Obstacle Avoidance Using Dual Sensors: Xbox Kinect and Ultrasonic Transducer

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Introduction

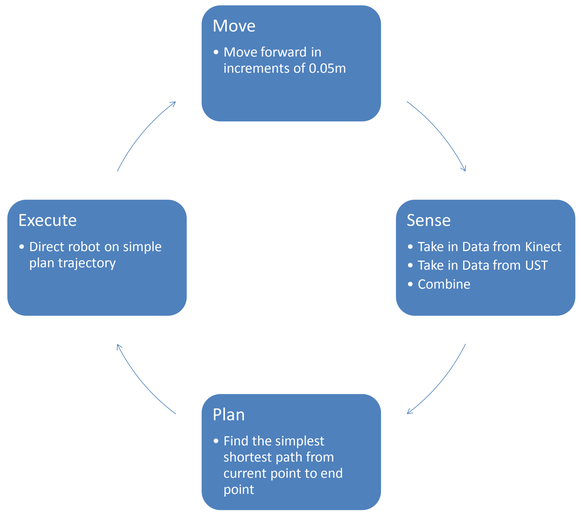
In this project, we sought to improve the "vision" of our robot by utilizing a dual-sensor array as opposed to a singular sensor. We sought to use two sensors that complimented one another and in this, we focused on the ranges of the respective sensors. We chose to pair the Kinect camera and the Parallax Ping))) Ultrasonic Transducer for the fact that the Ultrasonic Transducer has a minimum range of 0.03m while the Kinect had a minimum range of 0.8m. What this means is that if the obstacle is closer than 0.8m, the Kinect cannot sense it at all. However the Ultrasonic transducer has problems with resolution at longer range sensing.

Figure 1. Vision from Kinect Camera of two obstacles

The above figure demonstrates the depth mapping made by the Kinect camera of two obstacles placed in front of it with a gap. The Kinect forms the depth map by using a known pattern of infrared light and infers the distance from the changes in the known structure[1]. The Ultrasonic Transducer emits pulses of sound waves and measures the time from emittance to reception to infer distance.

[1] MacCormick, John. "How Does the Kinect Work?" Web. 10 Apr. 2015. <http://www.cs.bham.ac.uk/~vvk201/Teach/Graphics/kinect.pdf>

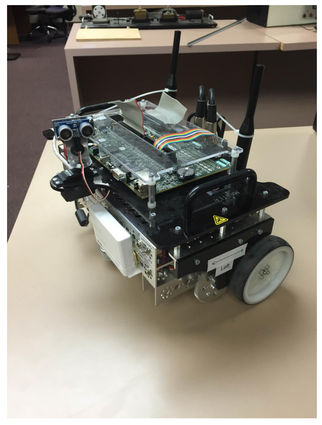
Implementation



Our initial implementation takes one of the most basic approaches to the problem of obstacle avoidance. In this, we simply move in small increments of approximately 0.05 m forward until an obstacle is detected to be in the projected path. The obstacle mapping is where we change things up from a basic approach since we have two sensors instead of one. The logic here is:

1. Sense obstacles <0.8 m away by the Ultrasonic Transducer
2. Sense obstacles >0.8 m away by the Kinect Camera
3. Combine the two obstacle mappings into a single array of obstacle values
4. Check the array vs the projected path, correct path if needed

Hardware



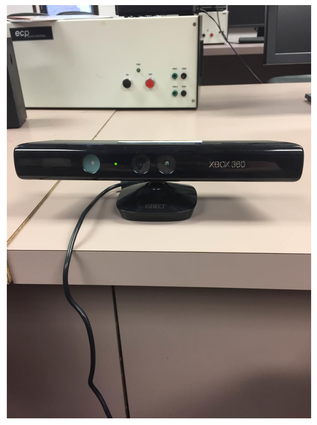


Figure 2. SB-RIO robot with Ultrasonic Transducer (left) and Xbox Kinect Camera (right)

Conclusions

So far there have been some promising results from the sensors as we have been developing the algorithms to make the robot move. We have already found and identified a few areas of improvement for the future:

- The Movement algorithm: We know of some better algorithms to utilize but the implementation of these would likely mean an overhaul of our existing code.
- Computing: At the current time, the Kinect must interface with a laptop, resulting in a less compact robot. This could possibly be addressed

We hope to continue work on this in the future to see tangible results of the benefits of the pairing.