ABSTRACT

Lake pollution caused by human activities has become an environmental issue that drives the development of automated monitoring systems based on Unmanned Surface Vehicles (USV). This study designs a collision avoidance system for a Solar Autonomous Boat as part of a Swarm USV, aiming to support safe autonomous navigation in aquatic environments. The system utilizes four JSN-SR04T ultrasonic sensors mounted on the front, back, right, and left sides of the boat to detect obstacles, with a TTGO ESP32 LoRa microcontroller that processes the data and transmits it to a gateway via a LoRa communication network. The system circuit was designed using EasyEDA and programmed through the Arduino IDE. Implementation was carried out on three boat units and tested in Situ Techno Lake, Telkom University. From 50 test scenarios, the system successfully classified danger zones (≤100 cm), warning zones (101–300 cm), and safe zones (301–600 cm), with 18, 21, and 11 cases respectively. The system demonstrated a 94% success rate in detecting and avoiding obstacles, proving its effectiveness in supporting autonomous navigation. With this performance, the system is considered feasible for Swarm USV deployment and has significant potential for further development, particularly in water areas that are difficult to reach by humans directly.

Keywords: Solar Autonomous Boat, Unmanned Surface Vehicle (USV), ultrasonic sensor, TTGO ESP32 LoRa, collision avoidance system, swarm technology