# **Master Thesis Contents**

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# **0. Abstract**

We can control a UAV with a joystick two UAVs with 2 joysticks we discuss here a solution to control more UAVs using human poses from the UAV flight space.  
Our solution is based on multiple axis.  
- Asynchronous controller kernel for UAV manipulation.  
- Collision avoidance integration for technological platforms.  
- Object detection from cameras.  
We research here multiple domains Human Computer Interactions (HCIs), unmaned air vehicules (UAVs), Swarms and Object Detection and Recognition.

# **1. Introduction:**

*rajouter du context général sur les UAVs  
rajouter contexte swarn UAV*

* expliquer brièvement qu'il n'y a pas de concensus sur le control des essains de UAVs

Pb : controler des UAVs en essain

*petit résumé pour dire les future chap qui arrive*

General context about UAVs:  
UAVs have become pivotal in various sectors, from surveillance to delivery services. However, the control of UAV swarms remains a complex issue without a consensus in the field.

Swarm technology in UAVs presents unique challenges and opportunities, particularly in coordination and control. Understanding these dynamics is essential for advancing UAV technologies.

We research here multiple domains Human Computer Interactions (HCIs), unmaned air vehicules (UAVs), Swarms and Object Detection and Recognition. We are proposing novel solutions for controlling UAV swarms.

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# **2. Related Works:**

Collision Avoidance Systems:

Use sensors like ultrasonic, infrared, and optical flow for obstacle detection.

Passive Collision Avoidance Systems:

Indoors location system to create virtual boundaries.

Aircraft avoidance systems detect and avoid other aircrafts

Collision Avoidance Algorithms:

Categorized into reactive, predictive, and cooperative algorithms.

Reactive algorithms respond to immediate obstacles.

Predictive algorithms anticipate future obstacles.

Robust MADER Algorithm (MIT Research):

An asynchronous, decentralized multiagent trajectory planner.

Allows individual trajectory formulation for each UAV.

Includes a delay-check step for collision-free trajectories despite communication delays​

Regulatory Aspects and Standards:

FAA and other regulatory bodies have set standards for UAV collision avoidance systems.

Standards vary based on UAV capabilities and weight​

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Multi-Vehicle Cooperation and Collision Avoidance: There's a significant focus on autonomous vehicles (AVs), particularly in how they can cooperate and avoid collisions. The complexities of AVs' interactions, especially in mixed autonomy environments where both human-operated and autonomous vehicles coexist, are a key area of research. This research often includes developing models and frameworks that can handle the varied dynamics of such environments, emphasizing the necessity for robust collision avoidance systems in UAVs.​

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Reinforcement Learning for Quadrotor Collision Avoidance: In the realm of UAVs, specifically quadrotors, reinforcement learning techniques are being used to develop collision avoidance strategies. These strategies involve training policies that can efficiently guide UAVs in complex tasks like formation changes and package delivery. The goal is to achieve efficient task execution while ensuring safety through collision avoidance, even in environments with multiple UAVs. This kind of approach highlights the potential of machine learning algorithms in enhancing UAV operations in real-time, adaptive scenarios​

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UAV Flight Control Regulations and Airworthiness Standards: There are established regulations and standards that dictate the flight activities of UAVs, focusing on reducing collision risks and ensuring airworthiness. These regulations cover aspects like flight area, speed, duration, and operational risks. They also include standards for various types of UAVs, specifying performance requirements that ensure safety and collision avoidance capabilities. This regulatory framework plays a crucial role in guiding the development and implementation of UAV technologies, ensuring that they meet safety standards and can effectively avoid collisions​

In summary, the integration of asynchronous controller kernel, collision avoidance, and object detection technologies in UAVs is an area of active research and development. The focus is on creating systems that can operate autonomously and safely in mixed environments, utilizing advanced algorithms and adhering to rigorous safety standards and regulations. These technologies are not only crucial for the efficient operation of individual UAVs but also for their interaction within larger systems, including those involving human-operated vehicles.

The object detection looks fast and robust while still runinng in realtime we will certainly use these technics as they

###### **2.1: Asynchronous controller kernel**

###### **2.2: Collision Avoidance**

###### **2.3: Object Detection**

###### **conclusion part 2:**

# **3. Contribution 1: *Control UAVs :* An Asynchronous controller kernel as a technological platform**

#### **- 3.1 Introduction : Link to the Vision and reason to build an asynchronous controller**

Importance of an Asynchronous API for Controlling UAVs

Instantaneous API Calls and Background Processing: Asynchronous APIs enhance the functionality of UAV control applications by handling requests in the background. This approach maintains application functionality while keeping resources free to process new requests. Especially in UAV operations where real-time responsiveness is crucial, this capability ensures efficient handling of multiple tasks simultaneously​

Adaptability to Connectivity and Execution Time: Asynchronous APIs are particularly beneficial in environments with variable connectivity or where requests have longer execution times. They allow for the processing of complex operations without causing delays in the application's responsiveness, crucial for real-time UAV control where delay can have significant consequences​

Event-Driven Communication: Asynchronous APIs, being event-driven, enable more intelligent communication between internal and external services. This is especially important in UAV operations where multiple events or commands may need to be handled in real time, ensuring smoother and more efficient workflows​  
​  
Support for Various Protocols: These APIs support a range of messaging protocols and transports such as WebSockets and GraphQL subscriptions, which are essential for the dynamic and varied requirements of UAV control. This flexibility allows for more robust and versatile UAV operation management​.

