SCIENCE

THIS INSANELY HARD, SELF-DRIVING ROBOT RACE TAKES PLACE IN A PARKING LOT

SPARKFUN'S ANNUAL AUTONOMOUS VEHICLE COMPETITION PUSHES THE LIMITS OF CHEAP TECH

By **Ted Burnham** Posted June 27, 2015

Robot rock

Ted Burnham/PopSci

The hexapod robot in the foreground was constructed by Larry Watkins and Todd Heinze. In the background, a robot constructed by Ben Greer ambles along.

The challenge of the Autonomous Vehicle Competition, hosted by hobbyist electronics vendor SparkFun at its Boulder, Colorado, headquarters, seems simple enough: Build a robot that can navigate itself around the company's parking lot. Though the AVC course is dotted with small obstacles, it's really just one lap — a distance of less than 900 feet. But for the majority of competitors, it feels more like the path into Mordor.

Flashback to last weekend, in the thick of this year's competition. The phrase: "I just hope I make it around the first corner" fills the air under the Pits Tent, where long tables are cluttered with skeletal RC cars, thickets of loose wire, boxes of circuit boards and spare parts; the detritus of a mad roboticist's laboratory. Clustered around them are students, engineers, and hobbyists of all ages making the frantic last-minute adjustments that they hope will give their bot the speed and smarts to run the course under its own guidance.

"I just hope I make it around the first corner."

"In seven years, it's gotten really,

really advanced," says Nathan Seidle, who founded SparkFun in his college dorm room and created the AVC to settle a friendly debate among his employees about the best strategy for making self-guided vehicles. "The very first years, it was pretty spectacular when a robot made the first corner," he says.

This year, half of the 71 teams entering the AVC will clear that first bend. But only a handful of bots will make it all the way around the course — dodging barrels, jumping ramps, and possibly tangling with The Discombobulator, an eight-foot plywood platform that spins at 50 RPM and guards a coveted shortcut.

Unusual suspects

Ted Burnham/PopSci

Competitors at the AVC display not just technical prowess, but creativity too. The vehicles come in all shapes, sizes and colors,

from souped-up RC cars to tissue paper dragons on custom frames.

Despite advances in electronic sensors, the proliferation of low-cost computers like the Arduino and Raspberry Pi, and high-profile projects like Google's self-driving car, building a robot that doesn't ram itself into walls is still pretty difficult for amateurs and pros alike.

Nathan Peterman, an 18-year-old, recent high school graduate from Cleveland, saw the proof first-hand when he attended the DARPA Robotics Challenge earlier this month, which featured humanoid bots built by corporate and academic teams with vast resources and expertise. "The robots were almost as unreliable as these ones here," he says. "They fell over every 10 seconds."

Peterman's own robot, a tank with foot-long metal treads, is based on a kit sold by SparkFun. It's steered by an Arduino Uno that reads signals from a pair of ultrasonic rangefinders, which use sound waves to detect walls and obstacles. Peterman says it worked fine in his hotel room, but the haybales that line the actual course seem to absorb

ultrasonic frequencies. The bot rolls right into them, never knowing they're there.

Tanks for the memories

Ted Burnham/PopSci

Nathan Peterman, who just graduated from high school in Cleveland, says this rugged design was "was kind of a big mistake." The treads made it hard to measure the bot's progress around the course. Lesson learned, says Peterman: "Tanks are not a good idea, no matter how cool they are."

Many other teams use similar sensors for "object avoidance," but pair it with GPS for navigation. Peterman opted not to, in part because there are bonus points for doing so. "Although looking back, it probably would have been a good idea," he says.

Well, maybe not. A lot of GPS-enabled bots could barely make it off the starting line before getting confused. In one heat, a pair of insect-like “hexapods” crawled immediately to the left, right into a fence, as though trying to terrorize the spectators. In fact, one of the teams told me, it was probably just a discrepancy between the preset waypoints they’d pulled from Google Maps and the bot’s real-time coordinates as reported by GPS satellites.

"We’ve learned that robotics is very frustrating."

“As it turns out, GPS is not very accurate,” says Ted Meyers, a software engineer at Northrop Grumman who entered the competition alongside his 9-year-old son, Rory. Neither of their four-wheeled bots use GPS at all. “It may be accurate to about two or three meters for the GPS units they’re using out here, and that’s not enough,” Meyers says. Three meters is about the width of the entire course, so a robot can easily end up heading to a spot well out of bounds.

The humans

Ted Burnham/PopSci

This was software engineer Ted Meyers' fourth time entering the AVC, and the first time for his 9-year-old son, Rory. In addition to learning about math, programming and magnets, Meyers says, "We've learned that robotics is very frustrating."

"We've found that simpler is better," Meyers explains. "Our first design tried to use a lot of sensors like sonar and infrared range-finders. We've eventually got down to this point where we have two sensors, and that's only two things that can go wrong."

Meyers' approach is to plot out the exact path he wants the bot to follow. All it takes is a gyroscope or compass to know which direction it's pointed, and an odometer to measure how

when the route is known in advance. The Meyers' bots made it to the finish in nearly every heat to take second and third in their division, while another bot — "Roadrunner", built by Lockheed Martin engineer Rich Burnside — used the same strategy to take first place for the third year in a row.

Roadrunner outfoxes the competition again

Ted Burnham/PopSci

Rich Burnside holding Roadrunner and accepting the award.

