Low cost automated system for limnological monitoring of water bodies

Sistema automatizado de baixo custo para monitorização limnológica de massas de água

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ABSTRACT
Population growth directly affects the aquatic ecosystem, since rivers end up being used as industrial waste deposits and domestic sewage. Limnological monitoring is done through the periodic collection of samples from the water body for analysis in the laboratory or in the field using some portable equipment. But this preventive monitoring can be more effective if it is automated, and can even take several measurements in a single day. The project will be developed and applied in the municipality of Ji-paraná/RO, and a stream will be selected in the urban perimeter to carry out tests with the prototype of the automated system for monitoring limnology. The research will be of a quantitative nature, aiming to measure the effectiveness of the use of the referred prototype. The tests will be carried out in two stages, where the first will be in a controlled environment (laboratory) and the second will take place in a river or stream that will be chosen later in the urban area of Ji-Paraná. For the implementation of the prototype, an ESP32 board will be used because it has more RAM memory space, allows greater electrical current in the circuit, in addition to having Bluetooth and WiFi in its system.

Keywords: ESP32, Eutrophication, Sensors.

1 INTRODUCTION

Population growth and its anthropic influences on water quality directly affect the aquatic ecosystem (GLORIA; HORN; HILGEMANN, 2017) Population growth directly affects the aquatic ecosystem, since rivers end up being used as deposits of industrial waste and domestic sewage. The result of these actions harm not only aquatic organisms, they also harm human health due to the ingestion of contaminated water. These organic

materials and pollutants have been considered responsible for the eutrophication of aquatic environments and have caused great concern due to the level of pollution (TUNDISI, 2006). Considering the 100 (one hundred) largest municipalities in Brazil, only 23 (twenty-three) treat more than 80% of their wastewater, and on the national scene only 50.8% of wastewater is properly treated (TRATA BRASIL, 2021).

To avoid the imbalance of the aquatic ecosystem caused by anthropic actions, it is necessary to perform limnological monitoring of water bodies. This monitoring can be done by periodically collecting samples from the water body for laboratory analysis or by using portable electronic equipment with specific sensors. The available equipment that measures the water quality in loco is not fully automated, because the user needs to be present operating the equipment to collect the parameters.

2 MATERIALS AND METHODS

The project will be developed and applied in the municipality of Ji-Paraná/RO, and a stream in the urban perimeter will be selected for testing with the prototype of the automated limnological monitoring system.

The research will be quantitative, aiming to measure the effectiveness of the use of the prototype. A bibliographic review of articles, dissertations, and books will be conducted to identify the normality parameters of water bodies and the parameters that indicate eutrophication.

Subsequently, the prototype will be assembled using an open source prototyping board with sensors to perform the measurements. The tests will be conducted in two stages, where the first will be in a controlled environment (laboratory), using a tank with water to simulate the limnological parameters of interest to verify the effectiveness of the prototype. In the second stage, the prototype will be tested in a real environment, placing it to perform collections in an aquatic body (river or stream).

As a product, a manual will be produced on the process of assembling the prototype so that this methodology can be used in other locations and regions for monitoring aquatic bodies.

