An Ellipsoidal Remote Wireless Robot for Wetland Ecological Monitoring

Zheng, Qiyun (School: Shanghai Foreign Language School Affiliated to SISU)

Wetland ecosystems play critical roles in maintaining biodiversity, regulating hydrological processes, and supporting carbon sequestration—functions that align closely with United Nations Sustainable Development Goals (SDGs) 6 and 15, particularly regarding water quality and terrestrial biodiversity. This project presents an ellipsoidal amphibious robot equipped with LoRa communication modules, designed to detect core wetland water quality parameters—pH and turbidity—in accordance with the EPA "Gold Book" and Ramsar Convention guidelines. The system features a fully-sealed ellipsoidal shell, a three-stage gear transmission, and a sliding balancing mechanism. Through PID control and Kalman filtering, it operates effectively in muddy, shallow, vegetation-dense environments. An onboard K210 edge AI vision module enables simultaneous ecological feature recognition. Overall, the design enhances multi-terrain mobility and addresses key challenges in wetland monitoring, including high ecological disturbance, limited real-time transmission, low efficiency, and adverse-weather susceptibility, providing a robust in-situ sensing and remote monitoring solution for wetland ecosystems. Experiments demonstrate that in shallow water, the robot maintains a trajectory deviation of =2.6% and a control latency of =92 ms, operating at depths of around 15 cm with an IP67-rated enclosure. The total cost is approximately 380 USD, showcasing superior cost-effectiveness compared to existing solutions and making the robot suitable for resource-constrained regions. This ellipsoidal remote wireless solution demonstrates strong potential for scalable deployment across global wetland ecosystems, which collectively cover approximately 12.1 million km2, thereby contributing to SDGs 6 and 15.

Awards Won:
First Award of $6,000