Developing a Novel Autonomous Swarm-Based Beach Cleaning Robot

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Beach pollution is an ever-growing global challenge that negatively impacts coastal ecosystems. Current solutions either involve having humans pick up pollutants (inefficient) or using beach plows to skim the beach surface for pollutants (not environment-friendly due to how they pick up both pollutants and non-pollutants like shells or small organisms). Thus, the engineering goal was to develop a robotic system that utilized machine learning and swarm robotics to make cleaning beaches both efficient and environment-friendly. In order to achieve this goal, a physical prototype was developed and constructed through an iterative design process that utilized CAD and 3D printing. The final prototype was scalable, able to pick up pollutants, store pollutants, and move around. After all functions of the prototype worked, a copy of the prototype was constructed to test swarm behavior. Then, a machine learning system was developed to help the robots differentiate between pollutants and non-pollutants as well as intelligently navigate towards pollutants. After the system reached design goals, it was implemented on both robots using OpenCV and Jetson Nanos. Finally, the robots were field-tested on a test area composed of beach sand. The robots were tested on their accuracy in cleaning up pollutants and their accuracy in avoiding non-pollutants. The results showed that the robots were at least 90% accurate in picking up pollutants (goal 80%) and 100% accurate in avoiding non-pollutants (goal 100%). All in all, the robots are both efficient (they clean up pollutants in a continuous and systematic manner) and environment-friendly (they only clean up pollutants).

Awards Won:
Second Award of $2,000