Human Interface Device for Mobile Robot Navigation

Functional Description and Complete System Block Diagram

Brian Walsh and David Buckles

Advisor: Dr. Malinowski
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Introduction

The Pioneer 3D-X series robot has been used at Bradley University for previous senior projects; the most recent being a project that focused on mapping and navigating a combat environment. This project will continue to expand upon said work by retaining the automated functionality and adding an override feature that will enable users to control the robot with feedback from a glove with gyroscopic and other forms of sensors. Also, data from the sensors will be mapped in 3D in real time and displayed to the user via an LCD eyepiece.

The robot currently uses 8 sonar sensors to gather data from plus or minus ninety degrees. The scope of this project also entails adding a sensor to detect ceiling height, possibly an ultrasonic sensor, as well as implementing the currently unused infrared sensors already mounted on the Pioneer chassis.

The overall purpose for integrating these features into the Pioneer chassis is to create an agent that can operate in a combat environment autonomously or be controlled by the user in real time while mapping the environment and relaying sensor information in an easily comprehensible visual format.

Goals

The goals for this project entail:

- Mapping the robot's current environment in 3D, in real time, and utilizing OpenGL to display the data on an LCD eyepiece to provide visual feedback
- Provide user override of the automated navigation systems via a glove with sensors and software with feature recognition
- Implement infrared sensors
- Implement a sensor (possibly ultrasonic) to detect ceiling height
- Implement a grasping device controllable by the sensing glove
- If time permits, attach a 2 degree of freedom robotic arm to the grasping device, also controllable via sensor glove with feature recognition
- If time permits, implement Potential Field planning as a method for the robot to navigate and map its environment
- If time permits, add force-feedback functionality to the glove that is used to provide feedback from the grasping mechanism or in manual override mode for obstacle avoidance.

Subsystems

The first subsystem is the robotic glove. The sensors mounted on the glove will provide pitch, yaw, and rotational feedback, as well as finger position and tracking for overall hand movement. The force feedback sensors would be located on each of the fingers.

The second subsystem is the microcontroller. The microcontroller will obtain data from the sensors located on the glove and transmit them to the laptop, as well as controlling the force-feedback sensors used with the grasping mechanism.

The third subsystem is the laptop, which will interpret sensor data from the robot, provide the algorithms used in autonomous mode, and map the data from the environment from the sensors and display it on a user eyepiece.

 The Pioneer robot subsystem shall gather data about its surroundings using ultrasonic and infrared sensors and transmit this data to the computer, as well as receive commands from the computer for either navigational mode.

