Human Interface Device for Mobile Robot Navigation

Functional Requirements List and Performance Specifications

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Introduction

The overall purpose for integrating features onto the Pioneer 3D-X 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. This project seeks to use ultrasonic and infrared sensors to gather information about the mobile agent's environment. This data can be used directly by the robot in autonomous mode or relayed visually to the user via an LCD eyepiece. In manual override mode the robot is controlled using a sensor glove that detects hand motion and recognizes gestures.

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.

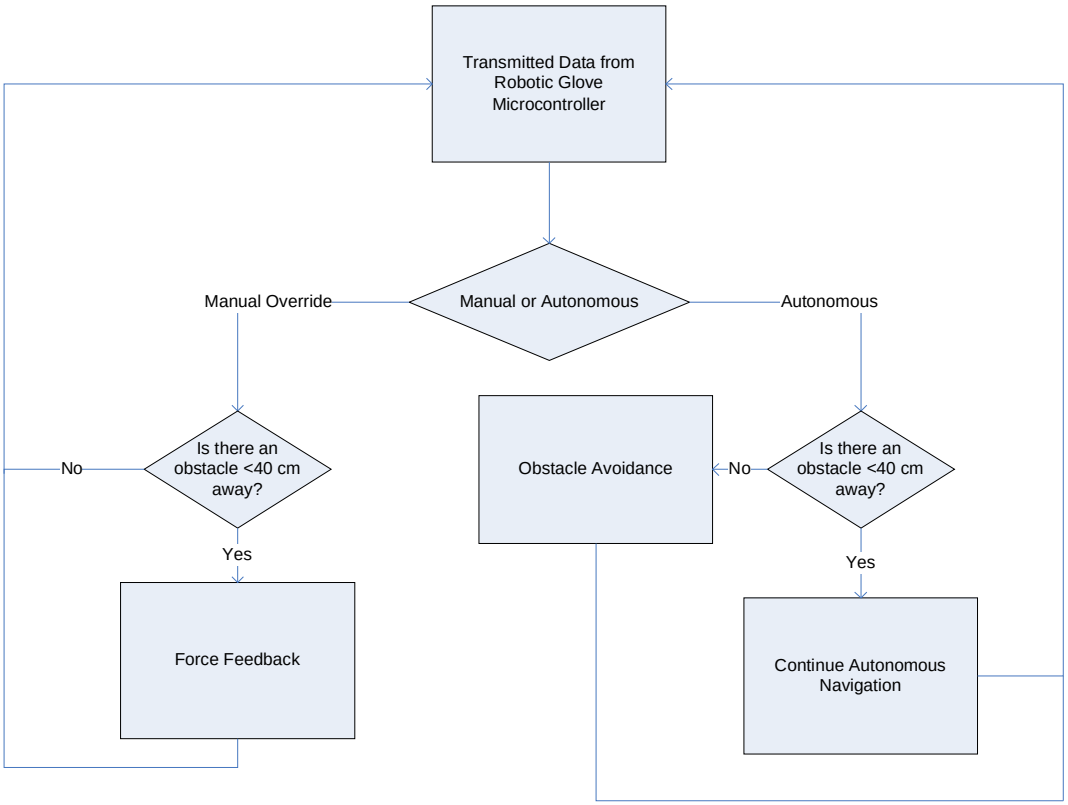

Figure 1: Software Flowchart for the Laptop Subsystem

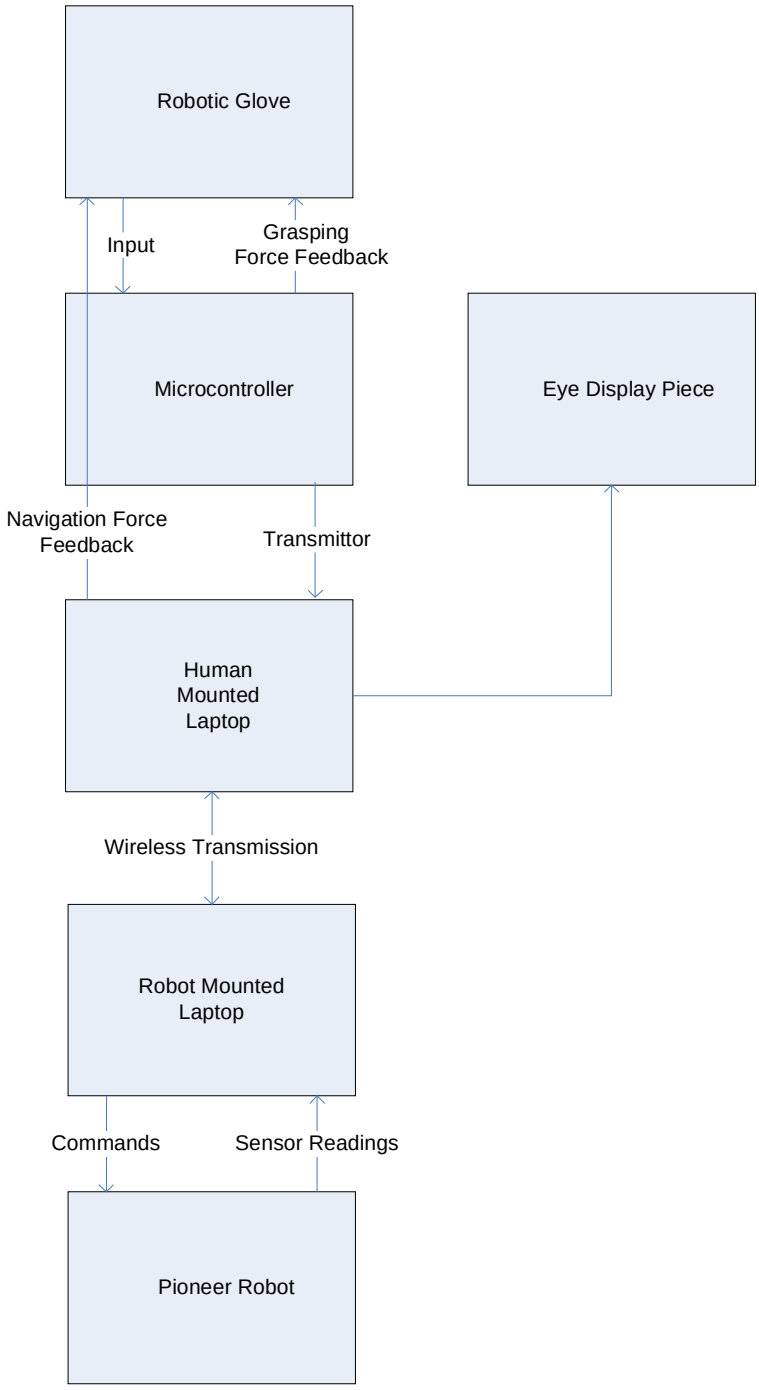

Figure 2: Functional System Block Diagram

Functional Requirements

- This system shall be able to operate in autonomous or manual override mode
- Mode shall be selected using feature recognition from the glove
- A sensor glove shall be able to detect the flex of fingers
- A sensor glove shall be able to detect the orientation of the hand

- A sensor glove shall be able to pick up a shift in position of the user's hand utilizing gyroscopes, accelerometers, digital compass, and whatever else may be necessary to attain a usable amount of precision
- Motion of the feedback LCD eyepiece shall be detected utilizing gyroscopes, accelerometers, digital compass, and whatever else may be necessary to attain a usable amount of precision
- This motion shall be used to control the perspective of the visual feedback
- The robot shall be able to autonomously navigate by potential field planning
- The robot shall be able to take manual directional controls from a sensor glove
- The LCD eyepiece shall display the environment found by sensors on the robot using openGL
- The environment will be mapped using infrared sensors for wall, and a single sonar sensor for the ceiling

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