Paper Dispenser Monitoring System Using Ultrasonic Sensor and MQTT Protocol

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***Abstract*—This paper presents the development of a prototype system capable of real-time monitoring of paper levels in dispensers using an ultrasonic sensor and communication via the MQTT protocol. The main goal is to prevent users from finding the dispenser out of paper, thus improving user experience in public or commercial establishments. The system sends alerts when critical levels are reached, being low-cost, replicable, and scalable. Data visualization is performed through a mobile application developed in React Native.**

I. Introduction

The absence of toilet paper in public or commercial restrooms is a recurring problem that negatively affects both user experience and the image of the establishment. From this observation, the proposal arose to develop a system capable of monitoring paper levels in dispensers using an ultrasonic distance sensor and MQTT communication. When the system detects that the paper is running low, it sends an alert to allow for replenishment before the paper runs out completely.

II. System Description

The system is composed of:

- HC-SR04 ultrasonic sensor (up to 4 meters range);
- ESP32 CP2103 microcontroller;
- MQTT communication using Mosquitto broker;
- Mobile application developed in React Native with Expo and JavaScript;
- Paho-MQTT library for MQTT integration;
- Battery power supply (currently in testing);
- Transmission frequency: 200 ms.

The sensor measures the distance between its position at the top of the dispenser and the top of the paper stack. If the dispenser is full, the distance is short. As the paper is removed, the distance increases. When the measured value reaches 70% of the total dispenser height, the system sends an alert indicating that paper replenishment is needed.

MQTT communication is divided into three topics:

- Dispenser fill percentage;
- Text status: “full”, “needs refill”, or “empty”;
- Total distance and percentage combined.

Currently, the system displays this information in the application, but notifications will be implemented in future versions. The system supports multiple connected devices, although this is not a critical feature for this prototype.

Figure 1. Prototype system with ultrasonic sensor and ESP mounted on a test bench.

III. Expected Results

It is expected that the system will enable efficient monitoring of paper levels in dispensers, with real-time alerts before the resource is depleted. The system can be easily replicated and applied in other contexts where resource levels can be measured by distance (e.g., trash bins, inventory shelves).

IV. Testing and Validation

Three bench tests have been performed so far, within a laboratory environment. The results showed moderate accuracy, sufficient to demonstrate the system’s feasibility. The next steps include:

- Battery tests to assess power autonomy;
- Real-world environment tests (installation inside an actual dispenser);

- Enclosure for physical protection of the system;
- Implementation of secure MQTT communication (TLS);
- Historical data storage;
- Web monitoring interface.

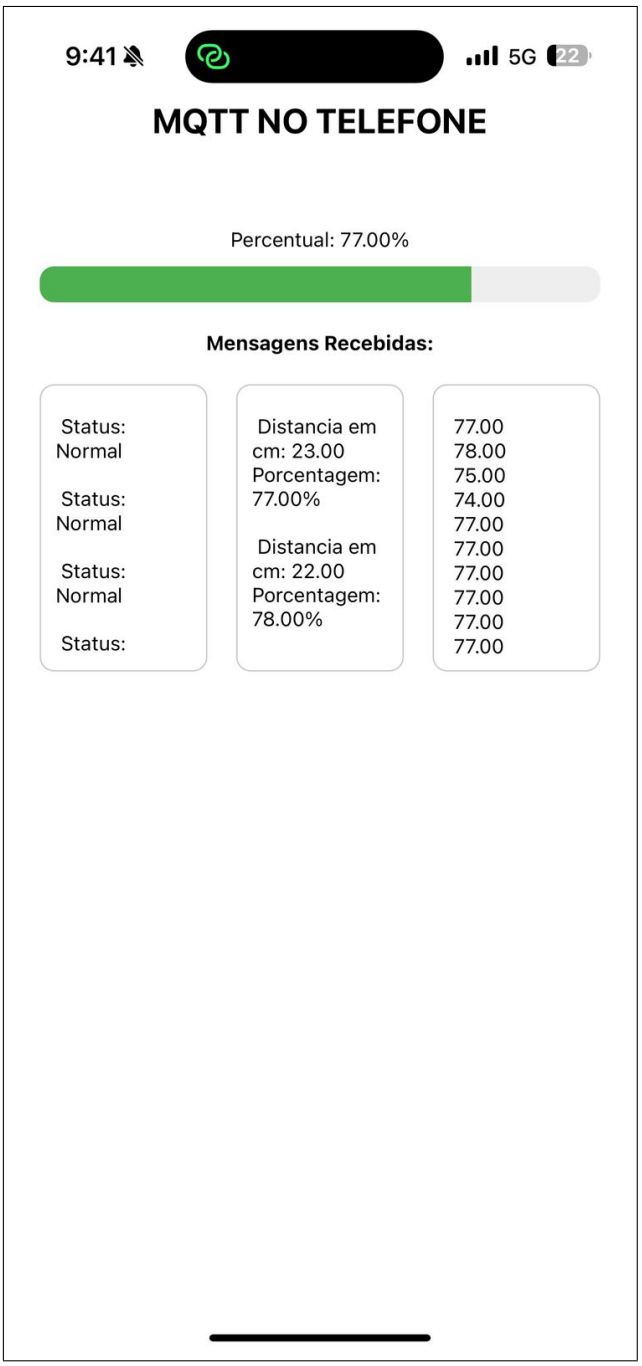

Figure 2. Main screen of the mobile app developed to monitor data via MQTT.

V. Conclusion

The developed system offers a practical solution to the problem of paper shortage in dispensers, providing a better experience for users. Its simplicity and low cost allow for easy replication and scalability. With future improvements such as increased accuracy, real-world deployment, and communication security, the system shows promise both as a commercial product and as an academic solution. This project will be submitted as the AP1 coursework and presented at the Brazilian Telecommunications Symposium (SBrT).