Background of competition and boat:

The Association for Unmanned Vehicle Systems International (AUVSI) will be hosting the 7th Annual RoboBoat competition in July of 2014. The competition requires autonomous boats to navigate through obstacle courses held in a large pond. In addition to designing and building an autonomous platform, students are also required to create a webpage, write a journal paper, and give a presentation of their boat. Highest scoring teams and clever designs win cash prizes for teams.

Fig 1 2013 RoboBoat champion.

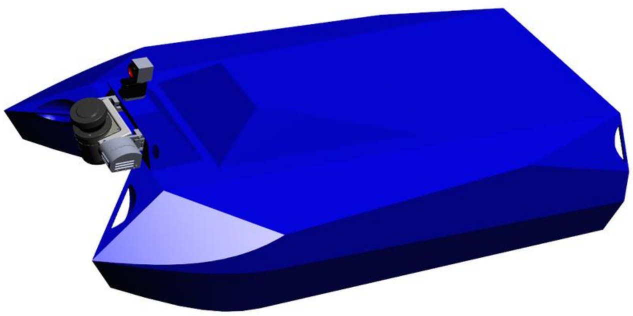

Fig 2 CAD of student designed fiberglass shell for the 2014 RoboBoat competition.

The University of Florida competed for the first time in 2013 with PropaGator (figure 1). PropaGator consisted of a catamaran design with four trolling motors for propulsion. A scanning laser, inertial measurement unit, and machine vision camera provide the boat with the ability to sense its environment. The Robot Operating System (ROS) enables PropaGator to tie all of the sensors together in software. While the 2013 boat was a winning platform (RoboBoat 2013 champions), a newer and better boat is in the works. The new boat hull (see Figure 2) will be fabricated and constructed by students and will feature a student developed propulsion system. One of the limitations of the new hull will be a minimum detection range of 0.5 m using the LIDAR. LeddarTech's new LEDDAR could be used as an accessory to the LIDAR allowing significantly reduce the minimum range and also give us a redundant system for longer ranges for a more robust solution.

How we tested:

The LEDDAR was tested in both indoor and outdoor environments. Indoor testing was conducted in a large room and in a long hallway. Both were lighted with florescent lights and had ambient light from the sun. The first test, shown in Figure 3, targeted a person in our lab. A computer screen shows the LEDDAR returns. The second test targeted a RoboBoat competition grade Polyform A0 Buoy to measure the sensing range of the LEDDAR. The buoy was suspended from a beam at a height equal to the LEDDAR. Using the beam, the buoy was maneuvered to determine the maximum detection range of a small object. Next, the maximum range of a human size target holding a 4'x1.5' wooden panel was measured.

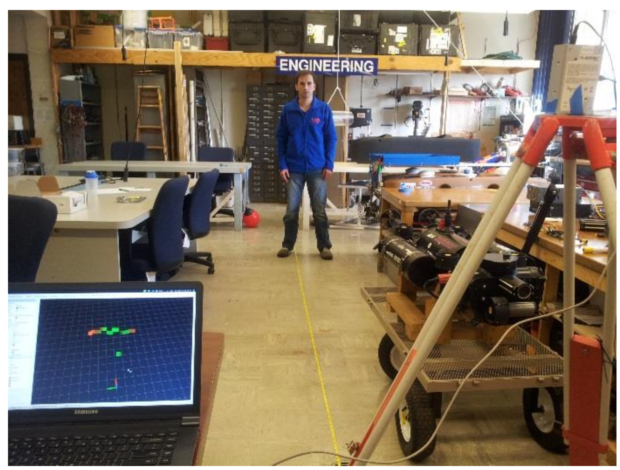

Fig 3 Visualizing the LEDDAR data using RVIZ.

(The panel is shown in Figure 4). The panel was held at the same height as the LEDDAR. The long hallway used was greater than 50 m long. To measure the maximum range, an individual holding the panel walked away from the LEDDAR until no longer detected.

Fig 2 While the sun caused some noise, the ranging from the LEDDAR was still accurate.

The LEDDAR was also tested with the same wooden panel, but outside at 3 p.m., a time when the sun was directly behind the test object and facing the LEDDAR. The maximum outdoor range was not measured.

