COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Rafael Nunes Linhares Papa

for the degree of Doctor of Philosophy (Ph.D.)

"Space-time Graph Path Planning for UAS Traffic Management Systems"

December 6, 2021, 10:30 a.m.
Virtual Dissertation

Zoom
Meeting ID: 863 9734 6814
Passcode: 2R1MxQ

DEPARTMENT:
Computer and Electrical Engineering and Computer Science.

ADVISORS:
Mihaela Cardei, Ph.D.
Ionut Cardei, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Mihaela Cardei, Ph.D., Co-Chair
Ionut Cardei, Ph.D., Co-Chair
Eduardo B. Fernandez, Ph.D.
Imadeldin Mahgoub, Ph.D.
Mohammad Ilyas, Ph.D.
Valentine Aalo, Ph.D.

ABSTRACT OF DISSERTATION

Space-time Graph Path Planning for UAS Traffic Management Systems

The unmanned aerial vehicle (UAV) technology has evolved considerably in recent years and the global demand for package delivery is expected to grow even more during COVID-19 and the social distance era. The low cost of acquisition, payload capacity, maneuverability, and the ability to fly at low-altitude with a very low cost of operation, make UAVs a perfect fit to revolutionize the payload transportation of small items. The large-scale adoption of drone package delivery in high-density urban areas can be challenging and the Unmanned Aircraft Systems (UAS) operators must ensure safety, security, efficiency and equity of the airspace system. In order to address some of these challenges, FAA and NASA have developed a new architecture that will support a set of services to enable cooperative management of low-altitude operations between UAS operators. The architecture is still in its conceptual stage and designing a mechanism that ensures the fair distribution of the available airspace to commercial applications has become increasingly important. Considering that, the path planning is one of the most important problems to be explored. The objective is not only to find an optimal and shortest path but also to provide a collision-free environment to the UAVs.

Taking into consideration all these important aspects and others such as serving on-demand requests, flight duration limitation due to energy constraints, maintaining the safety distance to avoid collisions, and using warehouses as starting and ending points in parcel delivery, this dissertation proposes: (i) an energy-constrained scheduling mechanism using a multi-source A* algorithm variant, and (ii) a generalized mechanism for path planning using a space-time graph with multi-source multi-destination BFS generalization to ensure pre-flight UAV collision-free trajectories. This dissertation also uses the generalized path planning mechanism to solve the energy-constrained drone delivery problem. The experimental results show that the proposed algorithms are computationally efficient and scalable with the number of requests and graph size.

BIOGRAPHICAL SKETCH
Born in Belo Horizonte, Brazil
B.S., PUC Minas, Brazil, 2003
M.S., Federal University of Minas Gerais-UFMG, Brazil, 2006
M.S., Florida Atlantic University, Boca Raton, Florida, 2018
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2021

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2018 – 2021

Qualifying Examination Passed: Fall 2019

Published Papers:

R. Papa, E. B. Fernandez, and M. Cardei, A Pattern for a UAV-aided Wireless Sensor Network, In Proceedings of the 26th Conference on Pattern Languages of Programs (PLoP '19). The Hillside Group, USA, Article 5, 1–9, October 2019.

R. Papa, I. Cardei, and M. Cardei, Energy-constrained Drone Delivery Scheduling, The 14th Annual International Conference on Combinatorial Optimization and Applications (COCOA'20), December 2020.

R. Papa, I. Cardei, and M. Cardei, Generalized Path Planning for UTM Systems with a Space-Time Graph, Journal Paper, (Submitted).