ECOGuard - Autonomous Drone for Selective Waste Collection in Large, Hazardous, or Inaccessible Environments, Based on Deep Neural Networks and Advanced Artificial Intelligence Methods for Automatic Detection and Classification

Sofronea, Vlad (School: Informatics Liceum Grigore C. Moisil)

Waste affects nature because it often accumulates in inaccessible spots like lakes, crevasses and slopes. In the mountains tourists can bring in and wind scatter wastes like plastic, paper, metal, and organic materials. These places where waste accumulates usually pose a high risk for the people in charge to clean. This project investigates whether an autonomous drone can detect, classify, and selectively collect waste in such environments using artificial intelligence. ECOGuard is a light autonomous drone designed to detect, collect, classify and carry the waste in a designated spot or nearby trash bins. The system integrates a global-shutter camera on a gimbal mechanism, a GPS module, an onboard processing unit, and an active gripping and intake mechanism designed to retrieve and transport waste items. A modified deep neural network based on the YOLOv8 segmentation architecture which was trained to detect and classify waste into multiple categories, including plastic, paper, metal, glass, organic waste, cigarettes, garbage bags, and trash bins. Training was performed using the TACO dataset, and a custom top-down dataset of trash bins to enable autonomous disposal. The drone structure was designed in Fusion 360 and 3D printed using PET-CF filament to ensure deflection and high temperatures resistance. This prototype aims to test flight stability, image clarity, detection accuracy for different types of irregular objects, and maintaining a hold of the object while transporting. Analyzing the test results the conclusion is that the autonomous aerial detection and collection of waste in dangerous or inaccessible environments is feasible. EcoGuard shows that drones using deep neural networks can be a solution for a cleaner mountainous area.

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