But at the AVC, it's not just about winning. Like everything SparkFun

does, the event's mission is primarily educational. There are plenty of adult competitors, but most are college students, members of high school robotics clubs, or younger kids learning about robotics from their engineer parents.

"It's totally awesome to see so many kids get inspired and excited about robots," says Seidle. "And hopefully we're encouraging them to enter into the STEAM fields — math, science, engineering, all that fun stuff."

One of those kids is 11-year-old Marie Roell, who took home the Rookie of the Year award. She and her father, Thomas, started building her robot "Killer Kitty" about six months before the competition. Marie was responsible for designing, assembling and testing the bot, while her dad contributed the programming — under Marie's direction.

The Rookie

Ted Burnham/PopSci

Marie Roell, 11, took home the Rookie of the Year award, which is how SparkFun's judges recognize the first-time competitor whose progress they're most excited to follow in coming years. When asked if she'll be back, Roell's answer is a firm "Yes."

Last year Thomas collaborated with Marie's older brother, Leon, who this time was able to do most of the work on his own robot himself. "It shows the kids engineering principles," says Thomas. "Things will go wrong. If they go wrong, how do you fix them?"

In the fall, Marie will join Leon at the Byers campus of the Denver School of Science and Technology, which offers a robotics club and programming classes as part of the middle-school curriculum.

"I like that you can use technology to create things that come to life," Marie says. "I just think it's so fun."

There's always next year

Ted Burnham/PopSci

Another competitor played fitting homage to Nintendo's *Mario Kart*.

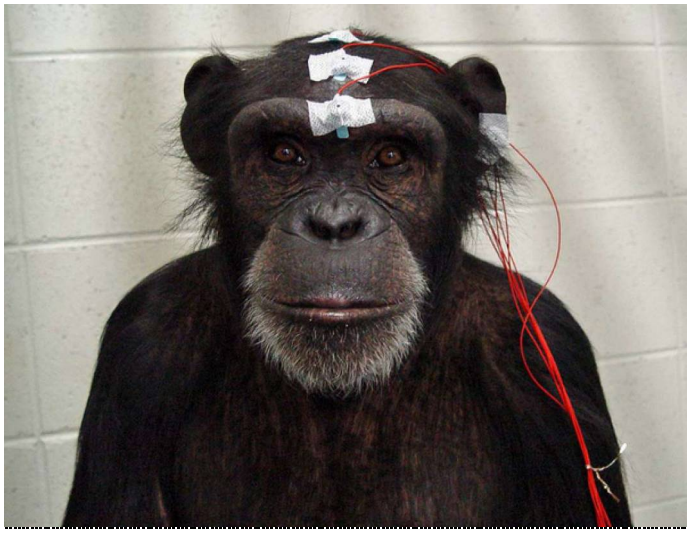
TAGS: TECHNOLOGY, ROBOTS, SPARKFUN, AUTONOMOUS VEHICLE COMPETITION, AUTONOMOUS VEHICLES, SELF-DRIVING ROBOTS, SELF-DRIVING CARS, AVC, DARPA ROBOTICS CHALLENGE, DIRECTION, INTELLIGENCE, SOFTWARE, HARDWARE, BATTLE BOTS, SCIENCE

SCIENCE

MONKEY MIND MELD MOVES AVATAR ARM

BECAUSE THREE HEADS ARE BETTER THAN ONE

By **Alexandra Ossola** Posted 4 hours ago



A chimpanzee hooked up to electrodes for a 2012 experiment.

Hirata et al 2013, Nature

For the first time researchers have used the combined brainpower of several rhesus monkeys to move a digital arm and complete various tasks with it, according to a study published today in *Scientific Reports*. If such a connection were possible in humans, we might be able to solve problems far better than any individual alone.

Researchers have known for a long time that brains have a tendency to sync up. When two people are tasked with the same activity, neurons in

their brains start to fire at the same speed and in the same place, even if the people weren't instructed to cooperate. No one really knows why this happens, but it's a well-observed phenomenon—our brains are naturally inclined to cooperate with one another.

The researchers behind this study knew that the same held true for monkeys, and they wanted to see how this convergence could be applied to the brain-machine interface. In the study, they sat groups of two or three monkeys in separate rooms in front of a computer screen. Each of these monkeys had electrodes implanted in the parts of their brains associated with motor skills and somatosensation, the sense of where the body is positioned in space. The monkeys all shared control of the digital arm, able to move it along various axes so that, together, the monkeys could complete a common task of moving the arm towards a circular target on the screen. Once they achieved that, the researchers gave them juice as a reward. They first learned to move the arm with a joystick, then the researchers hooked up their brain implants to control the arm with just their minds.

Over the course of several weeks, the

monkeys got much better—and faster—at working together. Collecting data from the monkeys' brain implants, the researchers found that more neurons fired when more monkeys were working together, and that their neurons were lighting up in the same parts of the brain.

This type of neurological collaboration in humans could be useful for tasks where more minds are better than one, such as a surgery in which different members of the surgical team control a different tool, *New Scientist* suggests. And though that reality is still pretty far away, studies like this one indicate that it could happen much more quickly than previously thought.

TAGS: BRAIN-COMPUTER INTERFACES, BRAIN-BRAIN INTERFACES, RHESUS MACAQUE, COLLABORATION, SCIENCE