Simultaneous Localization and Mapping by Cooperative Robots

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SLAM

- Is it possible to place a mobile robot in an unknown environment and for the robot to incrementally build a map of its environment while determining its position within that map?

Source: H. Durrant- Whyte and T. Bailey, *Simultaneous Localization and Mapping: Part 1, 2006.*

Advantages of Cooperation

- Potential for diverse vehicle cooperation
  - Land, air, and sea
- Faster more fault tolerant mapping
- Having overlapping information, which can compensate for sensor uncertainties

Multiple Robot Control

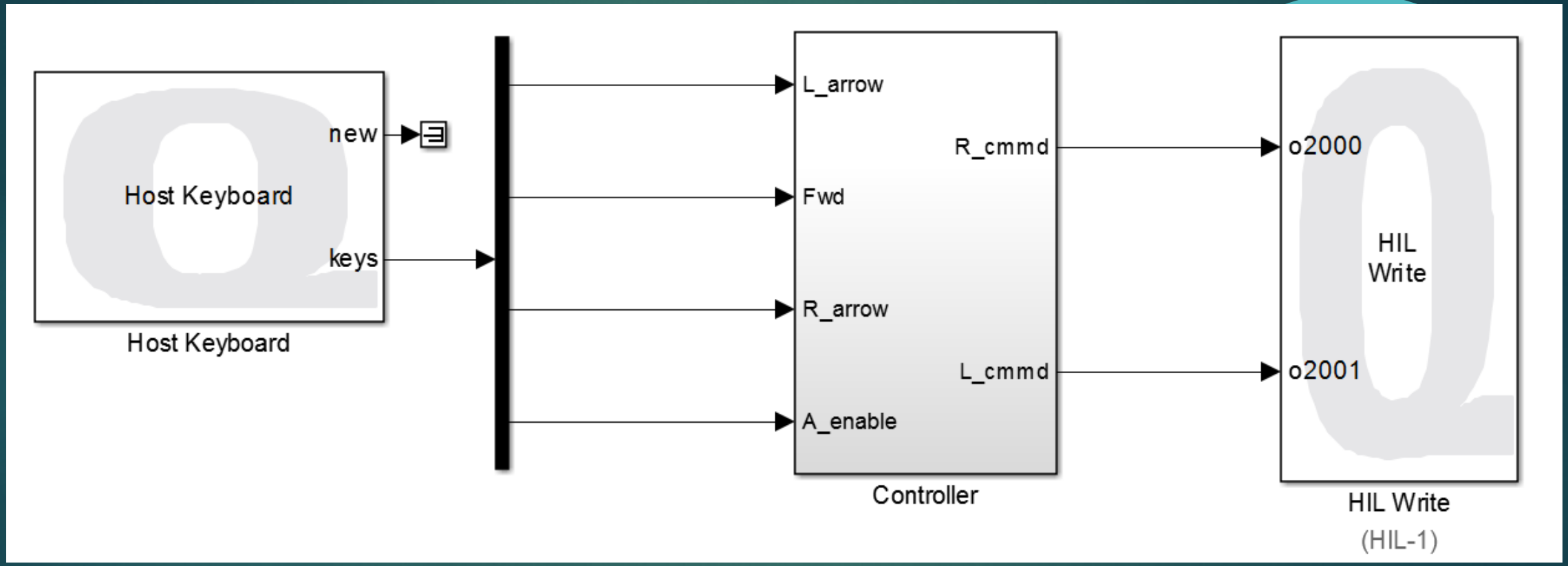

Figure 1: Keyboard Control

Multiple Robot Communication

- Wheel encoders
  - Determine planar coordinates and heading direction
- Kinect sensor

