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Decentralized Intelligent Sensor Networks for Wildfire Detection and Monitoring Systems

Maria João Sousa[a,*], Alexandra Moutinho[a], Miguel Almeida[b]

[a] IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Portugal
[b] ADAI, Universidade de Coimbra, Portugal
* corresponding author: maria.joao.sousa@tecnico.ulisboa.pt

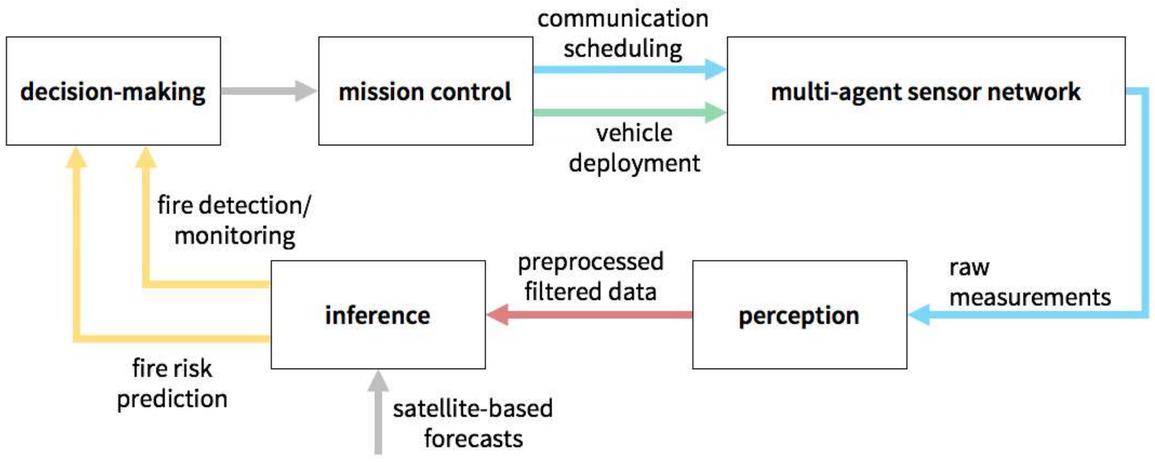
Motivation

Due to climate change, meteorological conditions of high propensity for ignitions are more frequent, leading to an increasing number of wildfire events. These phenomena are strongly tied to complex Earth systems dynamics that develop through land and air interactions, involving ecosystem cycles related to vegetation growth and meteorological conditions.

Since wildfires have a high degree of spatiotemporal uncertainty, with the escalation in severity of these events, there is an increased urgency in diminishing the response time for emergency teams. Hence, real-time fire detection and monitoring systems are crucial to identify and follow-up fire ignitions in an early stage.

Approach

This project proposes an integrated system based on satellite and sensor networks data to assist in early detection and monitoring of fire events. The system combines static sensors on the ground and dynamic sensors onboard mobile aerial platforms e.g. drones and high-altitude balloons (HABs), that can be deployed to monitor areas of high risk.



