Hameed Ullah

Stabilization and control of aerial manipulators in contact with the environment for on-site measurements

Tutor: Fabio Ruggiero

Cycle: XXXVII   Year: First Year

My background

- MSc in Electrical Engineering (Specialization in Control), National University of Sciences and Technology, Islamabad, Pakistan

- Research group/laboratory: PRISMA Lab

- PhD start date: 01/11/2021

- Scholarship type: Marie-Sklodowska-Curie Innovative Training Network (ITN)

- Partner company: AEROTRAIN

Research field of interest

AERO-TRAIN:

- Consist of 15 ESRs, 9 beneficiaries and 7 partner organizations
- Operations & Maintenance industry of civil and industrial infrastructures
- Deploying innovative aerial robotic solutions to reduce the risks and costs
- The aims is to fill the gap between scientific research and industrial needs

I am here

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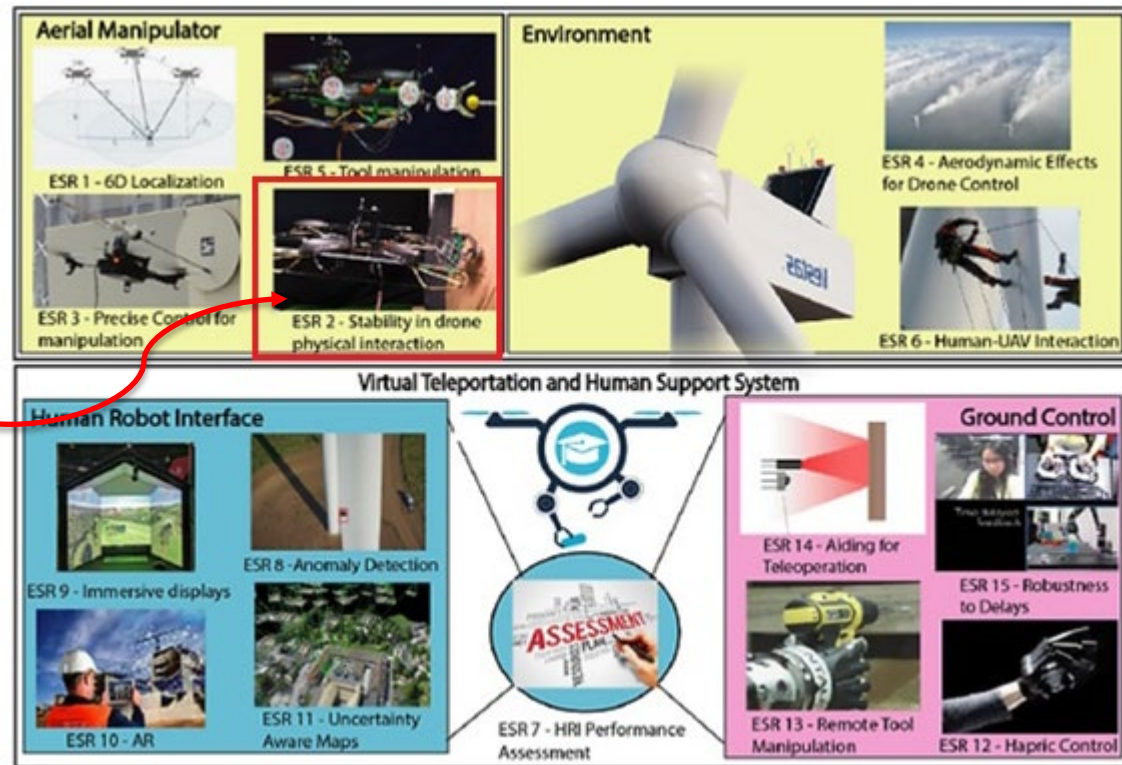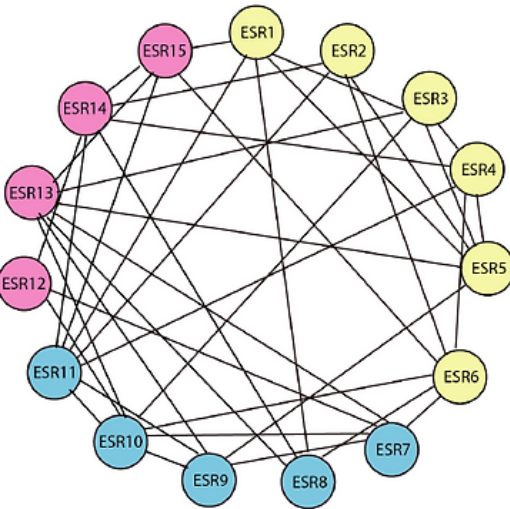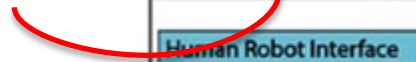
Research field of interest

Objective:

Develop an aerial manipulators (Drone with robotic arm) for physical interaction with the environment for on-site measurements.

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Research field of interest

Drones But Why ?: Due to their high maneuverability, different size and shape, superior agility, vertical takeoff and landing ability and the ability to handle the heavy payload.

- It can be used in different types of environment.
- Contactless operations which exploit advanced on-board sensing, for example, cameras, pressure sensors, flow sensors, LIDAR.
- Owing to these advantages, UAVs find many applications.

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Summary of study activities

Ad hoc PhD courses / schools

1. "**Robotics lab**", Lecturer: Dr. Jonathan Cacace: The course gave an overview of the fundamental tools and techniques used to program advanced robotics systems (ROS and GAZEBO).

