04 - AUTONOMOUS ENVIRONMENTAL SENSING

Communities living near airports are disproportionately affected by noise and emissions pollution created by aviation, with higher chances of developing medical conditions such as respiratory and cardiovascular diseases. To implement effective measures for mitigation, policy makers require comprehensive noise and emissions models of aviation based pollution. However, accurate data required for the development of such models is not available.

Mission Objective

The Autonomous Laboratory for Environment and Climate (ALEC) is a sustainable system that aims to provide a detailed map of noise and emissions caused by aviation close to runways and in near-airport communities. The project objective is defined as "To accurately measure noise and pollution at specific locations which can be used to create a footprint of environmental metrics." The system will provide an environmental database containing noise and emission measurements, as well as a preliminary model of aviation attributable pollution.

System Design

ALEC will consist of three emissions drones, two noise drones, 15 ground level sensors, and a ground station. As ALEC is used to measure pollution, a vital requirement is that the system is environmentally friendly. ALEC aims to have over 70 % of the monitor parts be recyclable, produce no emissions, and primarily function using renewable energy. Additionally, a key aspect of the design is its low impact on airport operations and the well-being of local communities.

The emissions drones will measure a variety of pollutants in the plume caused by specific aircraft during landing or take off. The sensors require laminar flow to obtain accurate measurements. Therefore, a small wind tunnel is built in the center of the drone, which consists of a fan at the bottom which laminarizes the flow passing through the tunnel. The use of multiple drones allows the system to take measurements at various locations simultaneously. Each emissions drone has a size of 98 cm by 98 cm, and has a hovering time of 25 minutes. The noise drones will measure noise by landing beside the runway during the aircraft-based event. This allows performing accurate noise measurements as the drones' motors will not produce additional noise.

A ground station is required to charge the drones, analyze the measured data, compute the optimal locations to sample, and generate a preliminary model of the environmental footprint. The optimal locations to sample will be determined using Bayesian optimization, a machine-learning technique which takes into account various parameters such as aircraft path, aircraft type, and atmospheric parameters. Ground-level sensors will be distributed in near-airport communities on public properties, such as schools, town halls, and lantern posts. These ground-level sensors contain a microphone that will measure the noise created by aircraft flying nearby.

In the remaining weeks of the Design Synthesis Exercise, the ground station and noise drone will be designed in more detail, and the performance of the emissions drone will be thoroughly analyzed.