Multi Robot Navigation and Mapping for Combat Environment

Functional Description & System Block Diagram

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Introduction

The Multi Robot Navigation and Mapping for Combat Environment project will safely enable a robot to navigate through an indoor or outdoor (urban) combat environment. The idea behind this project is that a relatively inexpensive/expendable robot would first scan an unknown area and relay a map of the area back to central command. Central command would then use that map for safe navigation of a more expensive/comprehensive robot. The overall goal of this project is to guide autonomous supply caravans or troops safely through a combat zone.

The robots that will be used for this project are the Pioneer 3D-X series robots. The 3D-X model has 8 sonar sensors in the front and sides that can get readings from + 90 degrees to -90 degrees. It has two wheels up front that allow the robot to move in any direction and an additional wheel in the back for stability. The first robot will be in charge of mapping the environment and designating a safe route that can be navigated by a second robot while avoiding any obstacles or dangers. The second robot will then use the map generated by the first robot and use a path finding algorithm to determine the best path through the environment that avoids all obstacles and threats.

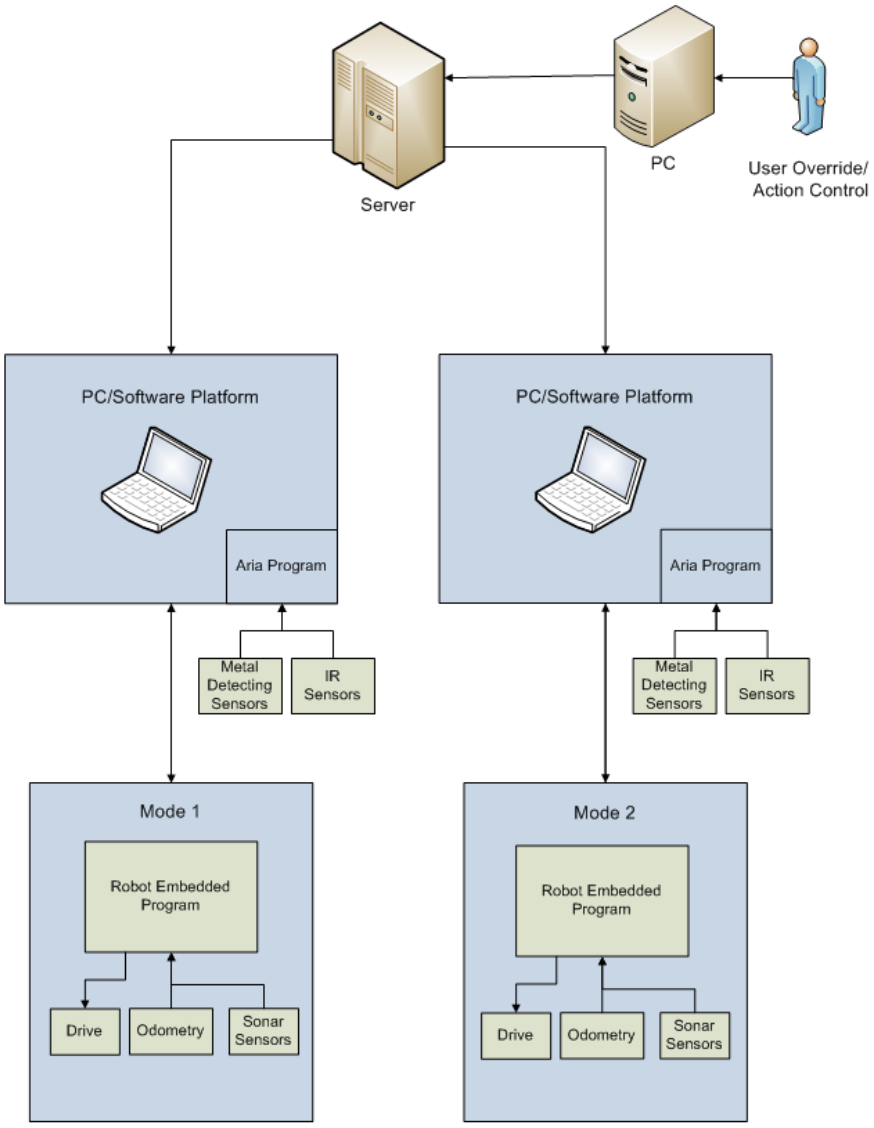
Current Project Goals

- Robot Navigating
    - Find and travel to closest wall/object
    - Position robot in a specific position to wall(s)/object(s)
    - Left/right wall following
    - Determine if sensors more accurate than sonar sensors will be necessary. If so, integrate the sensors into ARIA if possible.
    - Identify appropriate sensors for combat-alike environment
    - Acquire and integrate sensors for simulated combat-alike environment (metal detector?)
    - Develop communication framework allowing server/central command to override local control algorithms and remote control robot
- Environment Mapping
    - Research and develop algorithms to map an unknown environment
    - Research available ARIA or Pioneer robot compatible software for mapping
    - Develop framework to contribute maps to server/central command and update maps from the server
    - Research and develop algorithms to locate robot and its current map within global map available on the server/central command
- Other Tasks
    - Create digital maps of the real-life-alike environments for computer simulation
    - Setup the infrastructure server for multiple robot cooperation/coordination
    - Weekly website update on project progress

High Level System Block Diagram

The high level system block diagram in Figure 1 is divided into two modes with each mode being designated a robot that is interchangeable with the other. Each robot is connected to a laptop via a USB port. The laptop runs the actual C++ program (created in Visual Studio) that will control the robot. A program called ARIA then interfaces the C++ program with the robot. Mode 1 is responsible for mapping the unknown/combat environment and relaying that map to the server via a laptop with a wireless network connection. Mode 2 is responsible for retrieving the map also through a wireless laptop connection and safely navigating through the environment. Another PC is connected to the server in case manual override would ever be required. Additional sensors (IR and metal detection) will be added later and connected directly to the ARIA program.

