Title: Investigating the Identification and Documentation of Oceanic Macro-plastic Pollution Using Low Earth Orbit CubeSats

Author: Nico Moldovean

Abstract:
As plastic consumption increases exponentially, an estimated 4 – 12 million metric tons of plastics evade recycling and landfills annually, ending up in the ocean (Geyer et al., 2017). Once there, the sunlight and salinity break them down into increasingly smaller pieces, which can eventually be ingested by marine organisms, destroying fisheries and threatening marine biodiversity worldwide. I investigated the potential use of a fleet of Low Earth Orbit CubeSats as a cost-effective, efficient, and scalable way to track the concentration of oceanic macroplastics, enabling their removal before breakdown. I developed a concept of operations, built a CubeSat technology demonstrator, and programmed it with two versions of the same image-processing code: one using Python Imaging Library (PIL), and another using PIL and OpenCV. The CubeSat imaged random arrangements of simulated plastic trash of three different sizes and colors (red, green, and blue), comparing them to control scenarios. The OpenCV code correctly identified the plastics 89.8% of the time, compared to 6.57% for the PIL-only code. The color accuracy results were more balanced: the OpenCV code displayed an accuracy of 93.11%, compared to 93.94% for the PIL-only code. When excluding two trials with very poor imaging quality, the accuracies increased by as much as 8 percentage points. Assuming that the CubeSats can provide the necessary 1-2 meters of resolution, these results show that this overall method could effectively combat pelagic plastic pollution. However, on-orbit trials with high-fidelity prototypes are required to prove this concretely.