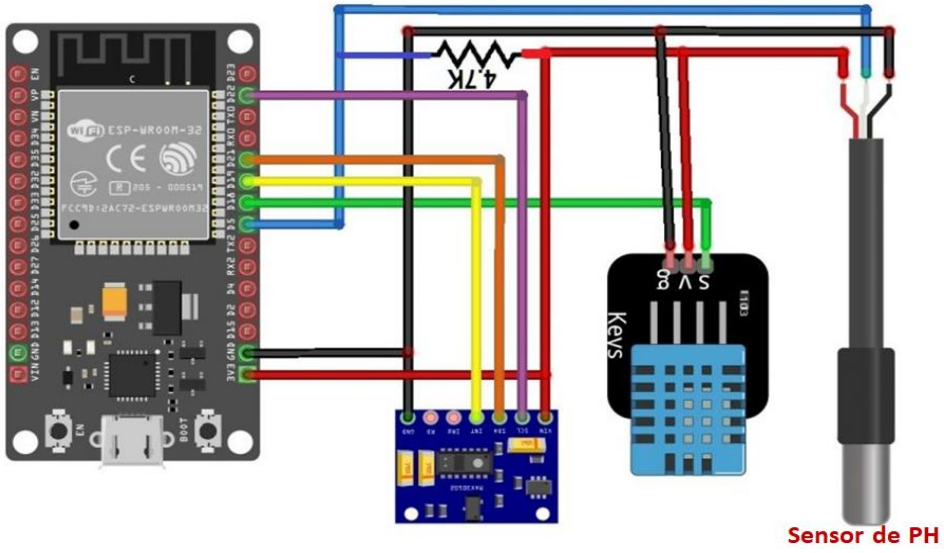
3 RESULTS AND DISCUSSIONS

Automated monitoring is entirely possible using controller boards such as the Arduino and the ESP32. The controller boards, an open source hardware platform, are designed on a single board micro controller for the development of multidisciplinary

electronic projects (electronic prototyping). In short, it is a small computer that can be programmed to interact (input and output) with external devices and components such as sensors for example (OLIVEIRA; ZANETTI, 2015).

With specific sensors integrated into the controller board it is possible to measure temperatures, check the turbidity of water, measure the amount of dissolved oxygen in tanks and rivers. Figure 1 outlines a schematic using ESP32 with Wi-Fi and Bluetooth to measure the pH of liquid substances. According to Jr. and Silva (2015), "sensors, roughly speaking, are devices responsible for 'feeling' physical quantities and converting them into an electronic signal proportional to the monitored quantity".

Figure 1 - Diagram with sensor connected to the ESP32 Board



For the limnological monitoring of water bodies, the ESP32 prototyping board with Wi-Fi and Bluetooth is a viable technological solution that would replace several pieces of equipment that are currently used for such monitoring. A single system collecting several parameters at the same time, facilitating even the processing of this information, being able to perform several collections in a single day, according to the defined schedule.

4 CONCLUDING REMARKS

As a result of the bibliographic research, there was an alteration in the choice of the controller board for prototyping, which in the initial proposal would be the Arduino. The change occurred because the ESP32 board has more RAM space, allows higher electrical current in the circuit, and also has Bluetooth and WiFi in its system.

REFERENCES

CAPSISTEMA. IoT-based patient health monitoring on ESP32 web server. 2022. Available at: https://capsistema.com.br/index.php/2021/01/23/monitoramento-da-saude-do-paciente-com-base-em-iot-no-servidor-da-web-esp32/. Accessed: 01 Oct. 2022.
JR., SÉRGIO.LUIZ. S.; SILVA, RODRIGO. A. Automação e Instrumentação Industrial com Arduino - Teoria e Projetos . São Paulo: Saraiva Publishing House, 2015.

GLORIA, L. P.; HORN, B. C.; HILGEMANN, M. Evaluation of the water quality of watersheds through the water quality index-IQA tool. Journal Caderno Pedagógico, v. 14, n. 1, p: 103-119, 2017.

OLIVEIRA, CLÁUDIO.LUÍS. V .; ZANETTI, HUMBERTO.AUGUSTO. P. Arduino Descomplicado - Como Elaborar Projetos de Eletrônica . São Paulo: Saraiva Publishing House, 2015.

TRATA BRASIL. Sewage. Available at: http://www.tratabrasil.org.br/pt/saneamento/principais-estatisticas/no-brasil/esgoto. Accessed on: 29 Dec. 2021.

TUNDISI, J. G.; MATSU MURA-TUNDISI, T.; SIDAGIS GALLI, C. Eutrophication in South America: causes, management technologies and control. IIE, Iiega, IAP, Ianas, ABC 2006.