Development of an aircraft taxiing BlueSky plug-in using ground traffic data for taxiway direction determination

Honours Programme Delft

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Abstract

BlueSky is meant as a tool to perform research on Air Traffic Management and Air Traffic Flows, developed as an open-source software. The aircraft taxiing plug-in is developed to deepen the completeness of the tool, and allow ground-traffic simulation. The chosen approach is to create graphs for each airport, on which the trajectory planning plug-in will work. For a realistic functioning of the plug-in, determining the taxiway directions of each edge in the graphs is necessary. A script is created to determine this based on historic data.

Aircraft taxiing trajectory planning BlueSky plug-in

In order to make a BlueSky [1] plug-in for aircraft taxiing trajectory planning, the following approach has been taken. A global path planning function will give an aircraft a path to follow, and a local behaviour function determines how the aircraft interacts with its environment.

Global path planning

In order to create the global path planning function, BlueSky's airport file is read, from which a dictionary of graphs, corresponding to all airports' closed network of taxiways, is created. Each graph corresponds to a single airport and contains information on the location of each waypoint and how each waypoint is connected to the network.

The global path planning function consists of two parts. The first step is to determine what the closest waypoint is to an aircraft, taking into account its position, direction and velocity. Then, from this point, an A* algorithm is used to determine the shortest path from said point to the desired destination. The A* algorithm is chosen as it is a computationally-efficient solution [2]. The global path planning function works both ways from- and towards runways.

Local behaviour

The local behaviour function will have a tactical approach towards collision avoidance, by regulating the speed of aircraft which are on a collision trajectory. Determining collision trajectories will be done continuously, with a short-range collision prediction.

Determining taxiway direction from ground traffic data

By analysing ground-traffic data from OpenSky [3], the movement of aircraft can be compared to the available airport graphs. A script that relates this movement to the most probable taxiway being taken by the studied returns the direction of a taxiway. By analysing aircraft movement in a large scale, taxiway directions can be predicted, and potentially, taxiway direction time-driven patterns can be determined. The resultant taxiway directions are then implemented in the airport file of BlueSky for the proper functioning of the taxiing plug-in.

