# MASTER OF SCIENCE
# IN
# COMPUTER SCIENCE

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**VISUAL ANALYSIS OF A RADIO FREQUENCY TRACKING SYSTEM FOR VIRTUAL ENVIRONMENTS**

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A variety of position tracking technologies have been utilized for virtual environments. Each has a different set of strengths and weaknesses which are usually compared on paper with numbers or generic statements. This thesis develops a methodology for the creation of 3D visualization tools to analyze position tracking technologies and their effectiveness under specific conditions. The methodology includes developing the questions, the models, the simulations, the visualization, and the rendering.

This thesis applies the methodology to Advanced Position Systems, Inc.'s RF tracking system which can be easily configured for large volume spaces, unlike any of the other technologies. The analysis asks "How does the positioning of the receivers affect the relative accuracy throughout the target volume?" The model uses the solution to the Time Difference of Arrival (TDOA) equations used by the system and the simulation evaluates the position error throughout the volume with a constant error in the TDOA measurements. Point icons represent the data and the Virtual Reality Modeling Language renders the visualization. The asymmetric error profile revealed by this 3D visual analysis arises from the asymmetric arrangement of the TDOA measurements and is not readily apparent with other analytical techniques.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Simulation, Visualization, Tracking

**VISUAL DATABASE QUERY LANGUAGE**

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Structure Query Language (SQL) is the most widely used query language in the modern relational database management system (DBMS). Its use is straightforward for simple queries, but it gets complicated, hard to comprehend and express for the complex queries. In terms of ease-of-use, Data Flow Query Language (DFQL) represents graphical user interface to the relational model based on a dataflow diagram, and retains all the power of SQL and is equipped with an easy to use facility for extending the language.

With Java's flexibility and power, it is possible to build such a system that allows the users to login any relational database through JDBC, graphically view the database structure, and implement the DFQL to query the data from the database.

The design recommendations and implementation of a prototype are the primary research areas of this thesis.

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**DoD KEY TECHNOLOGY AREA:** Computing and Software

**KEYWORDS:** Structure Query, SQL, Data Flow Query Language, DFQL, Java, JDBC, Database Structure

**RESOURCES REQUIRED FOR ADAPTIVE COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE MODELS IN A HETEROGENEOUS COMPUTING ENVIRONMENT**

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The goal of the Management System for Heterogeneous Networks (MSHN) is to provide a resource management system (RMS) to enable adaptive applications to use multiple sets of shared resources while accounting for dynamically changing priorities and environments. This RMS must be capable of providing each subscriber process with its required Quality of Service (which might include security considerations, deadlines, user priorities, and preferences) in a heterogeneous computing environment in which many processes are competing for shared resources.

Applying this RMS technology to C4I modeling and simulation applications would enable on-scene Commanders to simulate complex elements of the decision process in order to optimize the use of forces and materiel.

The objective of this thesis is to transparently intercept operating system calls made by a robust, C4I modeling application, the Extended Air Defense Simulation (EADSIM), in order to weigh the resources required against the confidence level of the outcomes obtained. Specifically, the goal is to determine resource usage required to run the application using both Monte Carlo simulation and deterministic simulation. MSHN needs this type of information to determine which version of an application to execute, in order to provide the best Quality of Service, while meeting operational deadlines.

**DoD KEY TECHNOLOGY AREAS:** Computing and Software, Command Control and Communications, Modeling and Simulation

**KEYWORDS:** Command, Control, Communications, Computer, and Intelligence, Wrapper, Resource Monitoring System, MSHN, Distributed System, Heterogeneous Computing, Modeling and Simulation, Warfighter, Client Library, Intercept System Calls, Deterministic, Monte Carlo, Stochastic, Quality of Service

**ORTHOGONAL WALL FOLLOWING AND OBSTACLE AVOIDANCE BY AN AUTONOMOUS VEHICLE**

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The purpose of this thesis was to integrate a wall following motion mode for a rigid body autonomous vehicle. Yamabico, an autonomous vehicle located at the Naval Postgraduate School, was used as the test and evaluation platform.

To implement the new motion mode, the vehicle was required to follow a straight wall with minor variations, navigate around corners, and avoid obstacles in its path while maintaining a specified offset distance from continuously connected wall segments. Sonar transmitter/receiver pairs were used to sense the environment and collect positional data for analysis. Modifications to pre-existing motion and sensor software libraries on board Yamabico were performed to achieve the motion goals. One of the major

contributions from these modifications was the addition of a linear fitting algorithm using a decay factor. The algorithm produced quick response by the vehicle to changing conditions in its environment.

The experimental results by Yamabico were successful with the algorithm developed by the author. The result of this thesis is that an autonomous vehicle can be given the capability to perform smooth and efficient motion adjustments to an environment composed of orthogonal wall segments and obstacles.

**DoD KEY TECHNOLOGY AREAS:** Computing and Software, Other (Robotics)

**KEYWORDS:** Autonomous Vehicles, Wall Following, Obstacle Avoidance