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IoT System for Monitoring the Physicochemical Quality of Irrigation Water: Towards Efficient Agricultural Management

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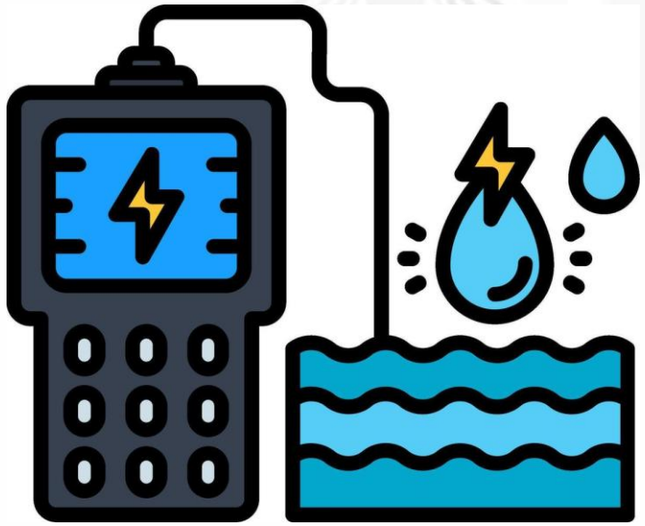
Conference: The Fifteenth International Conference on Smart Cities, Systems, Devices and Technologies SMART 2026, Valencia, Spain.

Presentation Outline

Introduction	❑Motivation
Materials & Methods	❑Architecture & Components
Results & Discussion	❑Results Analysis
Conclusions	❑And Future Works
References	❑Information Sources

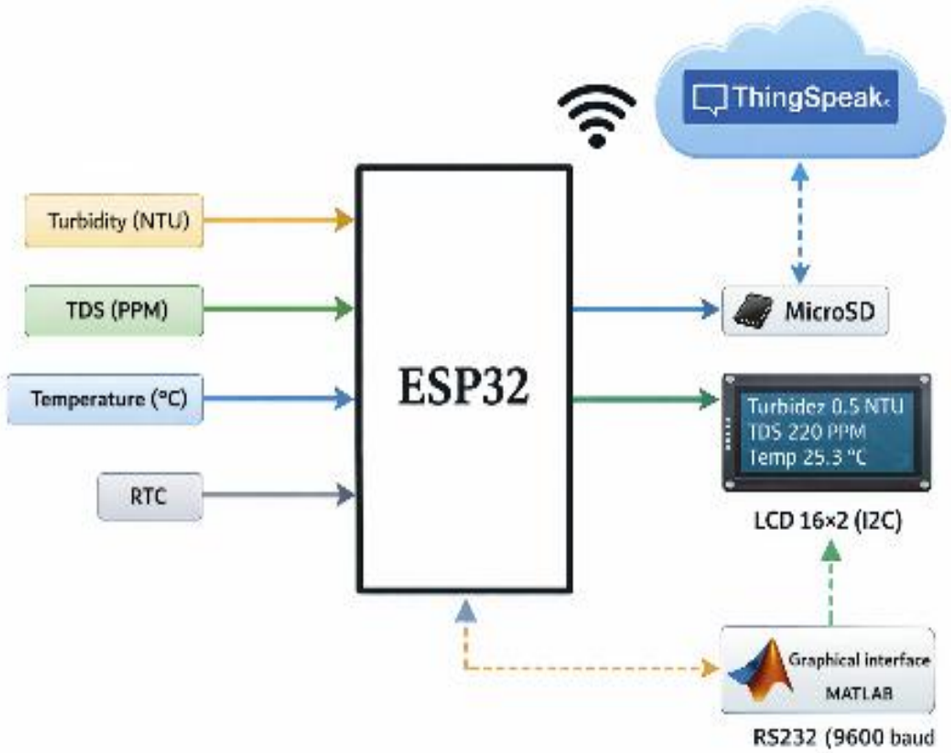
Introduction

Water quality affects agricultural productivity. An IoT system using ESP32 and low-cost sensors is proposed to monitor parameters in real time and support efficient irrigation management..



