Obstacle Avoidance System for the ROSS USV

THE ROSS USV

The ROSS Unmanned Surface Vehicle (USV) collects oceanographic data on salt/fresh water interfaces to better understand how these systems interact with ocean currents. These interfaces are commonly found near glaciers where melting fresh water ice meets ocean salt water. The ROSS USV was built as a safe means of collecting data from the inherently dangerous glacial environment.

An Object Avoidance System allows ROSS to maneuver around icebergs and other ocean vessels reducing the chance of equipment damage both to the USV and other ocean traffic. This is especially useful for the systems next mission in the Gulf of Mexico where small fishing boats without transponders will be prevalent.

Oregon State University

Unmanned Surface Vehicles (USVs), such as Robotic Oceanographic Surface Sampler (ROSS), must be able to avoid obstacles in their path to prevent equipment damage and as a safety measure for other maritime vessels. The Autonomous Vessel Vision System (AVVS) utilizes a front facing monocular camera stereo and a SSD neural network to Identify potential obstacles and report them to the ROSS's operators. This is a first step in creating a fully autonomous object avoidance system which is planned for development next year.

Figure 1. Object Bounding Box and Classification

OBJECT DETECTION AND CLASSIFICATION

Our object detection uses a pre trained neural network made specifically from maritime environments.

The pre trained neural network was created from the Singapore Maritime Dataset - a dataset providing videos and ground truth information of on-board and on-shore data.

The neural network is used with the object detection algorithm SSD Inception v2, an efficient single-shot detector. Each frame in a video feed is analyzed with the neural network to provide bounding boxes around the detected objects.

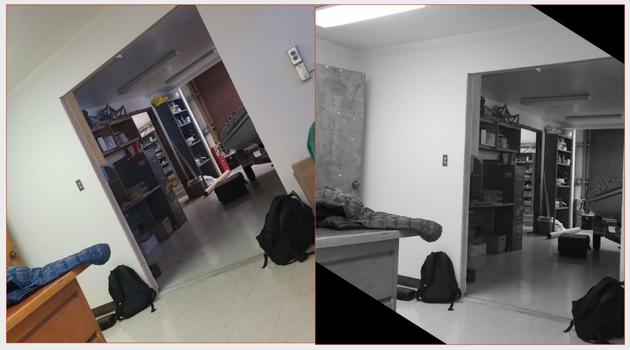

Figure 2. Left: Unaltered input frame (skewed roll ~30°). Right: Corrected Image

IMAGE CORRECTION

As the ROSS vessel traverses through the open waters, images taken from the camera are skewed due to the vessel being at different orientations the moment the image was captured. The skewed images affect the object detection and tracking, so they must be accounted for.

We use an Inertial Measurement Unit (IMU) sensor to determine the pitch, yaw, and role of the ROSS in real time. Using the IMU data, and specifications about our camera's optical properties such as field of view, we are able to correct and stabalize images taken during operation.

ACKNOWLEDGEMENTS

- Max Harkins, Chris Patenaude, Tobias Hodges, Michael Gabriel, Greg Sanchez.
- harkindo@oregonstate.edu, patenauc@oregonstate.edu, hodgesto@oregonstate.edu, gabriemi@oregonstate.edu, sanchegr@oregonstate.edu
- Client: Dr. Jonathan Nash, CEOAS

Detected object position is reported back to the client system as a compiled list of degrees from the ROSS's current heading. This is done by calculating the degree value per pixel of the camera and multiplying this scalar value by the distance in pixels from the centerline (see figure 3).

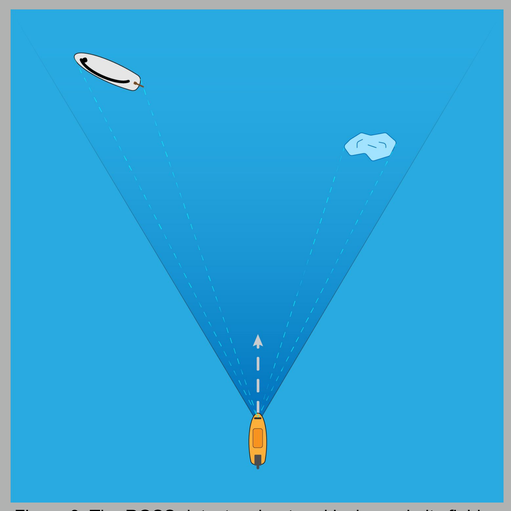

Figure 3. The ROSS detects a boat and iceburge in its field of view. An angle is calculated between the ROSS's heading and and the detected objects.

Team Photo (from left to right): D. Max Harkins, Chris Patenaude, Tobias Hodges, Michael Gabriel, Greg Sanchez.