of things, or IoT (Internet of Things), as it is commonly known.

The need for automatic monitoring, through electronic sensors, has become a growing reality. The benefits of using interconnected systems, IoT are numerous, from the cost to the automation of a process. In addition, the wireless sensor networks (WSNs), which provide a wide range of applications for control and monitoring, can be cited as an example of the work of [2], which developed a network of sensors for monitoring the quality of water to the logo of the River Avon in England and that is making this data available online for eventual decision making.

II. JUSTIFICATION

Several devices are developed for monitoring water quality. Taking into account the low cost of embedded systems, these can be developed to facilitate the collection and analysis of data, automatically, through electronic sensors. In the construction of a prototype for this purpose it is necessary to take into account its cost, since it must be, more in account than the one existing in the market, or at least with more functionalities, adding value to the product.

When it comes to this type of system, the bridge between an idea and a viable end product lies in the design of a functional prototype. In order to carry out this project there are several steps to be followed, from the choice of the components, taking into account their need and the niche to be met, structuring and testing with the purpose of identifying problems and correcting them.

For the reason exposed, our research is justified by a guiding question, that throughout the trajectory of the research, we will analyze. It is feasible to develop a system, using embedded hardware, with initial application in a system of monitoring the water quality and that has a

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lower cost than those found in the market, to meet the demand of research institutes or producers in the area of hydroponics and fish culture.

III. ANALYSIS OF PREVIOUS WORK

For reasons and development of the previous studies, researches were done referring to works already completed and that resemble the theme chosen. However due to the constant technological innovations, we carried out a systematic search in the period corresponding to 2013 to June 2019. The search terms used had the objective of finding works related to the topic with greater relevance.

The databases where the research was carried out were: ScienceDirect - Elsevier, where 1706 results were returned, of which 5 (five) were related to the proposed theme, according to the pre-established criteria, of which two (2) with the theme. In the capes - Cafe journal, we find fourteen articles, where only one is directly related to the topic. In the IEEE Explorer database, we found 703 articles, of these, 8 (eight) articles were selected, having relation with the proposed work, among which 2 (two) articles that resemble the proposed work. All the articles that brought the internet context of things, with a view to the monitoring of water quality were included in our research, below a syntax of how were the criteria for inclusion of the articles.

The methodological procedures used in the search of articles published in periodicals were: the choice of journals, the language and the period. Thus, the chosen language was English, the search was between: 2013 to June / 2019, it is emphasized that the research was carried out in the months of May and June of 2019. It has a different database, repeated studies, the were not included. For the criterion of exclusion of the bibliographic study, only works that deal, integral or relative, of the theme, which is the use of water quality monitoring systems, using the internet concept of things, were considered.

Table 1: works found Iot and water

AUTHOR	TITLE
Dan e Jan, 2017	Real-time water quality monitoring systemusing Internet of Things
Almeida, 2018	Projeto e desenvolvimento de laboratório móvel para monitoramento ambiental dos níveis de temperatura e humidade baseado em internet das coisas (iot)
Chen, Y; Han, D, 2018	Water quality monitoring in smart city: A pilot project
Salunke, P; Kate, J, 2017	Advanced smart sensor interface in internet of things for water quality monitoring
Vijayakumar, N. Ramya, R 2015	The real time monitoring of water quality in IoT environment
MOPARTHI, N. R.; MUKESH, CH.; VIDYA SAGAR, P; 2018	Water Quality Monitoring System Using IOT
YAURI, R.; RIOS, M.; LEZAMA, J; 2017	Water quality monitoring of Peruvian Amazon based in the Internet of Things
MANJU, M.; KARTHIK, V.; HARIHARAN, S.; SREEKAR, B; 2017	Real time monitoring of the environmental parameters of an aquaponic system based on Internet of Things

Given the above and analyzing in a summarized form the selected articles in (Table 1) there is an inclination on the part of the researchers to develop prototypes for use in research. Most of the works suggest the feasibility of using the Iot for water monitoring, for example the work of [9] - [14] in which the authors work with proposal, consequently there was no application in real production environment, only proposal or tests bench. Differently from the work of [2], [15] where tests were carried out in loco, in the monitoring of water quality, the two in Rivers located in their region of the research, the first to verify the quality of the water for consumption and the following to research directly linked to psychology.