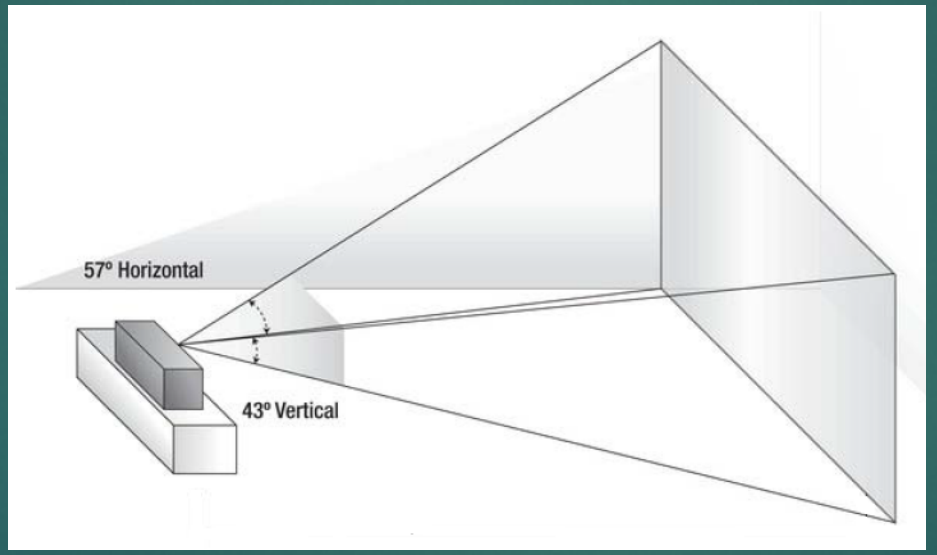

Figure 2: Kinect Field of View

Source: http://talkingaboutme.tistory.com/609

Map Building

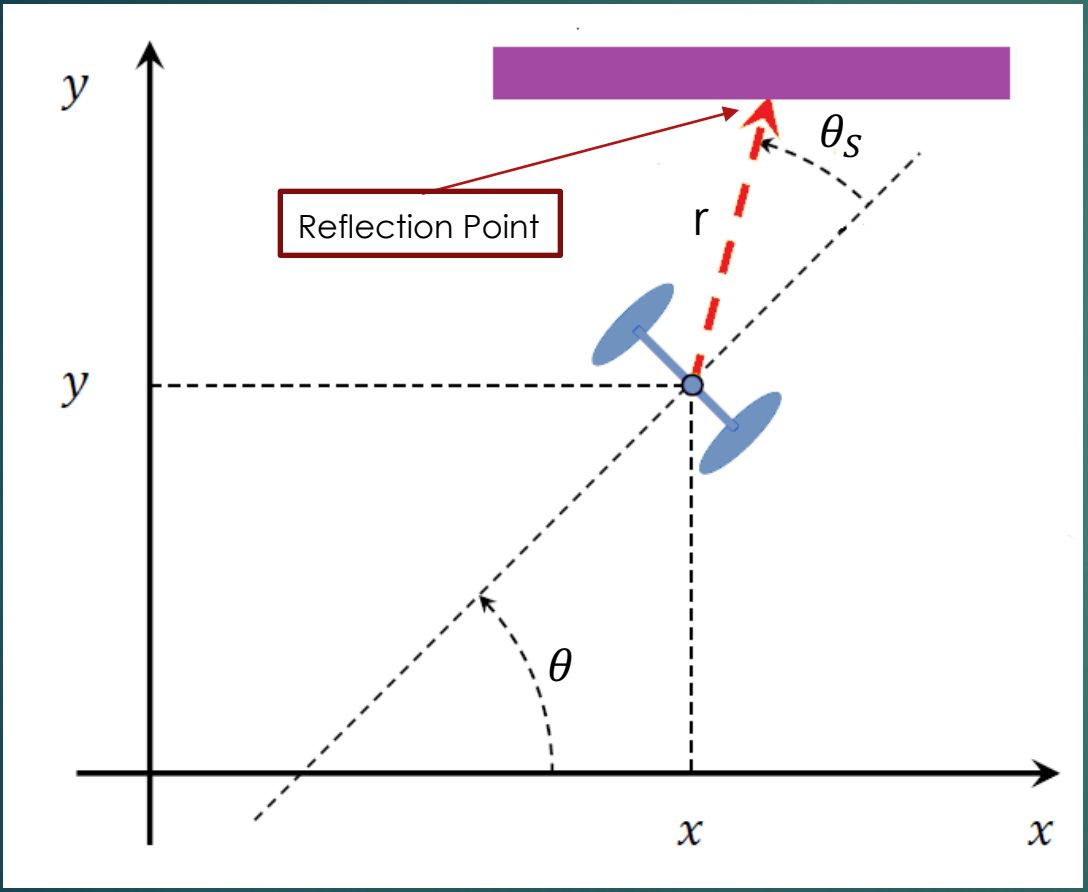

Figure 3: Coordinate Transformation

The location of the reflection point is:

$$x_{rp} = x + r * \cos(\theta + \theta_S)$$

$$y_{rp} = y + r * \sin(\theta + \theta_S)$$

Map Building

Figure 4: Mapped Environment

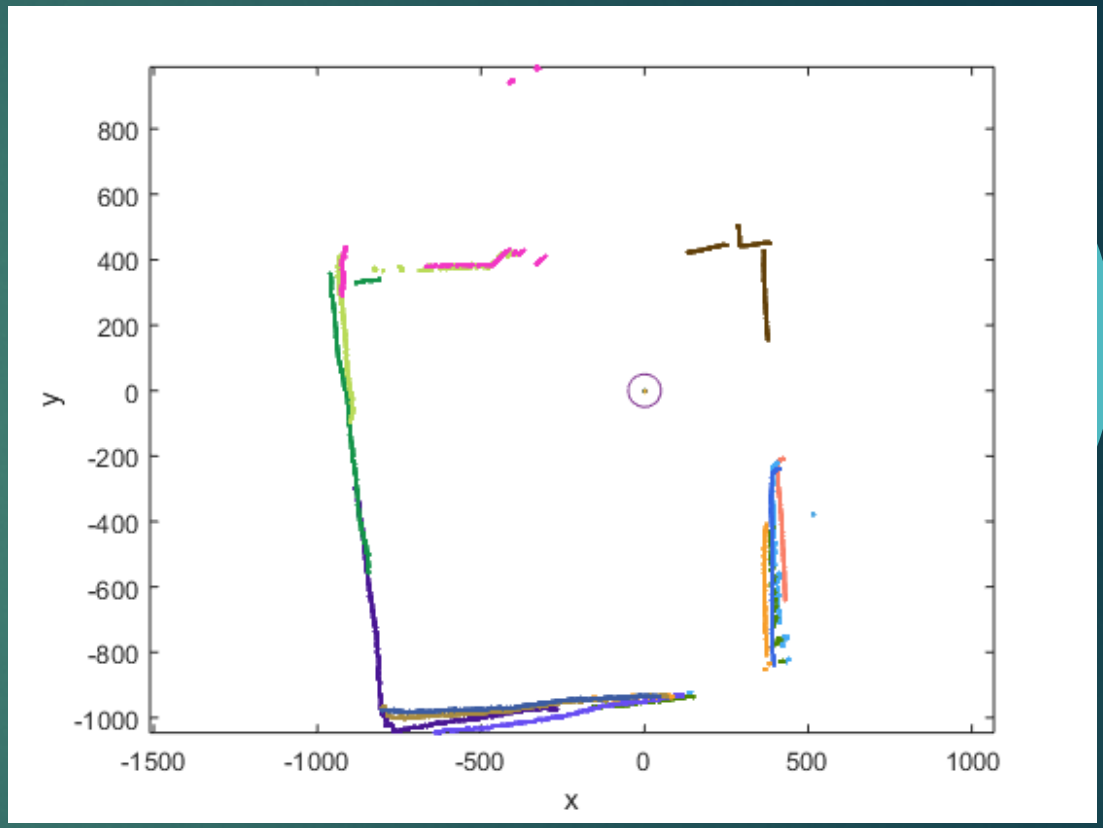

Figure 5: 2D Map

Map Building

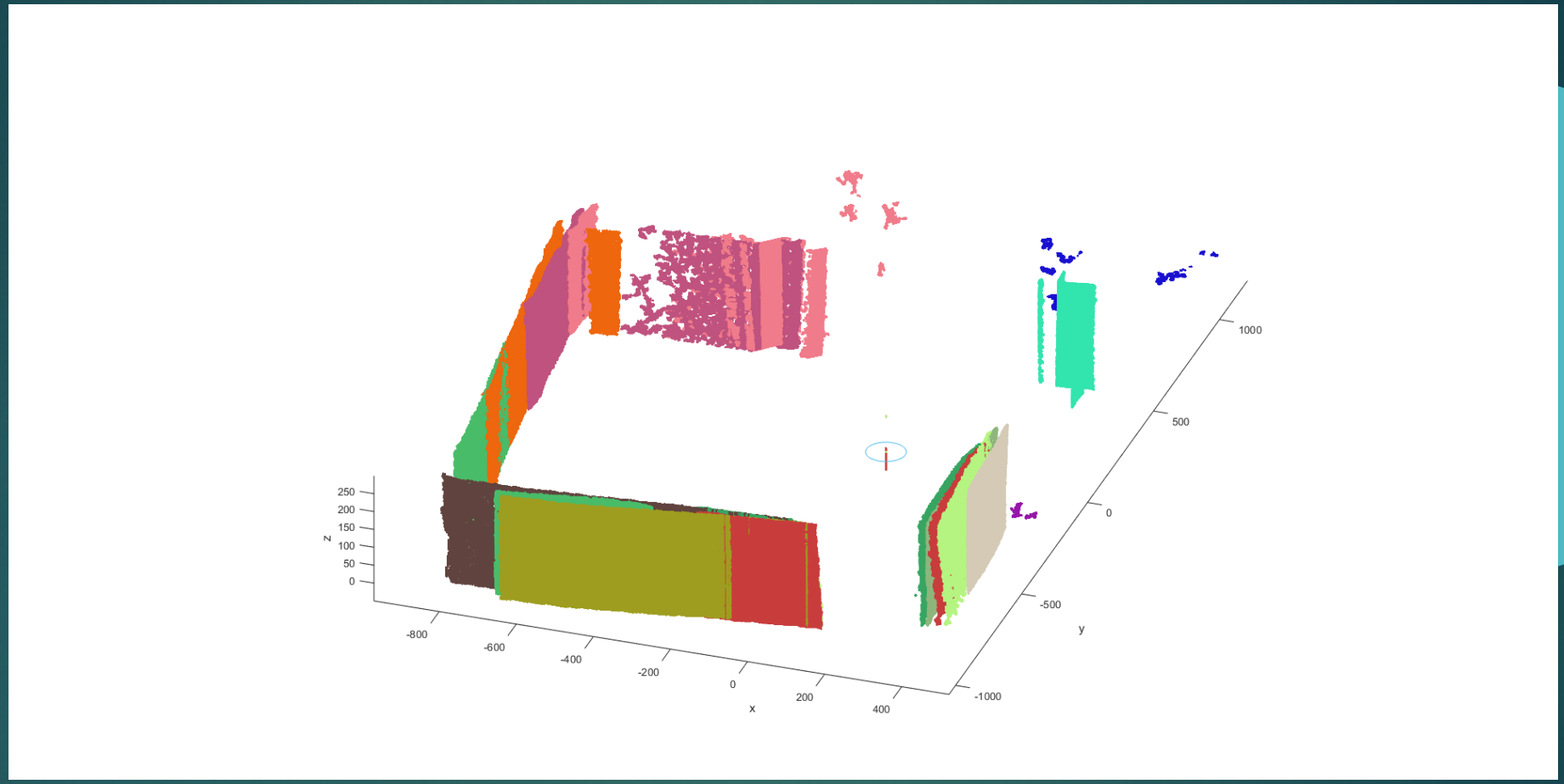