Improved User Experience: Asynchronous APIs facilitate a smoother user experience by eliminating the delays characteristic of synchronous APIs. This is crucial in UAV control scenarios where timely and interactive responses are necessary for safe and effective operation.

Enhanced Responsiveness and Performance: The ability to process multiple requests simultaneously without waiting for each to complete before starting another makes asynchronous APIs highly suitable for UAV control applications, where rapid response and high performance are essential.  
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#### **- 3.2 Extend radio python library to web API**

Multi-User Accessibility: Web-accessible asynchronous APIs allow multiple users to simultaneously interact with UAV control systems. This is particularly important in scenarios involving multiple UAVs or when UAV operations are managed by a team.

Handling Conflicting Commands through Non-Blocking Operations: The non-blocking nature of asynchronous APIs is critical in UAV control applications, as it allows the system to handle conflicting commands effectively. This ensures that the operation of UAVs remains smooth and uninterrupted even when multiple commands are issued simultaneously.

#### **- 3.3 Results**

* Results interpretation and analysis.
* Asynchronous controller kernel outcomes.
* Effectiveness of handler of conflicts

#### **- 3.4 Discussion**

* System comparison with existing technologies.
* Implications and potential applications.

#### **- 3.5 Conclusion**

Our research has shown that an asynchronous API functions effectively for controlling UAVs, especially in scenarios involving multiple users. Its ability to handle conflicting commands through non-blocking operations enhances the efficiency and reliability of UAV operations. This makes asynchronous APIs a vital component in the development of advanced UAV control systems.

## **Conclusion**

In conclusion, the asynchronousAPI demonstrated effective control over UAVs in indoor settings with multiple users, we tested with 5. It efficiently handled conflicting commands. The non-blocking commands and real-time processing capabilities of the API ensured smooth and responsive UAV movements.

Now that we can move we need to find a path through an environement.

# **4. Contribution 2: Motion planning/Collision Avoidance**

#### **- 4.1 Introduction : Link to the Vision and reason to build a collision avoider and motion planner.**

*éviter des obstacles c'est important  
qu'est-ce qu'un venv  
on peut mettre les UAVs dans un venv  
Pb : plannifier mvt UAV dans/via venv*

To avoid obstacles we first create virtual twins of these UAVs and place virtual obstacles in the UAV space and

#### **- 4.2 Project overview**

#### **- 4.3 Results:**

* Effectiveness of collision avoidance (%).
* Speed

#### **- 4.4 Discussion:**

* Results interpretation and analysis.
* System comparison with existing technologies.
* Implications and potential applications.

#### **Lien**

*résumé, on arrive à bouger les UAVs où on veut  
mais comment détecter les obstacles pour les éviter*

# **5.Contribution 3: Object Detection**

#### **Mini intro**

To ensure safe navigation and effective object avoidance, UAVs can be guided using a ground-based system equipped with advanced cameras, such as Intel RealSense. These cameras, positioned strategically on the ground, are used to scan the environment, identifying and locating objects within the space.

#### **Collision Avoidance in Indoor Environments**

* **Critical for Safety**: Indoor environments are often cluttered and unpredictable, making collision avoidance systems crucial for UAV safety to prevent crashes and damage.
* **Complex Navigation Needs**: Indoor spaces often require navigating around obstacles like furniture, walls, and people, necessitating advanced collision avoidance technologies.
* **Small Margin for Error**: The confined nature of indoor spaces leaves a small margin for error, emphasizing the need for precise and reliable collision avoidance.

#### **Motion Planning for Indoor UAV Operations**

* **Route Optimization**: Efficient motion planning is essential for optimizing routes and minimizing flight time, which is particularly challenging in constrained indoor environments.
* **Dynamic Environment Adaptation**: Indoor UAVs must adapt to dynamic changes in the environment, such as moving people or shifting obstacles.

#### **- 5.1 *projet***

* Image segmentation
* object depth

#### **- 5.2 Results:**

* Object detection results.

#### **- 5.3 Discussion:**

* Results interpretation and analysis.
* System comparison with existing technologies.
* Implications and potential applications.

#### **Lien**

# **6. Global Solution**

#### **Mini intro**

#### **- 6.1 *ton projet***

#### **- 6.2 Results:**

#### **- 6.3 Discussion:**

#### **Lien**

# **Discussion:**

Results interpretation and analysis.

System comparison with existing technologies.

Implications and potential applications.

# **Results:**

Asynchronous controller kernel outcomes.

Effectiveness of collision avoidance.

Object detection results.

# **7 Global Solution**

# **Conclusion:**

Summary of findings and contributions.

Reflection on significance.

Future research directions.

# **References:**