ABSTRACT

Water quality monitoring is still predominantly conducted manually and statically, making it less effective in capturing dynamic environmental conditions. Therefore, an efficient, real-time, and low-power communication system is required to support autonomous monitoring platforms. This final project aims to design, implement, and test a one-way LoRa-based communication system on a Solar Autonomous Boat as part of Swarm USV technology. The system is built using a TTGO ESP32 LoRa32 OLED microcontroller integrated with navigation sensors (GPS and compass), collision avoidance sensors (ultrasonic), and environmental sensors (pH, temperature, humidity, CO, CO_2, NH_4, and dissolved oxygen). Sensor data is formatted in CSV and transmitted wirelessly via LoRa at 866 MHz to a central gateway. The system was developed using the Waterfall method, including requirement identification, hardware and software design, and field testing. Test results showed a 100% success rate over 10 transmission trials, with an average delay of 3 seconds, signal strength (RSSI) ranging from −52 dBm to −66 dBm, and a communication range reaching up to approximately 210 meters. The system operated stably and efficiently, capable of functioning independently without reliance on cellular networks. In conclusion, the developed communication system is proven to be effective, energy-efficient, and suitable for real-time environmental monitoring using swarm-based autonomous boats.

***Keywords**: LoRa, Swarm USV, Solar Autonomous Boat, TTGO ESP32, Environmental Sensors, Wireless Communication*