Figure 6: 3D Map

Moving Object Detection

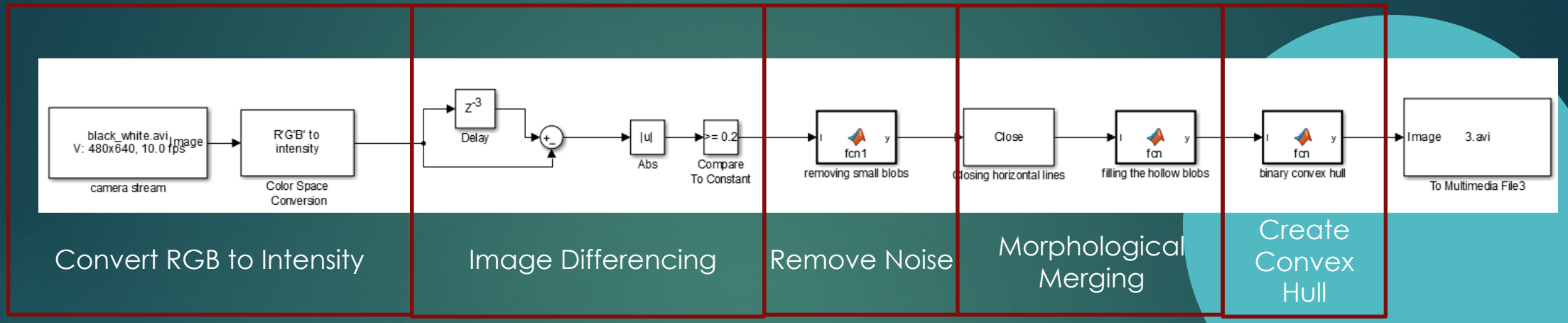

Figure 7: Moving Object Detection Flowchart

Figure 8.a: Original Video

Figure 8.b: Frame Subtraction

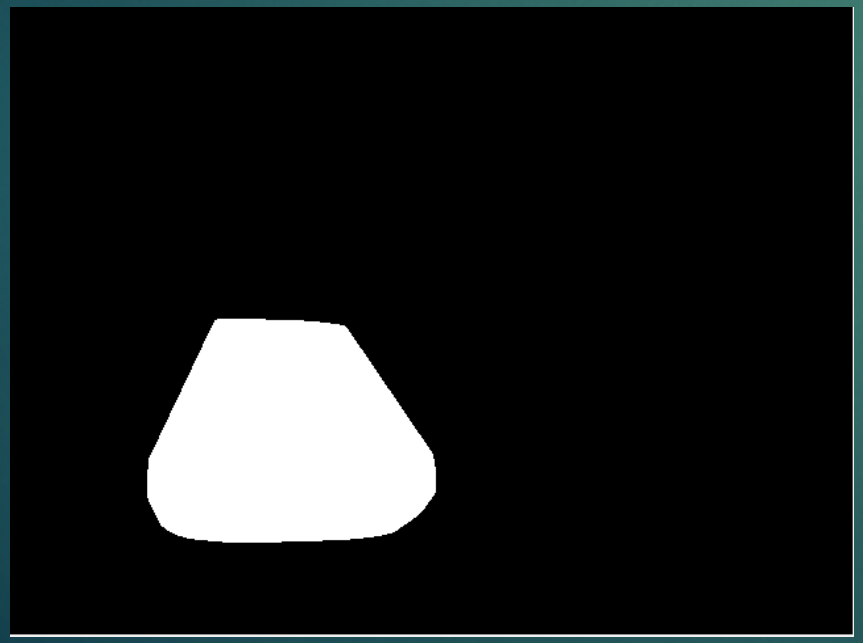