2. "**Field and Service Robotics**", Lecturer: Dr. Fabio Ruggiero : The course provided an overview of the tools employed to model, plan, and control wheeled robots, unmanned aerial, underwater vehicles and legged robots.

3. **"Robot Interaction Control"**: Lecturer: Prof. Bruno Siciliano : The course provided the skills for controlling the interaction between robots and scarcely structured environments. Topics covered are force control, visual control, flexible joints, grasping and cooperative manipulation.

Training schools:

1. Training School 1. Training School on Unmanned Aerial Systems for Inspection and Maintenance at University of Seville, Spain organized by AEROTRAIN.

2. Training School 2. Training School on Autonomous systems working in uncertain environments at DTU Denmark, organized by AEROTRAIN.

Summer schools:

1. Summer School on Multi-Robot Systems: IEEE RAS Summer School 2022 on on Multi-Robot Systems in Prague organized by Martin Saska, Czech Technical University, Prague, Czech Republic.

Conferences / events attended

1. "IEEE ICRA 2022 Workshop (Attended Online): 23rd May 2022: Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust.

Research activity: Overview

Problem:

- Drone industrial applications has increased astoundingly
- Drone mostly perform passive tasks.
- Limitation involves any kind of contact with the environment.
- UAVs have to migrate from passive tasks to active tasks that do require manipulation and physical interaction with the environment.

Research activity: Overview

Objective:

- For physical interaction, need Unmanned Aerial Manipulators (UAM).
- Aerial vehicle equipped with robotics arm or stick.
- UAM can perform various operations such as; push and slide operation, grasping, picking and placing, surface repairing and manipulations etc.
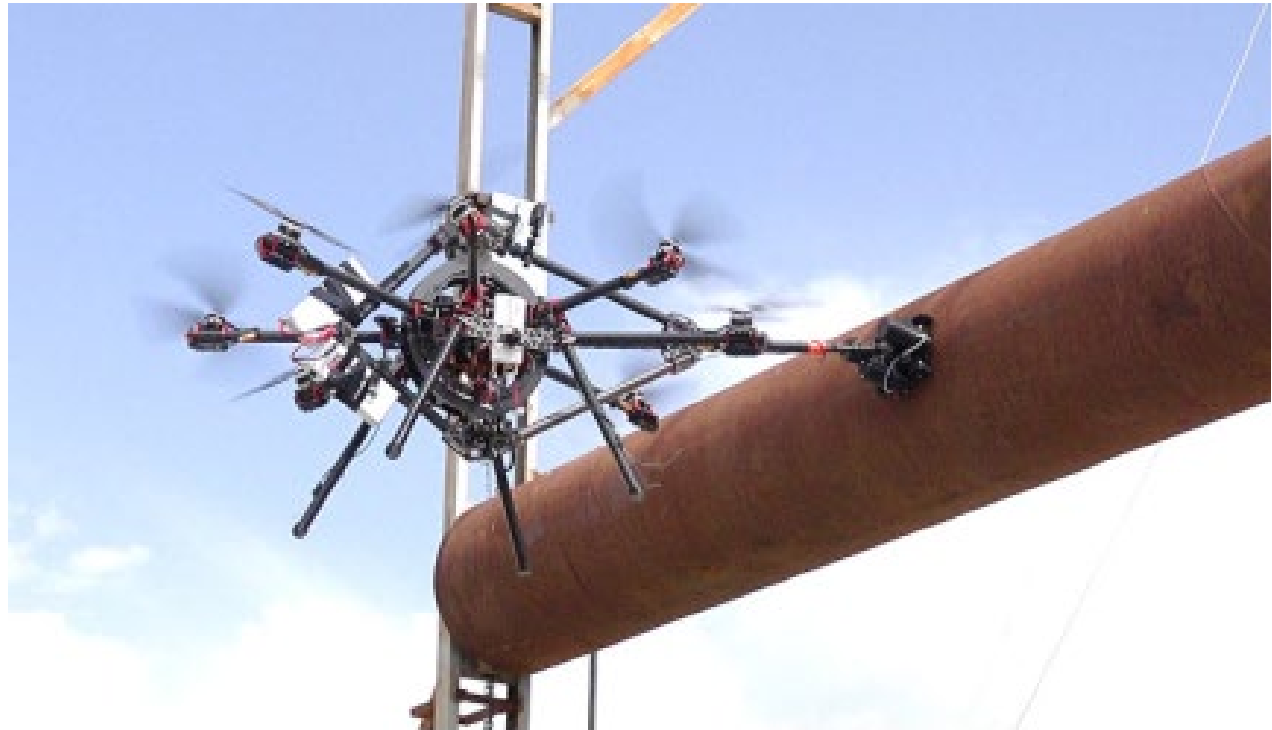

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Research activity: Overview

Methodology:

- Design a robust nonlinear controller.
- Stabilize the aerial manipulators during physical operation.
- Push and slide operations

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Research activity: Overview

Research activity during the First Year

• Comprehensive state-of-the-art of recent research work on the quadrotors and unmanned aerial manipulators.

• Mathematical modelling of the aerial platform.

• Implementation of various linear controller on the quadrotor.

• Sate of the art and deeply understanding of Nonlinear model predictive control (NMPC).

Research activity: Overview

Future work:

- Implementation of the Nonlinear model predictive control on the aerial manipulator

- To design force interaction controller and robust controller that can estimate external disturbance

- Simulations in Gazebo physics engine

- Implementation of the work on the experimental platform

- The goal is to complete Push-&-Slide operation

Thank you all for your attention

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