ClearPath Project Proposal

Isaac Hewitt, Sadeed Khan, Cannon Newbury, Michael Yun

Embry-Riddle Aeronautical University

CS490 Senior Capstone Design

Dr. Massood Towhidnejad

Problem Statement:

ClearPath aims to develop a simulation system that integrates with the existing XPlane simulator in LB 131 to model and analyze potential runway and taxiway incursions. This system should:

1. Utilize the physical simulator as a simulated aircraft
2. Navigate the simulated aircraft through runways and taxiways
3. Create scenarios that demonstrate potential runway or taxiway incursions
4. Provide a platform for studying and preventing such incursions in real-world situations

ClearPath aims to enhance the way ATC and pilots communicate during runway and taxiway incursions.

Stakeholders:

Primary stakeholder: Dr. Massood Towhidnejad

Secondary stakeholders: Flight simulator user

Proposed Solution:

ClearPath will leverage the existing XPlane simulator in LB 131 to create an enhanced simulation system focused on runway and taxiway incursions. The project will be built on two primary functionalities: modeling simulated aircraft behavior and developing scenarios that test and improve communication between Air Traffic Control (ATC) and pilots during critical moments.

What is In-Scope:

- **Integration with XPlane**: The system will utilize XPlane's flight simulation capabilities to model the behavior of aircraft on runways and taxiways. By treating the physical simulator as a "simulated aircraft," we can navigate it through different airport environments.
- **Runway and Taxiway Incursion Scenarios**: We will develop multiple incursion scenarios that involve realistic miscommunication, aircraft misrouting, or hazardous situations, simulating real-world safety concerns.

- **Study and Prevention**: The system will provide a platform for analyzing incursions and proposing prevention strategies. This includes exploring the effectiveness of ATC and pilot communications during different levels of runway and taxiway conflict situations.
- **Technology Integration**: ADSB, AI/ML, and data analysis tools will be integrated to track aircraft movement and predict potential runway or taxiway conflicts. These technologies will allow the system to simulate real-time aircraft tracking and decision-making.
- **2D to 3D Transition**: Initially, the simulation will be based on 2D modeling of aircraft movement on runways and taxiways. However, our long-term goal is to evolve the system to support 3D simulations, providing a more immersive and comprehensive experience of the incursion scenarios.

What is Out-of-Scope:

- Full-scale deployment in actual NAS systems.
- Real-time use of live data from real aircraft; we will primarily work with simulated data for this project.

Approach:

We will follow an iterative development process with milestones split across two semesters to ensure a robust and scalable solution.

Semester 1:

- **Integration of XPlane with Simulated Aircraft Behavior:** The focus will be on modeling the movement of the aircraft within the simulator, ensuring it can navigate through the runways and taxiways as intended. We will design the core interaction between the aircraft and the airport environment.
- **Basic Scenario Development:** We will create a set of basic runway and taxiway incursion scenarios, exploring various points of failure in communication between ATC and pilots.
- **ADSB Tracking Implementation:** This semester will also focus on integrating ADSB tracking technology to provide real-time positional data for the simulated aircraft, enabling the system to simulate tracking and incursion detection.

Semester 2:

- **Advanced Scenario Creation and AI/ML Integration:** Building on the work from Semester 1, the second semester will introduce more complex scenarios. These scenarios will incorporate the “Good Guy/Bad Guy” operational scenarios, which will test various conflict and resolution mechanisms in runway operations.

- **AI/ML for Conflict Prediction:** We will develop AI/ML algorithms to predict potential incursions based on aircraft behavior, ATC instructions, and runway conditions. These algorithms will be used to generate reports and feedback on how well pilots and ATC responded to simulated emergencies.
- **2D to 3D Conversion:** During the second semester, we will begin laying the groundwork for transitioning the simulation from 2D to 3D. This includes adding 3D elements to the runway and airport environment, gradually enhancing the visual realism and interactivity of the system.
- **Runway and Taxiway Communication Enhancement:** A key deliverable for Semester 2 will be the improvement of communication protocols between ATC and pilots during an incursion, based on scenario feedback and analysis from our system.

By the end of the project, ClearPath will offer a detailed simulation environment that not only models aircraft behavior but also allows users to study and prevent runway and taxiway incursions, improving both ATC and pilot communication in critical situations, with a long-term goal of fully implementing 3D simulations.

Proposed Project Budget:

We do not perceive any additional costs besides the simulator and XPlane software itself. Any unforeseen hardware or software malfunctions, fees, or damages will need to be addressed if or when they occur.

References:

No references were given to us regarding this project. We are the first group to start development and were told to define the project how we saw fit. Our work may be used as documentation for future groups.