Results:

Results from the tests were visualized using ROS visualization (RVIZ). RVIZ visually provided the bearing and range of each of the 16 returns. Additionally, the strength of the return was characterized using different colors. Green represented a strong return while red represented a weaker return.

When tested indoors, the LEDDAR was able to reliable measure a red and yellow buoy out to four meters. From four to five meters the buoy return flickered. Beyond five meters, the sensor was unable to detect the buoy. When the buoy was moved perpendicular to the LEDDAR and was close to the back wall, a return at the average between the buoy and the back wall was noticed. Returns from the back wall were very consistent and had very low noise.

In the hallway, the individual holding the panel could be detected out to 19 m. From 19 m to 21 m the return flickered. Beyond 21 m, the individual did not create a return. Because the sensor was unable to detect the back wall (> 50 m) averaging was not detected. The return values had very low noise. Immediately after starting the RVIZ simulation of the LEDDAR returns, IR interference from the sun was apparent. Returns from the back wall 18 m away carried more variance compared to the indoor tests. While noticeable, the noise did not prevent the LEDDAR from accurately detecting the individual holding the panel out to 18 m. Testing beyond 18 m outdoors was not conducted. When testing the minimum range of the sensor, weak reflections (ghosts) were observed at twice the distance of the individual, as described in Figure 4. Cause for the weak signals were not apparent beyond interference from the sun.

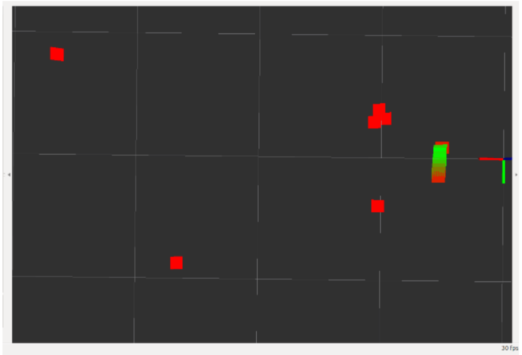

Fig 3 With the LEDDAR on the right facing the left, false returns or "ghosts" were observed. The green object is an actual object. The ghosts can be seen to the left and right behind the object.

Pros/Cons:

After testing the LEDDAR, the team found several useful attributes of the sensor. The 50 Hz refresh rate provided a very fluid model of the LEDDAR's field of view. The LEDDAR's compact design and light weight will allow for easy mounting directly to the boat or using a small gimbal. Detecting large objects out to 20 m provides ample distance for the maneuvering requirements of our boat. Because of the small minimum range, PropaGator will be able to use the sensor for docking

While the LEDDAR proved to be a powerful sensor while still being affordable, several limitations reduced the usability of the system. With only 16 beams, the data received created a very coarse image. Small objects fell in between the beams or were averaged with the background. The narrow field of view at 45 degrees was also limiting.

How we can use the LEDDAR:

Because of the long detection range of large objects, PropaGator can use the sensor to detect the shoreline and floating docks. The small minimum range capability will assist PropaGator in the required docking maneuvers. Because of the competition's docking requirement, the LEDDAR will most likely be mounted to the front of the boat. A gimbal may be required to ensure that the sensor does not miss objects while the boat pitches.

Comments and future work:

Future tests will be conducted to determine the effect of water on the IR returns. The SICK LIDAR we are currently using on the boat does not detect water in the calm water conditions that we have experienced. Waves may add noise to the LEDDAR (and LIDAR) returns.

The team has considered using the LEDDAR underwater using green LEDs. However, removing the current IR LEDs will reduce the range out of the water. Because of the range reduction, any tests using the sensor underwater will be placed on hold until above water tests of the LEDDAR have been completed; a second LEDDAR might be required for the underwater experiments. At the time of this writing, the ROS driver to test the sensor is still in beta testing. Sometimes multiple connection attempts are required to achieve communication with the sensor.

Links:

A ROS (Hydro) driver has been uploaded to GitHub at the following link:
https://github.com/uf-mil/software-common/tree/master/leddartech_evk_driver

PropaGator Website:
http://mil.ufl.edu/propagator/

AUVSI RoboBoat 2014 Competition Website:
http://www.auvsifoundation.org/foundation/competitions/roboboat/