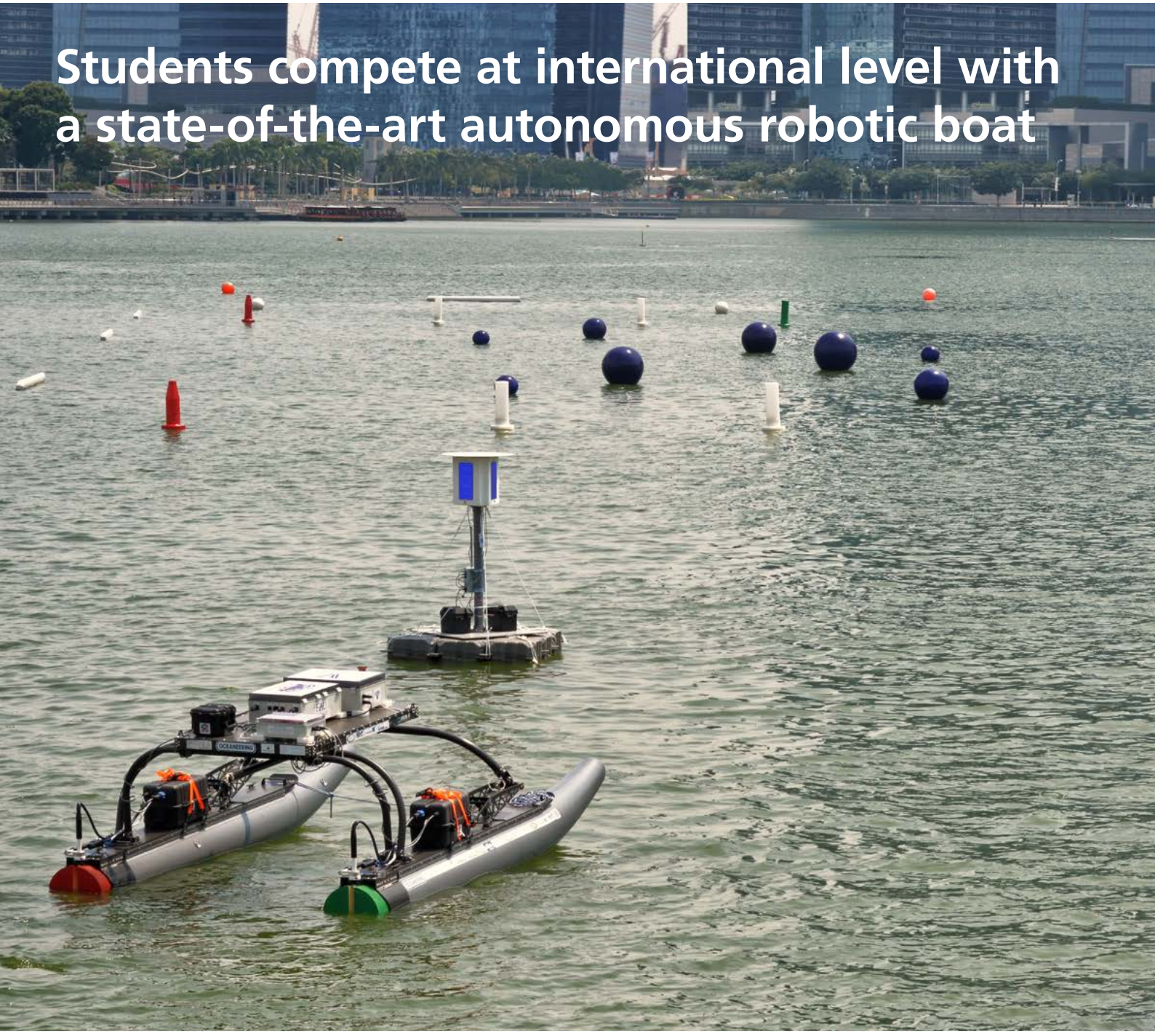
Villanova University

Students compete at international level with a state-of-the-art autonomous robotic boat



speedgoat
real-time simulation and testing

VILLANOVA UNIVERSITY

Students at Villanova University are developing a boat that uses a fused LIDAR/video vision system as the primary means of making navigational decisions to compete in international competitions

Autonomous vehicle technology is a rapidly growing interdisciplinary field due to its great potential for advancing industries in both the military and civilian sectors. With the ability to operate completely independently of human input, autonomous vehicles offer unique solutions to a variety of problems.

Villanova's team competes in both the Association for Unmanned Vehicle Systems International's RoboBoat competition, as well as the Maritime RobotX Challenge (the latter in partnership with Florida Atlantic University). The missions these vessels must complete are task oriented, focusing on key challenges that a boat would face at sea.

