Human robotic interaction with a semi-autonomous robot for collapsed building situations

Abstract

To reduce the chance of injury for surveyors and rescuers, a ground robot is currently under development to be placed in a building for initial inspection and to add to current Urban Search and Rescue (USAR) research. The ground robot’s model is a PhantomX AX Hexapod Mark II. The hope is to utilize the spider-like leg movement and analyze the model’s feasibility for moving around uneven terrain. The ground robot is equipped with a Asus Xtion Pro Live camera to use the infrared, depth, and color image sensing to determine how the robot can navigate various types of terrain autonomously. Also, the ground robot will be equipped with a Raspberry Pi 2 model and OpenNI2 and OpenCV libraries that can implement a wireless camera feed for a human to view from a remote location in order to make a real time assessment of the situation and take over robot control if necessary. Different simultaneous localization and mapping (SLAM) methods and collision avoidance algorithms are being investigated for use with the Asus Xtion Pro camera to achieve efficient image processing.

Background & Objectives

The primary objective is to reduce danger in collapsed buildings. The goal for the robot is to achieve the following:

- To have the ability for autonomy through image processing
- To have human control in case of robot malfunction

All hardware and software used in this project is available either commercially or as an open source product.

Approach

The kit for the Phantom X AX Hexapod Mark II comes with an Arbotix Commander remote control and an Arduino-Compatible Arbotix Robocontroller that can be set with Phoenix code firmware that is already provided on the hexapod’s documentation from Trossen Robotics. The firmware allows the robot to walk, to rotate, and to change elevation of the robot’s base. [4] Navigation modes are toggled using the Commander, but for autonomy, the navigation modes will be created to work together. The hexapod can be seen in Figure 1.

In order to compensate for the small room available on the robot, the Asus Xtion Pro Live camera was chosen due to the use of a USB connection for power. The camera can be seen in Figure 2. The camera will be connected via a USB Port to a Raspberry Pi 2 that runs a Linux operating system. OpenCV and OpenNI2 libraries will be installed onto the Raspberry Pi 2 in order to translate the data received from the camera into a video feed. [1] [2] PuTTY is a SSH client that will be used to create a Wi-Fi connection between the devices so the video feed can be seen on a remote computer. [3] The communication can be seen in Figure 3.

Discussion

The Xtion Pro Live camera runs with OpenCV compiled with OpenNI2 on the computer but achieving cross compiling on the Raspberry Pi 2 has proved more of a challenge since multiple dependencies must be installed. However, data on the distance from the camera to an object can already be found using the Raspberry Pi 2 by using code provided with the OpenNI2 library. Before any SLAM methods or other object detection algorithms can be implemented, this major problem will need to be addressed.

Conclusion

All of the major components of the project work individually, but more research is required to ensure efficient compatibility between all the hardware and software. One insurance is to have all image processing solely on the Raspberry Pi 2 and all navigation commands only on the Arbotix Robocontroller.

Future Work

- Finalize integration of Phantom X AX Hexapod Mark II with the Raspberry Pi 2 and Asus Xtion Pro Live camera.
- Adjust navigation firmware to use preset modes as a single mode
- Begin preliminary testing of object detection algorithms with integrated robot.

Example of current camera detection can be seen in Figure 4.

References


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