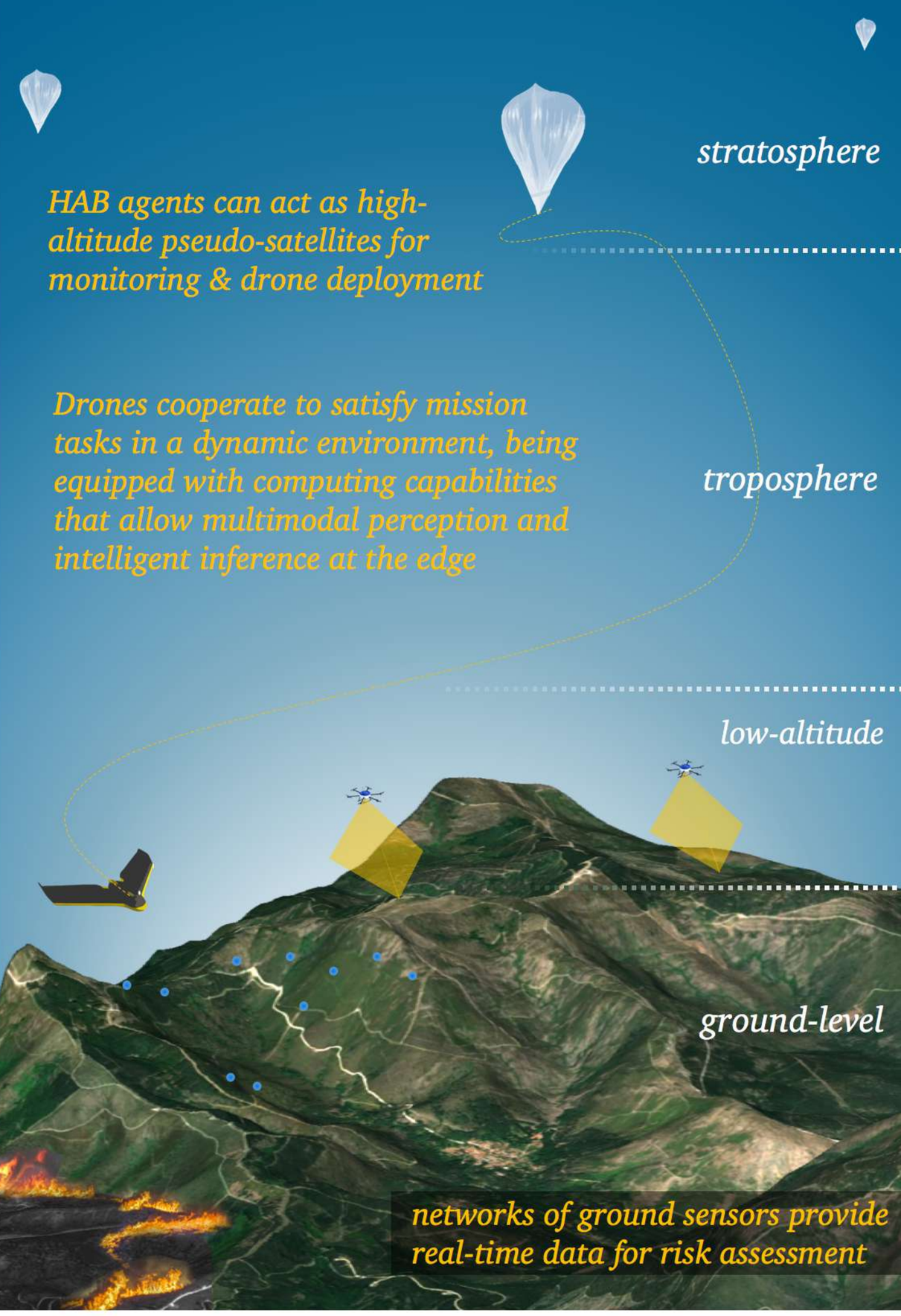
Objectives

- decentralized sensor network for real-time EO with multi-timescale data
- perception algorithms for environment sensing from multimodal sensors
- intelligent inference systems for fire event detection and monitoring
- cooperative control strategies for heterogeneous robotic platforms

IMPACTS: Real-time early fire detection and continuous fire perimeter monitoring systems can help avoid the occurrence of large burnt areas, the emission of greenhouse gases, and the mitigation of the social, environmental, economic and cultural consequences of wildfires, thus contributing to the United Nations Sustainable Development Goals.

Highlights:

- Network of sensing agents: HABs, UAVs, ground sensors
- Mobile infrastructure adapts to environment changes
- Distributed estimation algorithms provide fault-tolerance and low computational demand on each agent
- Intelligent inference at the edge enables early-warnings



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[1] Sousa, M.J., Moutinho, A., Almeida, M. (2019). **Classification of potential fire outbreaks: a fuzzy modeling approach based on thermal images**. Expert Systems with Applications. doi: 10.1016/j.eswa.2019.03.030

[2] Sousa, M. J., Moutinho, A., & Almeida, M. (2020). **Decentralized Distribution of UAV Fleets Based on Fuzzy Clustering for Demand-driven Aerial Services**. In 2020 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE). doi: 10.1109/FUZZ48607.2020.9177642