CIS 540 Spring 2015: Project

Problem

The goal of this project is to design an aircraft controller that navigates the aircraft from source to destination while ensuring that it does not collide with other aircraft in its path. The controller gets information about the current location and the target location of the aircraft. Further, it receives messages from aircraft in its vicinity and uses this information to navigate the aircraft and avoid collision with other aircraft.

In this project, we look at a simplified controller design problem as follows.

1. The aircraft can fly in a 2-D plane. Its source and destination are integer-valued points in the plane.
2. The aircraft flies with a constant velocity \( v = 1 \text{ km/minute} \) along either X-axis or Y-axis.
3. The aircraft controller can update direction of flight every \( k = 1 \) minutes. Note that it can decide to either fly straight or rotate left or right by 90 degrees but not turn back.
4. The controller also gets messages from any aircraft in a square grid with side length \( 2q = 4 \) km in the vicinity of the aircraft as shown in figure below.
5. Collision Avoidance: Each aircraft has a square region with side length \( 2d = 2 \) km around it such that no aircraft enters within this region as shown in figure below.

Further, we assume that the airspace consists of only two aircraft that start at time \( t = 0 \). The goal here is to design a controller (same for both aircraft) that ensures that aircraft reach their destination in as small time as possible while ensuring collision avoidance. In the problem, the sources and destinations for aircraft are provided as parameters and the designed controller should work with all such source-destination pairs.

Project Details

The project should be done in groups of two persons. The project is split into two phases

- Phase I (10 pts): Model Design
  In this phase, a report must be submitted with the following details
  - Input-output specification: Specify the inputs and outputs of the controller
– Requirements: Specify the requirements that the controller must satisfy.
– Design of a simple controller: Design an algorithm for a simple controller that ensures that the aircraft reach their destination. The algorithm should be precise and clearly specify how the output of the controller is computed.
– Design of the complete controller: Design an algorithm for the controller that ensures that the aircraft reach their destination as well as avoids collision with other aircraft. The algorithm should be precise and clearly specify how the output of the controller is computed. Also, the content of the messages exchanged between the aircraft should be clearly specified.
– Proof of correctness: Show that the designed controller ensures collision avoidance and also that the aircraft reaches its destination.

• Phase 2 (10 pts): Model Implementation
  In this phase, the controller must be implemented in Matlab.
  – Skeleton code to run the simulation and view the trajectories of aircraft will be provided. Details can be found in Readme.txt along with code.
  – Implement the controller designed in first phase and a safety monitor to check for collision avoidance. Sample implementations are provided in the skeleton code.

• Optional: Design a controller when the airspace consists of three aircrafts.

Submission
For the first phase, submit a report by 17th April 2015, 11:59pm on Canvas. Clearly specify the names of group members.

For the second phase, submit an archive by 1st May 2015, 11:59pm on Canvas. Only ONE team member must submit the archive to avoid duplication. The archive must contain the following files.

• Implementation of the controller and safety monitor along with the files needed to run the simulation.
• Report containing the final design of the controller. The names of the group members must be clearly specified.