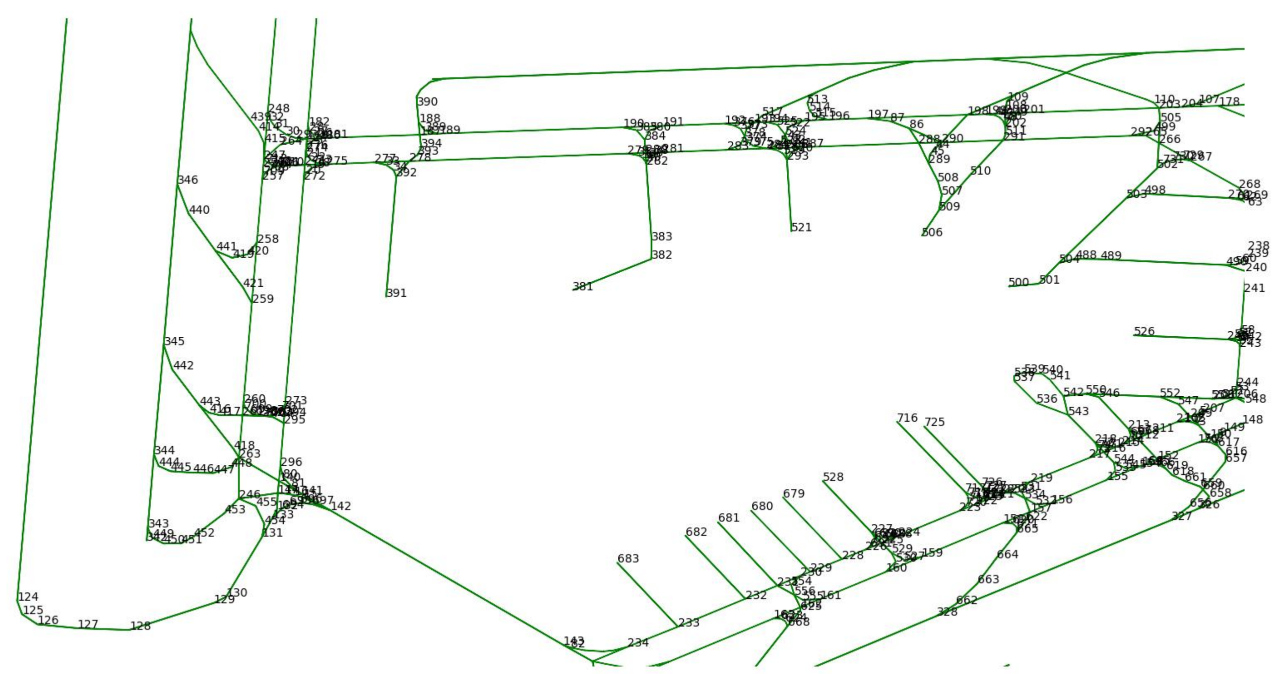

Figure 1. Amsterdam airport graph

Expected work and outcomes

The expected outcome of this work is a plug-in that will simulate ground-traffic control, by assigning shortest-path methods to taxiing aircraft. A script that determines the taxiways directions based on historic ground-traffic data, and implement it into BlueSky's airport file, will ensure the plug-in works in a realistic environment.

Figure 2. Example of aircraft taxiing in BlueSky

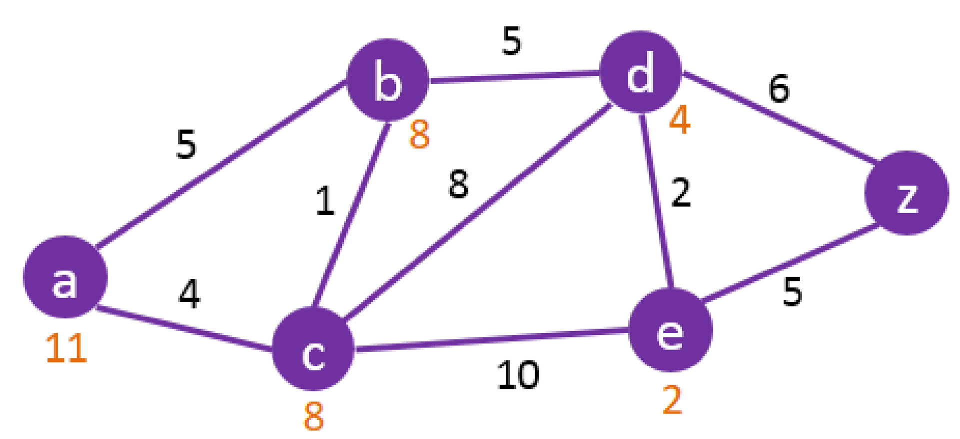

Figure 3. Example of A* algorithm [a]

References

[1] J. Hoekstra and J. Ellerbroek, "Bluesky atc simulator project: An open data and open source approach,", Jun. 2016.

[2] R. Johner, A. Lanaia, R. Dornberger, and T. Hanne, "Comparing the pathfinding algorithms a*, dijkstra's, bellman-ford, floyd-warshall, and best first search for the paparazzi problem," in *Congress on Intelligent Systems*, M. Saraswat, H. Sharma, K. Balachandran, J. H. Kim, and J. C. Bansal, Eds., Singapore: Springer Nature Singapore, 2022, pp. 561–576, ISBN: 978-981-16-9113-3.

[3] M. Schafer, M. Strohmeier, V. Lenders, I. Martinovic, and M. Wilhelm, "Bringing up opensky: A large-scale ads-b sensor network for research," *IPSN-14 Proceedings of the 13th International Symposium on Information Processing in Sensor Networks*, Apr. 2014. DOI: `10.1109/ipsn.2014.6846743`.

[a] `https://www.101computing.net/a-star-search-algorithm/`

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