IV. THE INTERNET OF THINGS IN SURVEYS

Much is discussed about the ubiquity that computing systems are taking, its interconnectedness and omnipresence, Mark Weiser, published an article in 1991 in Scientific American, where he tried to explain what those things would be. Specialized hardware and software elements, connected by wires, radio waves or infrared, will soon be so ubiquitous that no one will notice its presence [16], it seemed only the dream of a scientist, but it was the beginning of the birth of the Internet of Things - (IoT).

The Internet of Things comes every day, becoming more popular in the medium of Information and Communication Technology (ICT). The general concept of what is internet of things is still much discussed in academia. The Institute of Electrical and Electronics

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Engineers - IEEE, describes the term "Internet of Things" as: a complex, adaptable, self-configuring network that interconnects "Things" to the Internet through the use of standard communication protocols. These interconnected things have physical or virtual representation of the digital world, ability to detect / act, with programming capability being solely identifiable and containing information, including relevant identity, status, location or business, social or private information. [17, p. 73].

These "things", the author continues, offer services, with or without human intervention, through the exploration of unique identification, data capture and ability to act. In this way the system is easily used through the use of intelligent interfaces and is available anywhere, anytime, and for anything, Minerva, Biru and Rotondi, (2015).

In this way, we can infer that the Internet of Things is generally understood as a connection of things in a network, that is, of physical objects, connected to the Internet that provide data. With the expansion of Iot, a new market vision emerges, as it leads to an improvement in the automation process, minimizing errors and operating costs.

By relating in this research, the area of water quality monitoring to the Iot system, which is relatively new and incipient in research. The work of [18] considers the relevance in the use of automated monitoring of water resources, due to productivity gain and lower cost, the authors propose a low-cost system for the study and application of this technology in sanitation plants.

As a proposal, the work of [9] corroborates with our work, since, the proposal of the work is the development of a mobile equipment for monitoring the environment, showing the relevance in the development of these low-cost systems, giving greater importance in the monitoring of water resources for better environmental control.

Already the work of [2] demonstrated the feasibility in performing the data collection of water quality has real time, using electronic sensors. As a pilot project, the sensors were placed along the Avon River, which cuts off the city of Bristol in England, thus collecting information for environmental monitoring is being done autonomously and automatically, integrated into the urban water management system better management of water resources.

It is important to highlight that, for the authors already mentioned, the network of sensors, allied to the Internet, is a more efficient method for collecting environmental data, especially in relation to water quality monitoring, along the rivers and river basins that provide water for consumption.

In this sense, the work of [8] emphasizes that the use of a wireless sensor network in detriment of the conventional collection forms, has been gaining space in the most deferential means. The authors' work compares and evaluates different architectures proposed by several authors in terms of parameters, monitoring and architectures.

In his work, [6] underscores the low cost and reliability of a network of sensors for monitoring, real-time water quality. As well as the work of [10], [19] they have developed, with the use of sensors, a system for real-time monitoring of pollution of water resources, which therefore only demonstrates the researchers' concern to develop general purpose platforms for this purpose.

V. CONCLUSION

The conclusion we reached with this review study is feasibility in the development of low cost it is possible to notice similarities and differences in the reflections of the authors who are concerned about this topic, the common loop presented is that they deal with water quality monitoring automatically, through sensors. [20], in his work, emphasizes that the advancement of the internet of things must result from synergistic activities conducted in different fields of knowledge, in this sense, several are the surveys that are favorable to the development of new products and techniques using monitoring systems in real time and low cost, with Iot. Our future proposal is the development of a low-cost system for monitoring air and water quality, specially developed for the researcher and agricultural producer.

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