

Temasek Defence Systems Institute

## Mission Planning for Heterogenous UxVs Operating in a Post-Disaster Urban Environment

Tan Choon Seng Leon Mark

Thesis Advisor: Professor Oleg Yakimenko

Second Reader: Associate Professor Brian Bingham

Time is critical during search and rescue operations, as human survival diminish exponentially if survivors are not located and recovered efficiently. Can a swarm of heterogeneous UxVs be used to enhance operations?



Figure 1 Flow of Search Mission

This thesis sought to integrate technologies into a solution that helps rescuers plan for a mission utilizing multiple UxVs for search operations based on the flow in Figure 1. It exploits methods of image analysis to fuse data into a common map and identify key areas of search interest.

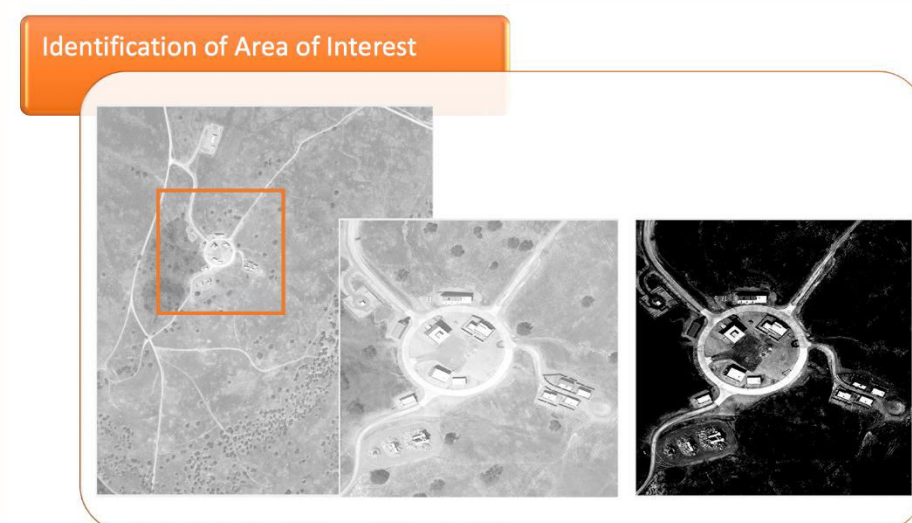


Figure 2 Identification of Key Mission Areas

The key mission areas were developed by comparing edge detection techniques on images obtained from remote sensing platforms in the DigitalGlobe database as shown in Figure 2. Together with close-up snapshots of the environment obtained from drones, three-dimensional maps were developed by stitching the images together into a comprehensive model for a mission commander's use as shown in Figure 3.



Figure 3 Development of 3-dimensional maps

With the mission bubbles developed, a probabilistic road map (PRM) as shown in Figure 4 was used to develop an optimal trajectory to the search area. It was found that the K-d method for connection and a weighted heuristic method for the A\* search formed the most efficient means to obtain a solution.