RoboBoat

Hosted annually in Virginia Beach, the RoboBoat competition is for small scale boats with a maximum size of 6ft (1.80m) in length, 3ft (0.9m) in width, and 3ft tall. Each team must construct and outfit their own vessel with the sensors, actuators and controllers they require to complete the year's tasks. The vessel must weigh less than 140lbs (63kg) to be eligible to compete. The vehicles have several safety requirements they must meet, and the vessel must be waterproof (the competition is held outdoors, rain or shine).

The Villanova team

RobotX

The inaugural Maritime RobotX Challenge was held in Singapore's Marina Bay in 2014, and the next will be held in Oahu, Hawaii in 2016. This is a much larger scale boat competition – each team is required to use a standard vessel, the 16ft (4.9m) long variant of the Wave Adaptive Modular Vessel by Marine Advanced Research. This removes the vessel design aspect that is present in the RoboBoat competition, but the complexity level is significantly higher for a larger vessel operating in open waters. There is no maximum weight for the vessel, though it is rated for a maximum payload of 300lbs (136kg).

Tasks

For both of these competitions, the mission the vessel must complete involves several tasks. Two required tasks are a thrust test, and a demonstration of navigation and control, which requires the vessel to navigate through two gates marked by a pair of colored buoys each. The mission tasks primarily include an obstacle detection and avoidance field, symbol recognition and automated docking, and underwater acoustic localization. The vessel also needs to be able to communicate with a server run by the judges to relay vital mission information, as well as to ensure normal operation for safety.

LIDAR/Video Fusion

Villanova's primary means of environmental sensing on the vessel is with a sensor fusion between a scanning LIDAR (a rotating laser sensor used to measure distances), and a video camera to capture color information. The LIDAR is a planar scanner, so it is gimbaled to provide a vertical field of view. The fusion is done through the use of a pin-hole camera model and coordinate transform, and allows for color information to be read from objects segmented by the depth field, or depth information to be read from objects segmented by color information.

Real-time navigation

The vessel needs to be able to process all the sensor data and make navigational decisions at a continuous dependable rate without delays to ensure the stability of the controller. A Speedgoat Mobile real-time target machine is used for this.

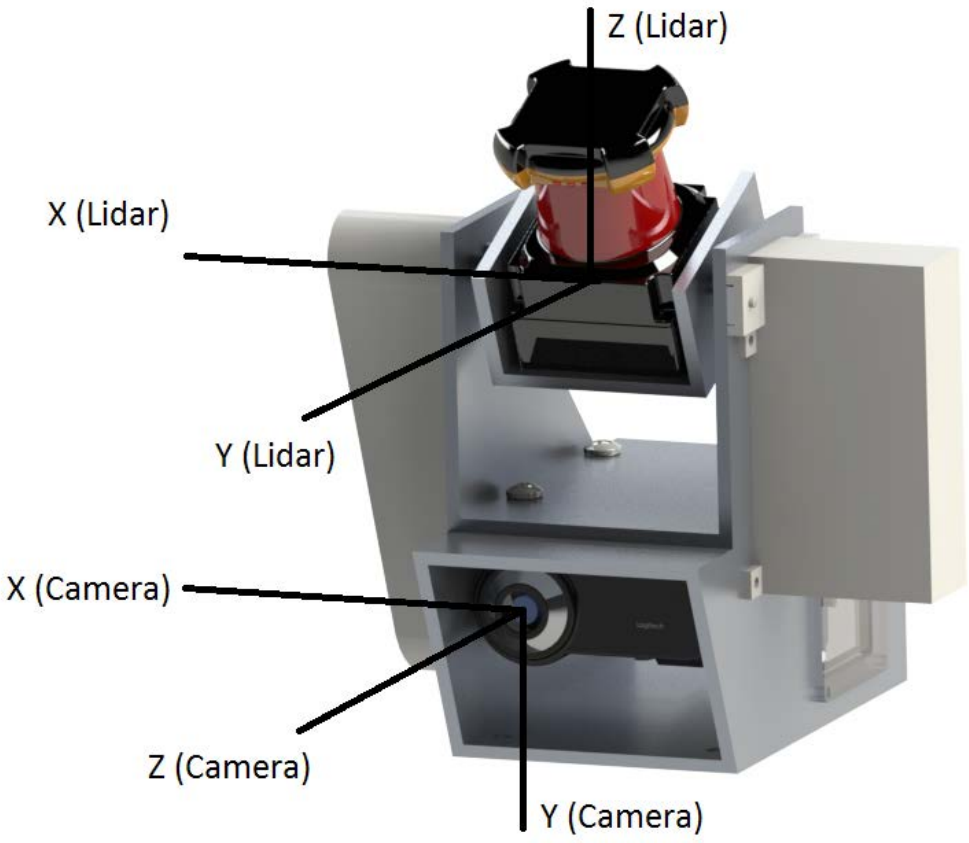
Without proper timing the control algorithm could easily overshoot or oscillate, or run commands that are not up to date with the current mission criteria. The target machine also has I/O for analog and digital signals, and several serial connections for the various sensors on the vessel, including inertial measurement unit, GPS, compass, and communicating with parallel processors such as Raspberry Pi's and Arduinos.