Figure 8.c: Convex Hull

Figure 8.d: Moving Object Removed

Robot Identification

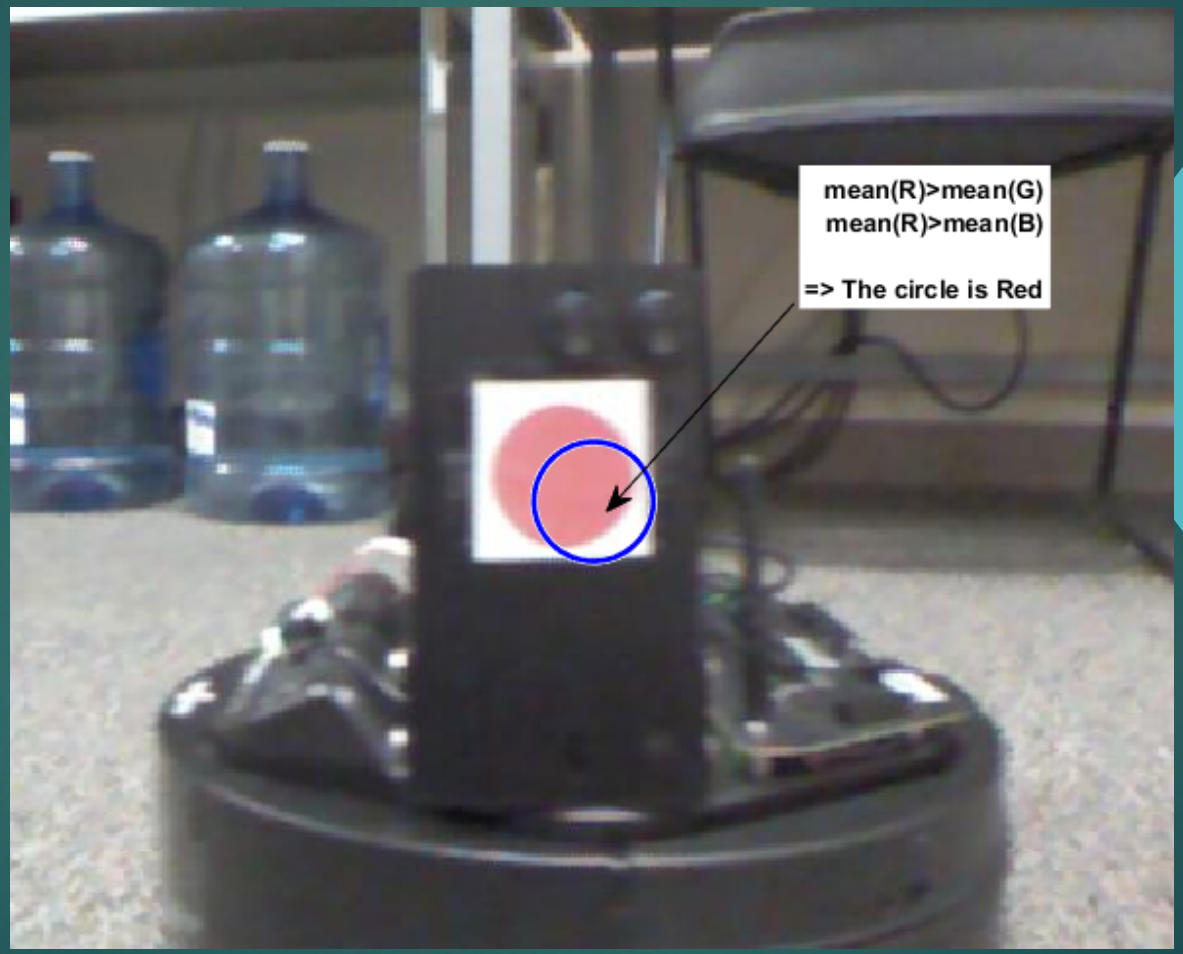

Figure 9: Robot identification

Future Steps

- Improving object detection and identification
- Combining individual maps
- Gaining familiarity with sensor fusion
- Implementing cooperative SLAM

Conclusion

- Control and communication with multiple robots
- Map making with individual robots
- Moving object identification and removal from the maps