An Autonomous Unmanned Aerial Vehicle (UAV) System for Ocean Hazard Recognition and Rescue: Scout and Rescue UAVs

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Autonomous Unmanned Aerial Vehicles (UAVs) can aid lifeguards as 82% of ocean-related deaths in California occur at unprotected beaches, and 90% of drownings occur at low- and mid-income countries. However, commercial drones employed at select beaches still require manual operation. An autonomous UAV lifeguard system was developed: a scout UAV detects rip currents and activates a rescue UAV, which shortens response time by dropping flotation devices and pulling victims to safety. The scout quadcopter was designed, built, and implemented with autonomous flights. The scout drone has wide-range triple communication links for control and manual override. Nine ocean scout missions were conducted, and 11.8k ocean images were collected over 13.4km at beaches. Image analysis with new information-weighted differential frame displacement vectors was conducted for optical flow and particle image velocimetry. Resulting wave displacement vectors were utilized for a novel channel current flow analysis and depth and risk model to detect rip currents. For the rescue coaxial hexacopter, a novel in-arm pitch axis was designed, built, and pilot tested. The rescue UAV spans 2.0m, weighs 12.3Kg with 44.1x9.8N of thrust, and folds into 1.1m for transportation. The in-arm pitch axis angle exceeds conventional end-arm pitch axes' angles by more than 65% as it accomplishes the greatest pitch rotor tilt angle of ±45 degrees. This project advances current lifeguard practices with improved coverage, accuracy, and speed at a lower cost while demonstrating the feasibility of autonomous UAVs to solve a worldwide leading cause of death—drowning.

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