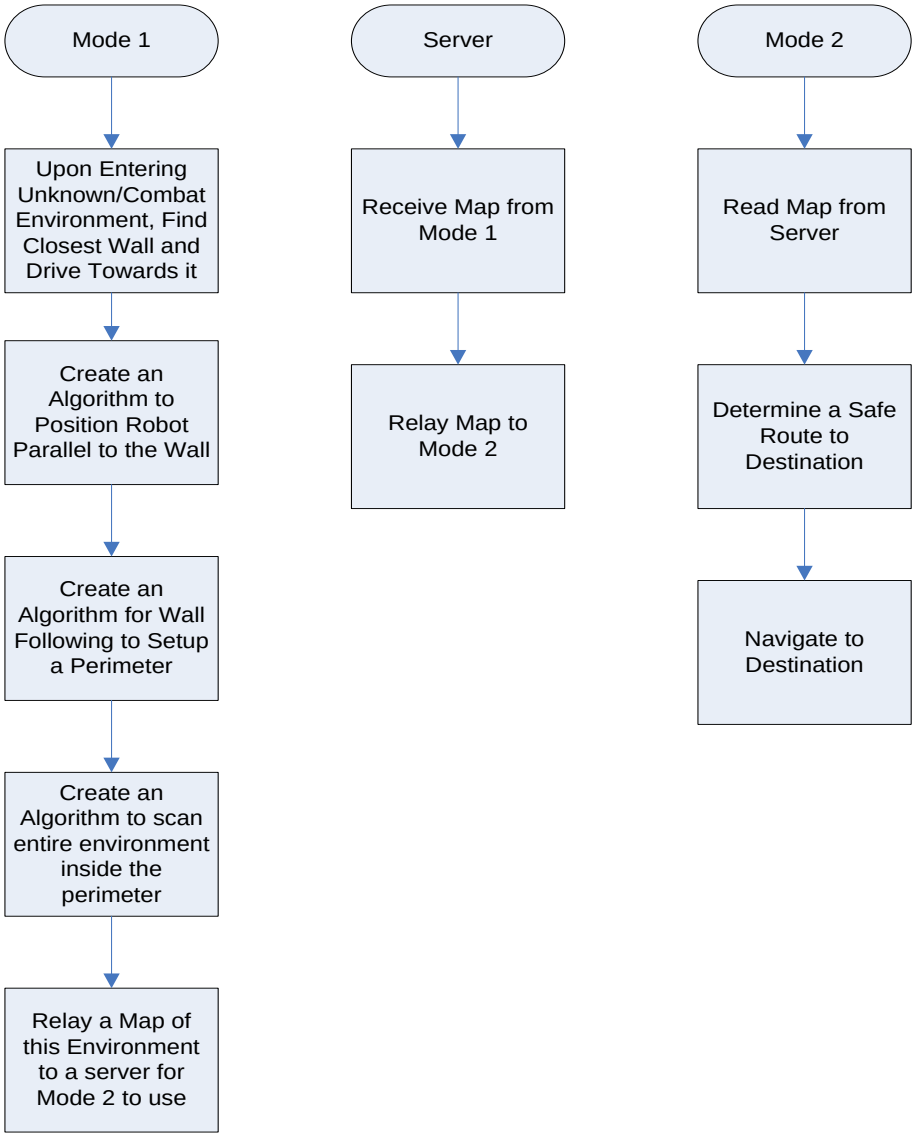
Figure 1: High Level System Block Diagram



Functional Description:

The high level system block diagram is divided into three main subsystems: mode 1, server, and mode 2. The first subsystem is the mode 1 subsystem. This subsystem's prime responsibility is to map an unknown/combat environment and send the map to a central server for storage. The second subsystem is the server subsystem which receives and stores the map from mode 1. When the map is completed, the server then sends that information to mode 2. The last subsystem is the mode 2 subsystem, which reads the map sent from the server. Based on the map received, mode 2 determines a safe route to the destination and then navigates through the environment. These three subsystems are all explained in better detail in Figure 2.

Figure 2: Subsystem Block Diagrams



Conclusion

The design of the multi robot navigation and mapping will require several algorithms in order to map an environment and be able to safely avoid obstacles. In addition, code will be implemented to allow server/central command to override local control algorithms and remote control robot if needed. The final product will be tested on multiple environments that will be simulated and also setup in Jobst Hall.

References

[1] Nourbakhsh, Illah R., and Roland Siegwart. Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents.) London: The MIT Press, 2004.