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ION's Autonomous Lawn Mower Competition

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Three teams of engineering students from universities in the Midwest design and field test robotic 'green machines' leveraging GPS receivers, navigation sensors, and command-and-control software.

Ohio University (OU) remains the king of robotic lawn mowers, with its student design team winning the Institute of Navigation's (ION's) 2nd Annual Autonomous Lawn Mower Competition, in Dayton, Ohio, June 3–4.

Although the competitive set stayed the same, the mix of students comprising the teams changed and their robotic lawn mower designs were upgraded across the board.

Uphill Battle

Following are just a few examples of how the field raised the blade, so to speak, for cutting-edge GPS-enabled autonomous lawn mowers:

- Miami University shed 500 pounds from its 2004 robotic lawn mower concept.
- All of the competitors added higher-power DC drive motors.
- Each team added optical ranging systems to identify and avoid obstacles.

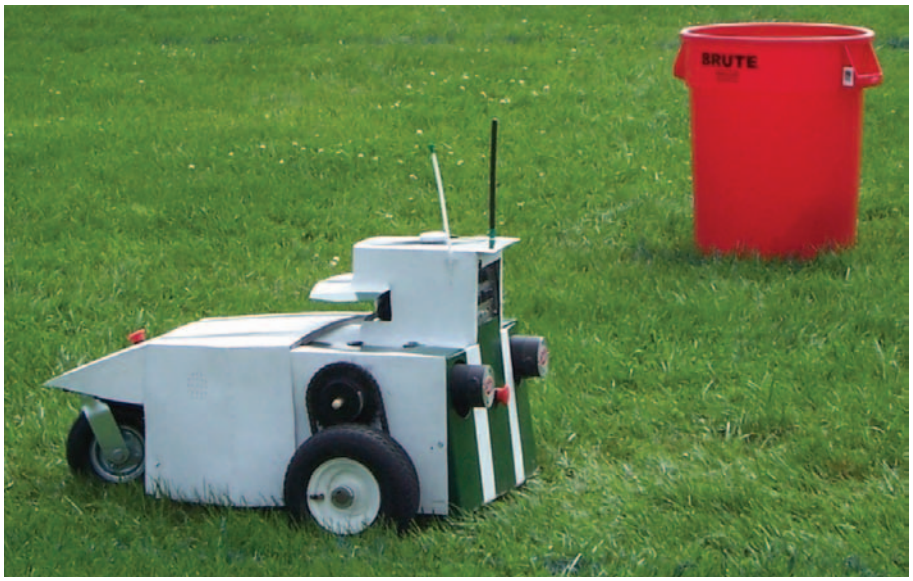
The rules changed a bit as well. For instance, contest officials evaluated sections of mowed grass by rigorously measuring areas with a grid superimposed on the field after cutting was concluded.

ION also added man-made obstacles to this year's competition:

- Officials placed an orange barrel in an area of the cutting field known to contestants — simulating a known stationary obstacle, such as a tree, which could be circumvented with a little warning by preset or on-the-fly directives.
- Organizers placed a second barrel at an arbitrary location just prior to each cutting run, requiring contestants to demonstrate on-the-fly avoidance of unexpected obstacles such as a ball suddenly launched from a neighbor's yard during mowing.

A Cut Above

Ohio University Professor Frank van Graas (not pronounced "van grass"), who coached the OU student team to victory, said the competition helps tomorrow's designers test



▲ **THE OHIO UNIVERSITY** autonomous lawn mower navigates past an orange barrel obstacle on its first pass at a marked cutting plot. OU students upgraded the university's mower from last year's competition to sport chain drives and more-powerful DC drive motors (evidenced by two red safety switches). Antennas help deliver GPS, WiFi differential GPS, and remote shut-off capabilities.

▲ **THE WINNERS CIRCLE** includes (from left to right) Ohio University's Nirav Parikh, Andy Shupe, Josh Kehl, Tomy Della Rocco, Dustin Bates, Duke DeVilling, and Nathan Hay accepting the first place check for $2,500 from Mikel Miller, one of the competition's key organizers.

their knowledge and theories in the field.

He said real-life issues — ranging the gamut from design and integration challenges and opportunities to an array of application concepts — sprout up all over the design, beta testing, and final evaluation processes. Lessons learned in overcoming expected and unexpected obstacles while meeting schedule and budget demands is another reason van Graas said OU places such a high priority on the design contest.

Of course, there are secondary benefits as well. After winning last year's cutting competition, OU received a grant to design search-and-rescue robots equipped to enter dangerous environments, locate survivors, and evaluate such risks as explosive gas.

Another lesson learned is the inherent limitations of differential GPS-enabled navigation and guidance. According to van Graas, the centimeter-level positioning accuracy required for lawn mowers in the contest is actually more difficult than automatically landing an airplane.

Each team was assigned a rectangular grass field of approximately 150 square meters. No team mowed its entire assigned area. Even the winning OU team cut just 32 square meters (28 square meters after deductions for straying outside the lines), leaving plenty of room for improvement.

Grabbing the Green

OU engineering students took top honors again, receiving $2,500 for their repeat victory in the contest. Further authenticating OU's bragging rights, the university also won the competition's $1,500 prize for best production report.

Illinois Institute of Technology moved up to second place this year, winning $1,500. Miami University of Ohio, which won second place in 2004, qualified for the competition on Friday, but suffered an equipment failure before its team's mowing blades were turned on.

Event sponsors ION and the US Air Force Research Laboratory – Sensors Directorate expect a growing field of contestants next year. Several nearby engineering schools sent teams of students to this year's competition to study design concepts and application challenges in anticipation of entering the competition in 2006.

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Design components and system manufacturers by student team

University	Sensors Integrated in Autonomous Lawn Mower
Ohio University	NovAtel *ALLSTAR* GPS receiver (12-channel L1-only with carrier phase output), a Microstrain *3DM* gyro, SICK *LMS-200* laser to detect obstacles up to 82 meters away with 1-centimeter accuracy, and US Digital *E6S* optical encoders for motor speed.
Illinois Institute of Technology	NovAtel *OEM3* DGPS receiver, and a FreeWave Technologies spread-spectrum wireless data link in communication with the reference station, allow low-cost optical encoders integrated to the motor driving shafts, and a SICK LMS-200 laser with an eight-meter range.
Miami University of Ohio	NovAtel *Superstar II* GPS receiver and various Hall-effect sensors on wheels to measure velocity and position of wheel.