Figure 1.0 illustrates the software flowchart implemented by the laptop subsystem and Figure 2.0 illustrates the overall functional system block diagram.
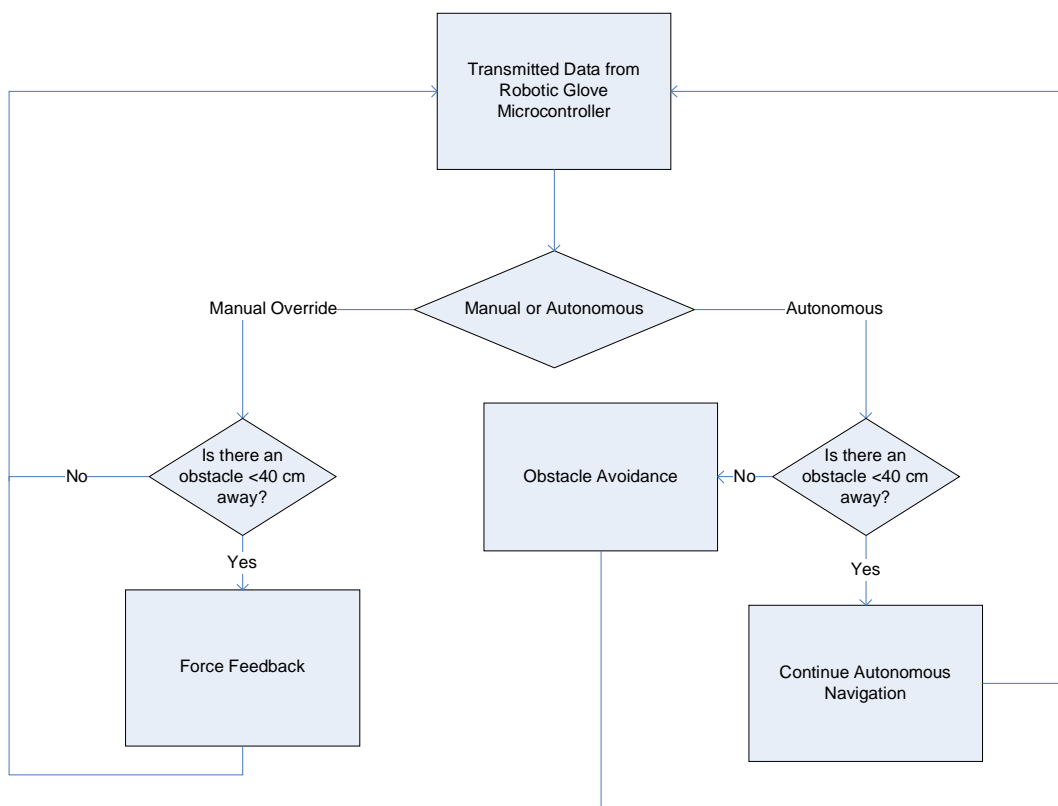
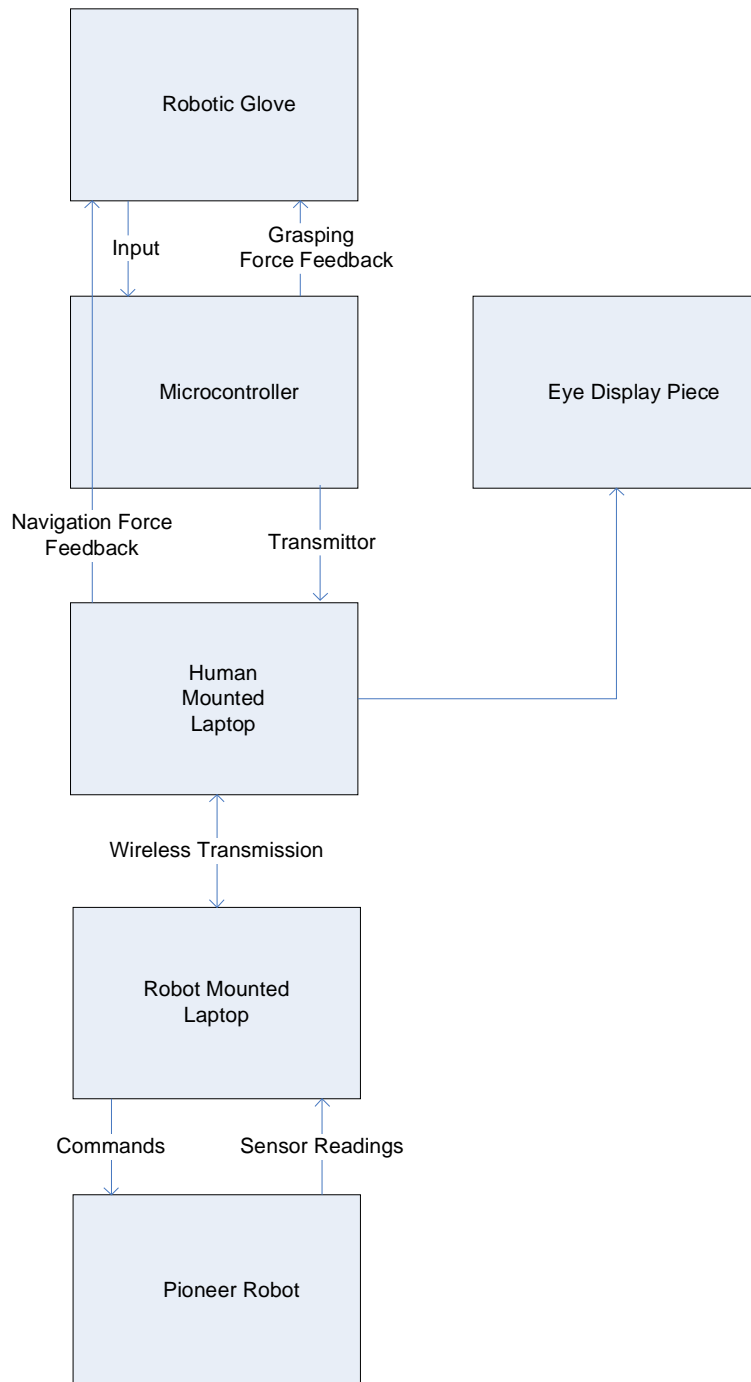Figure 1: Software Flowchart for the Laptop Subsystem

Figure 2: Functional System Block Diagram

Conclusion

This system will enable users to map and navigate an environment utilizing a Pioneer series robot in autonomous or manual override mode. The user will be provided with visual feedback via an LCD eyepiece, and, time permitting, force feedback via glove. The user will be able to control the robot in manual override mode by using the sensor glove, which will be equipped with feature recognition.

References

[1] Nourbakhsh, Illah R., and Roland Siegwart. Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents.) London: The MIT Press, 2004.
[2] Tipton, Scott, and Nick Halabi. Multi Robot Navigation and Mapping for Combat Environment: Functional Description and System Block Diagram. Bradley University, 2009