Speedgoat's contribution

"Data logging & monitoring capabilities have proved invaluable for debugging", Anderson Lebbad

"The Speedgoat system, as a platform that provides real-time control with configurable parameters that do not require re-compilation, has been very helpful for tuning control algorithms"

Anderson Lebbad, Team leader, Villanova University



The LIDAR/video vision system

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Villanova, Philadelphia
www.villanova.edu

Speedgoat products used

- Mobile real-time target machine
- IO102 Analog I/O module
- IO504 Serial I/O module

MathWorks software used

- MATLAB®
- Simulink®
- MATLAB Coder™
- Simulink Coder™
- Simulink Real-Time™

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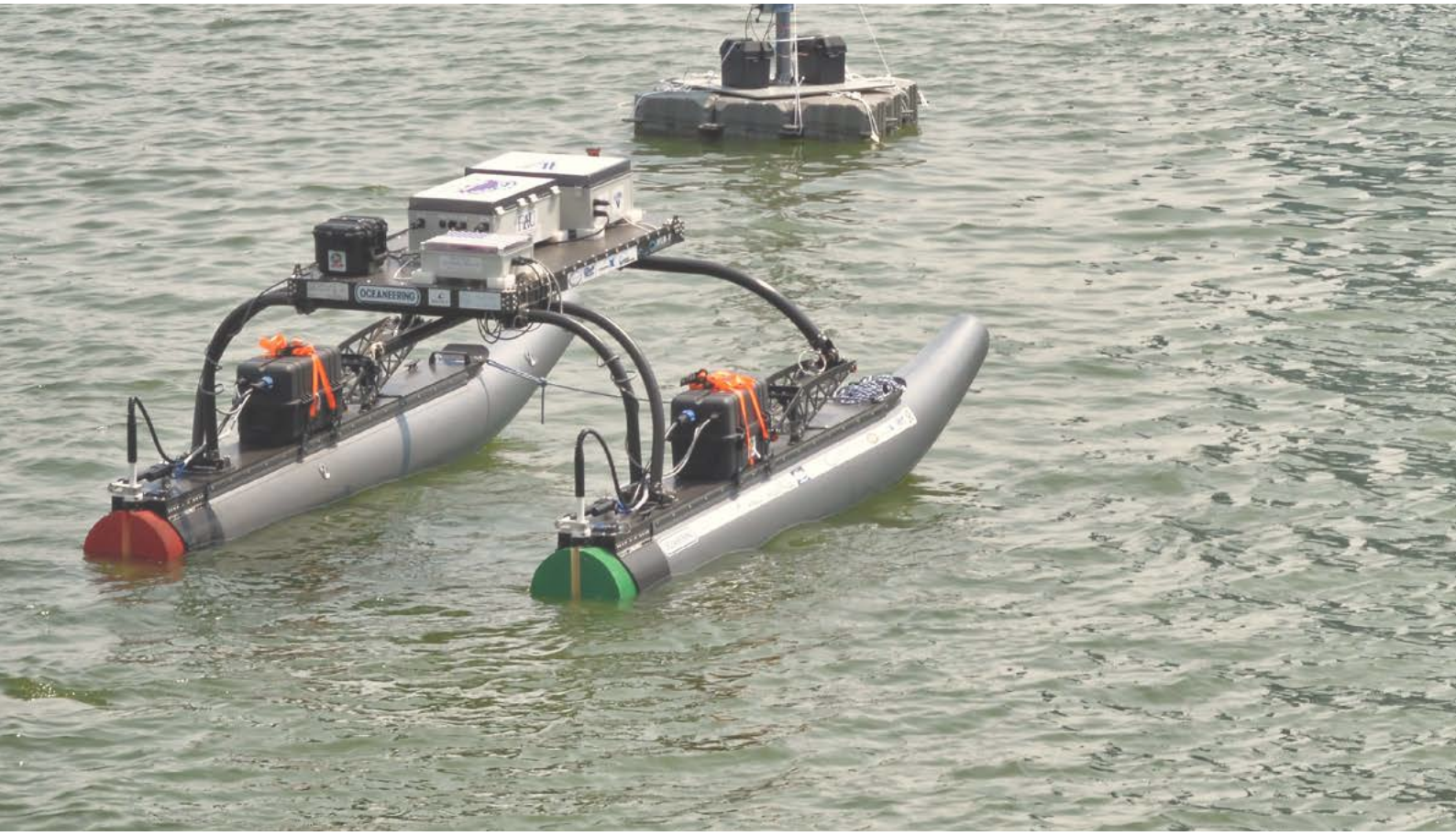

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