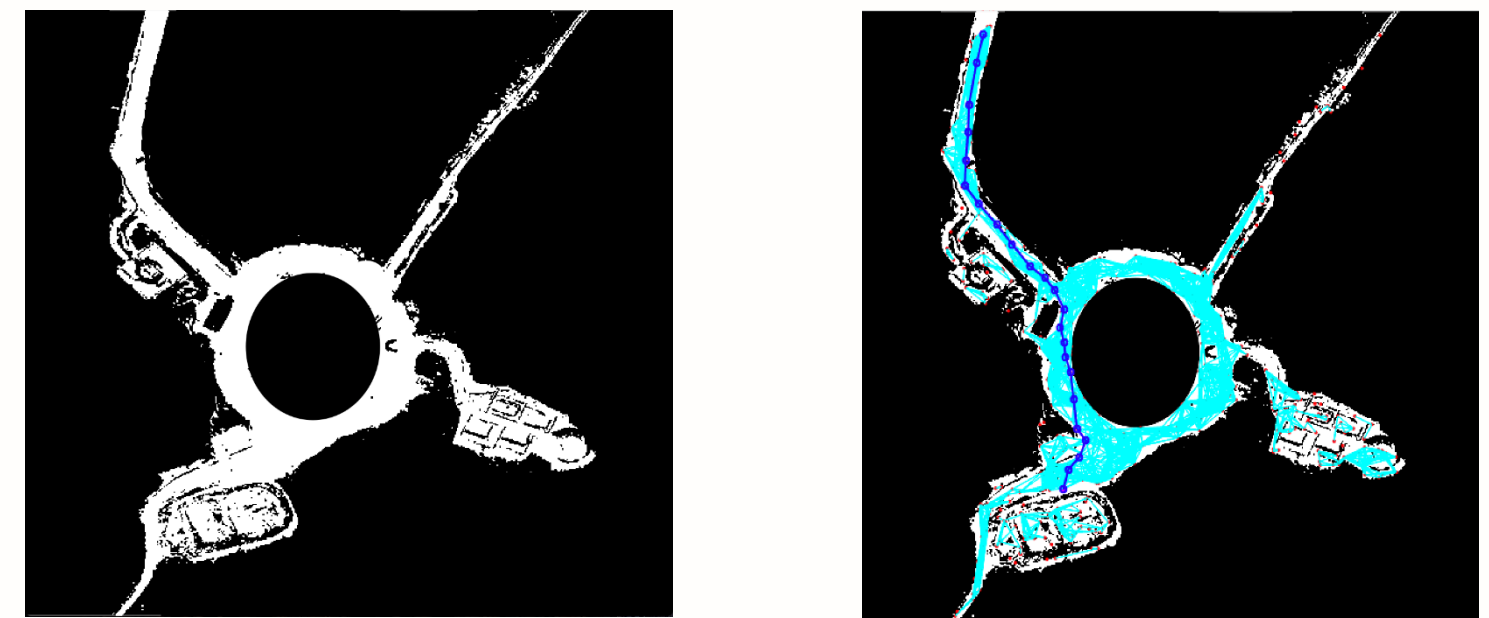


Figure 4 Development of trajectory using PRM

A search pattern was subsequently developed to search the area of interest. When one UAS with a single operator was used, the time to complete the search was approximately 30.5 minutes, and when two UASs were used, the total time required to complete the mission was 21 minutes. However by increasing to three UAS only one minutes can be reduced (20 minutes) as shown in Figure 5.

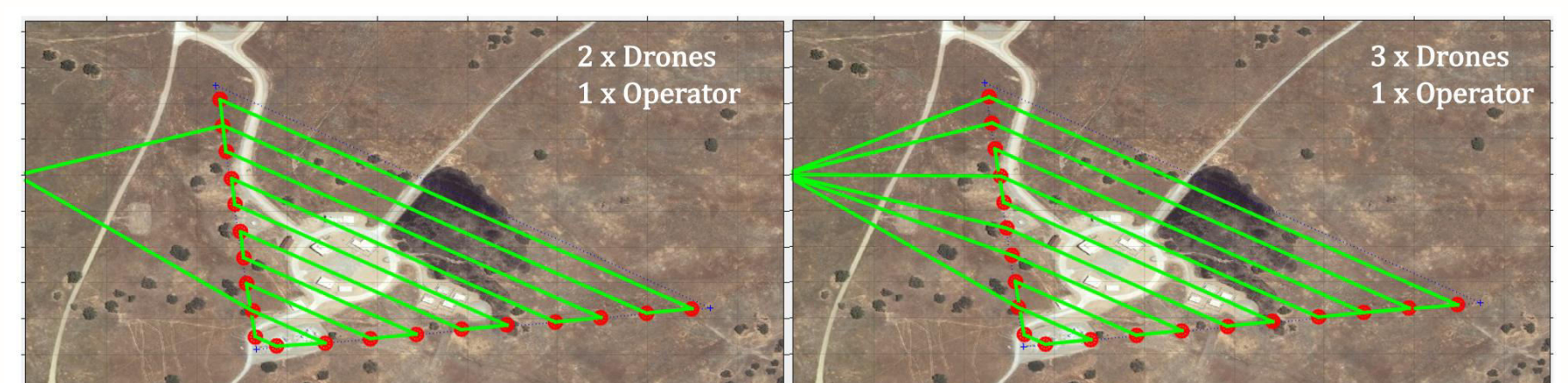


Figure 5 Development of trajectory using PRM

This tool was successfully experimented at Camp Roberts Technology was effectively used in the development of a mission planning tool utilizing a set of heterogeneous unmanned systems for a search mission, which can be expanded for various type of military applications.



Figure 6 Experimentation Results