**Using Agent-Based Modeling and Simulation to Understand Safety in Air Transportation**

**Project Background**

**Socio-Technical Perspective**
- The Air transportation system is a complex socio-technical system:
  - Many interconnected heterogeneous components
  - Predicting emerging behaviour is difficult
  - Existence of many stakeholders
  - Changes in one part may have unforeseen effects on other parts
  - Few points through which system behaviour can be changed to a desired state

**Research Methodologies**

**Agent-Based Modelling and Simulation**
- Increasingly recognized as a power approach to model complex socio-technical systems
- Provides a platform to integrate heterogeneous components at different abstraction levels
- Capable of obtaining emergent behaviour
- Suitable for domains that are functionally or geographically distributed into autonomous subsystems, and where the subsystems interact in a dynamic environment

**Human-Performance Modelling**
A computational approach to model human performance in the socio-technical air transportation system is necessary, in order to be consistent with the widely developed mathematical models of non-human parts in aviation research. Examples of human performance sub-models include:
- Multi-agent situation awareness propagation
- Human error
- Cognitive control mode
- etc.

**Safety Risk Assessment Cycle**

**Safety Risk Assessment of a Runway Crossing Operation: Schiphol Airport Case Study**

**Identifying the interacting agents**
- Aircraft: Pilot Flying, Pilot Non-Flying, FMS, GNC, etc.
- Environment: Wind, Visibility

**Modelling**
- Taking Aircraft (AC-70)
- Tusing Aircraft (AC-70)
- Runway Controller (RTG-R)
- ATC System

**Risk calculation**

\[
\text{Total Risk} = \sum \frac{\text{Probability} \times \text{Conditional Risk}}{\text{System data and Expense}}
\]

**Results**

**Research Aim**

The main aim of this research is to develop an agent-based modelling and simulation approach towards understanding the safety of air transport operations. The modelling approach should capture both the human and non-human agents of the socio-technical air transportation system, their interactions with one another, and the external dynamic environment. It should therefore enable changing the characteristics of the agents in order to experiment with different what-if scenarios.

**Risk assessment of single pilot operations**

The agent-based model can be used to perform a safety risk assessment of single pilot operations.

**Other Applications**

**Disruption Management by Airline Operations Control**

The agent-based model can be used to investigate the AOC's dynamic behavior relative to anticipation and decision-making upon various types of irregularities.

**Publications**


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