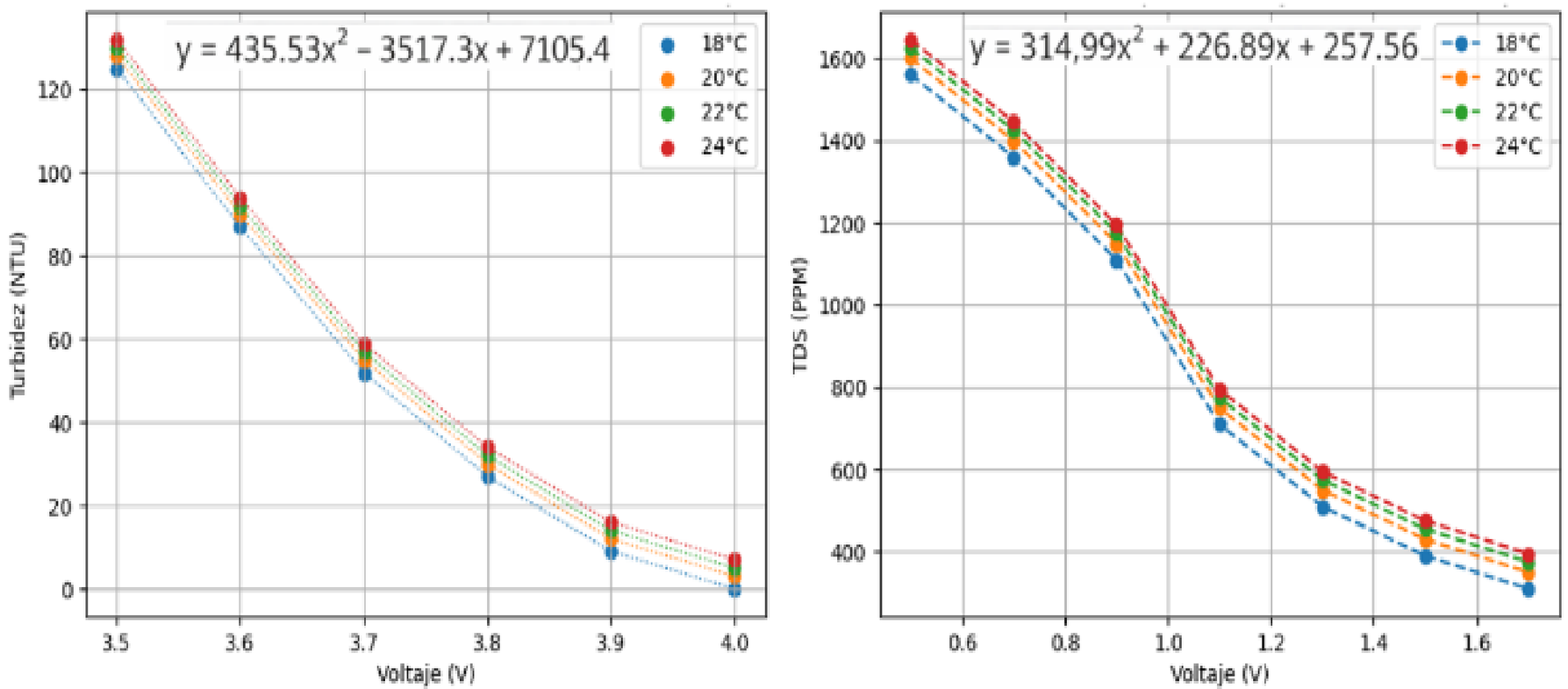
Materials & Methods

The embedded system consists of an ESP32 microcontroller module for Wi-Fi communication, a sensor unit integrating an TDS sensor for Total Dissolved Solids measurement, sensor TRW-20 for Turbidity and a DS18B20 sensor for temperature, a DS3231 RTC module for precise timestamping of data, and a 4GB microSD module for local data storage.

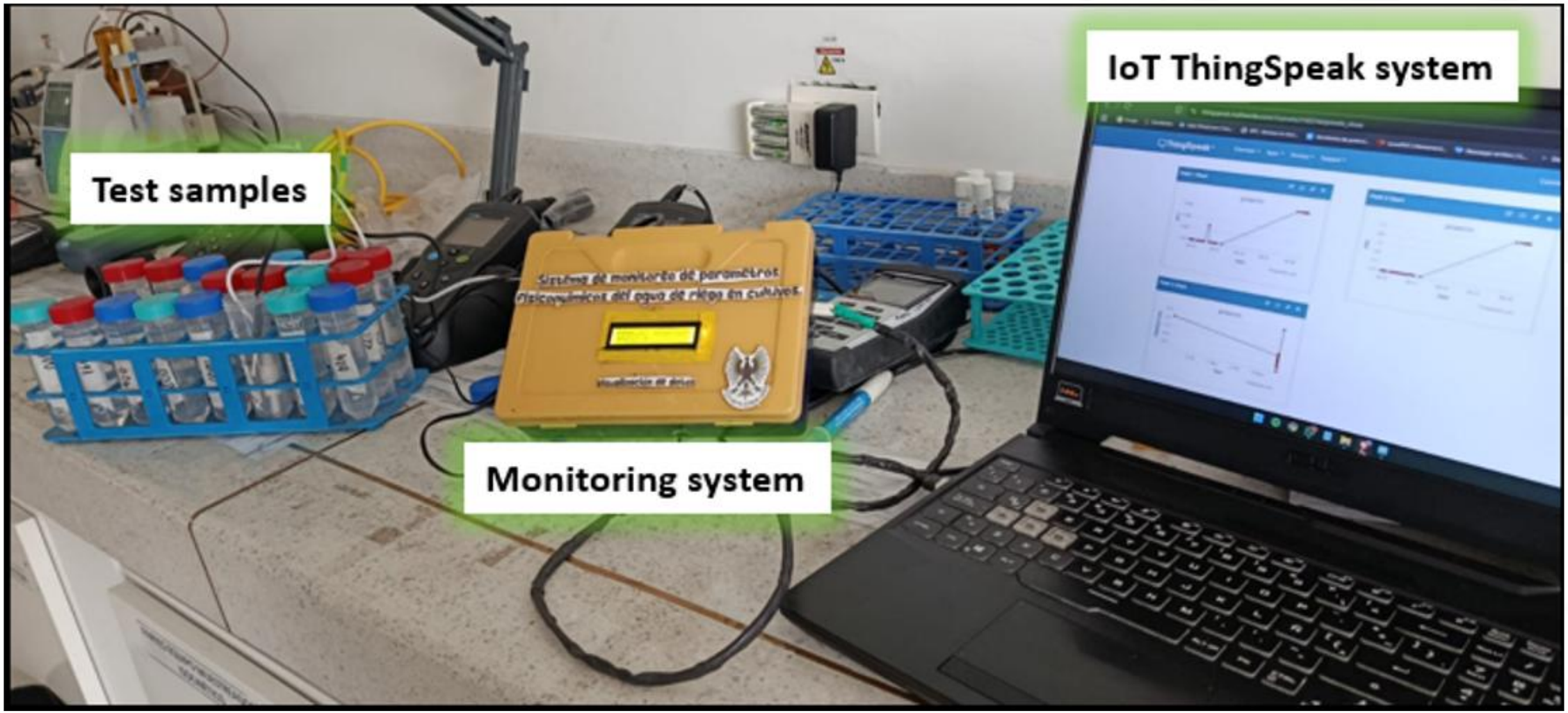


Results & Discussion

The tests were conducted in the Environmental Engineering Laboratory at UPTC, Tunja. Turbidity and TDS sensors were calibrated using standard solutions prepared in a laboratory. Formazin was used for turbidity (up to 4000 NTU) and saline solutions for TDS (up to 10,000 PPM), obtaining dilutions from 200 to 2000 PPM.



Results & Discussion



Results & Discussion

Alarm events are logged on a 4GB microSD card in **.txt* format, structured for compatibility with CSV files to facilitate further analysis.

	Obtained data from turbidity sensor (NTU)						
Theoretical value	**Reference instrument measurement**	**Data 1**	**Data 2**	**Data 3**	**Data 4**	**Mean**	**Error**
10	11.6	11.68	16.5	16.7	16.8	16.72	44%
20	22.3	16.2	16.0	16.2	16.33	16.18	27%
30	36.1	31.29	31.1	31.2	31.45	31.37	13%
40	48.5	86.36	86.36	85.0	85.9	85.98	77%
50	56.6	88.52	88.7	88.21	87.0	88.26	56%

(*) Nephelometric turbidity unit
(**) Squared error with respect to the value of the reference instrument

	Obtained data from TDS sensor (ppm)							
Theoretical value	**Reference instrument measurement**	**Data 1**	**Data 2**	**Data 3**	**Data 4**	**Mean**	**Mean deviation**	**Error**
400	509	631	536	586	558	571	42.7	12%
600	774	938	900	954	978	938.2	26.8	21%
800	1095	1211	1201	1220	1250	1216	18.7	11%
1000	1300	1377	1358	1360	1377	1372	11.4	6%
1200	1524	1424	1420	1430	1400	1417.2	10.4	7%

(*) Parts per million
(**) Error calculated with respect to the reference instrument

The IoT-based Physicochemical Quality monitoring system is a cost-effective solution, with a total development cost of 59 USD.

Developed IoT system	Associated Variable	Cost (USD)
Turbidity sensor	Turbidity	14.5
TDS Sensor	TDS	15.2
Temperature Sensor	Temperature	2.9
LCD + I2C module	Visualization	6.5
SD module	Data recording	1.3
RTC module	Time	2.1
Power source	Energy	1.8
ESP32	Processing / IoT	9.2
Structure and wire	Hardware assembly	6.6
IoT system subtotal	Turbidity, TDS, Temperature	**59**

Conclusions & Future Work

The monitoring system demonstrated the feasibility of integrating low- and mid-cost sensors with IoT platforms for real-time measurement of turbidity, TDS, and temperature. The ESP32-based prototype enables data storage, visualization, and cloud transmission. Experimental calibration using standard solutions and polynomial models allowed quantitative evaluation, revealing both metrological capabilities and limitations of the implemented sensors under controlled conditions.

System performance depends on concentration range, sensor characteristics, and environmental conditions. The TDS sensor showed 11% error with stable mid-high measurements, while turbidity reached 44% error. Temperature error was 4.76%, enabling compensation. Wi-Fi and ThingSpeak support remote monitoring, though limited in rural areas. The system is scalable and low-cost but requires energy optimization and maintenance for long-term operation.

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THANKS!

Questions?

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