Swerve robotic platform relies on SICK LiDAR sensor

A SICK Automation LiDAR sensor was used to build a winning robotic platform in the prestigious Drexel University's annual College of Engineering (CoE) senior project design competition.

For Drexel University's annual project design competition, Freddy Wachter (Mechanical Engineering and Mechanics, MEM); Alexander Nhan (Electrical and Computer Engineering, ECE); Harrison Katz (MEM) and Matt Wiese (MEM) set out to design and build a robotic platform. There was a lot of trial and error, testing and collaboration among the Swerve team during the project, which was done over three 10-week quarters of the 2017/2018 school year.

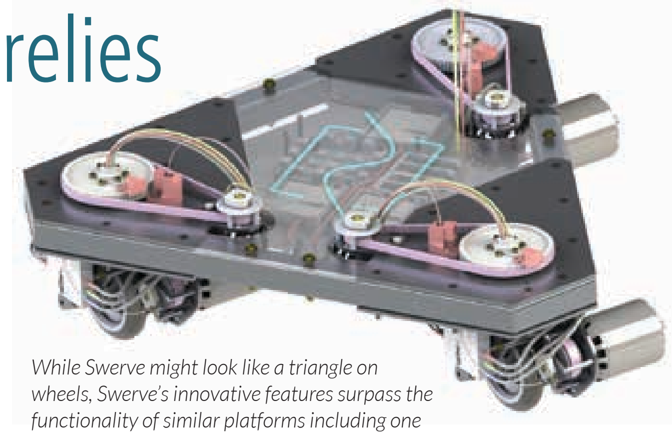
Among eight teams who competed, the first-place result was the Swerve Robotic Platform, a highly versatile, three-wheeled, autonomy-enabled vehicle that is capable of carrying large loads while moving at high speeds and accelerations. Swerve was designed, fabricated and tested using motion-capture systems, advanced machining, computer simulations and software, as well as SICK's LiDAR sensor.

While Swerve might look like a triangle on wheels with a lot of wires on it, the innovation lies in four design elements, which the team packed into one robotic platform.

"Robotic mobility platforms today contain just a couple of the lightweight, high-speed, omni-directional and integrated technology features, but Swerve incorporates all four," says Wachter. Such elements make Swerve innovative, surpassing the functionality of similar platforms including one designed by NASA. For starters, Swerve weighs less and carries more than similar robots.

The project's criteria included:

- The vehicle weight had to be under 45 kg and support heavy weights of up to 136 kg. Swerve weighs approximately 27 kg.
- The vehicle had to go faster than Olympic runner Usain Bolt – at more than 45 km/h – and accelerate faster than 5.8 m/s. Swerve can go as fast as 32 km/h in speed-limited tests, but without the limitation can exceed 45 km/h with ease.



While Swerve might look like a triangle on wheels, Swerve's innovative features surpass the functionality of similar platforms including one designed by NASA.

- To give it nimbleness, the vehicle needed omni-directional wheels which roll forward like normal wheels, but still slide sideways with almost no friction (also contributing to speed).
- Integrated autonomy was key: Swerve needed to have human-machine interface capabilities and function in both structured and unstructured environments. This meant the ability to be human-controlled while still having the option to move freely and autonomously as needed, responding to a set of previously input datasets to get around.

Sensor Technology

Sensors were a key technological element of Swerve's design to support navigation, autonomy and nimbleness. Swerve uses Sick Automation's 2D Light Detection and Ranging (LiDAR) sensors for area-monitoring data capture, and IMU (Inertial Measurement Unit) sensors. The Swerve robot receives the 2D LiDAR data through a SICK TiM561 sensor, which provides scan angles and ranges to the nearest object to those angles. These scans can then be visualised and used to create 2D representations of the robot's local environment.

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Mechanical elements of Swerve

A number of mechanical and structural elements make Swerve nimble, fast and omni-directional. "Swerve has caster wheels that can rotate in every direction and uses slip rings to keep all the wires tangle-free," Wachter explains. This means wheels can move independently and turn on a dime, while brushless DC motors allow Swerve to accelerate quickly.

Many of the mechanical design elements of Swerve impressed the CoE senior design project judges. "The major part of what helped us win the competition was in-depth design, which was described well in our report," says Wachter. Elements such as welded crush tubes built into the aluminium chassis gave Swerve the strength to withstand heavy loads. Fabrication of Swerve's components included 5-axis water jet cutting, 3D CNC milling, aluminium welding, as well as manual lathe and milling processes performed by the Drexel Machine Shop along with a local maker-space in Philadelphia called NextFab.

Swerve gets a life

The Swerve team had a strong idea going into the project, based on a request and sponsorship from a former co-worker, Josh Geating, project stakeholder and robotic tinkerer. Geating contributed design input and will potentially use Swerve to compete in BattleBots competitions in California.

Geating underscored how the team designed the platform with the human-machine interface in mind. "Project Swerve is an attempt to make the most agile robotics wheeled platform to date, while maintaining a high level of precision and sensing to enable autonomy and highly dynamic motion," says Geating. "Power, precision and mass are often mutually exclusive in robotics, and the combination of these three in the Swerve platform enables many unique applications."

While Swerve may live on in BattleBot applications for now, future uses abound. Personal mobility uses for Swerve include serving the disabled, while entertainment and amusement applications include serving as a base for trackless rides, allowing for easily changing the consumer experience without building a whole new attraction.

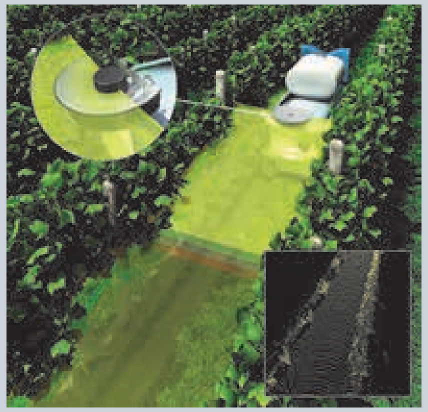
The logistics industry already has companies such as Amazon deploying robots in its warehouses for picking orders. Swerve could supplement a warehouse labour force to meet peak demand periods. "Swerve has the potential to work alongside warehouse personnel in a dynamic environment," Wachter says.

The Swerve platform also holds the potential to incorporate machine learning (ML) and artificial intelligence (AI). "The framework we used would allow the opportunity for ML and AI to be used. Though it would take a significant amount of time to develop customer-specific applications, it can be done," concludes Wachter. ❑

Manoeuvring agricultural robots with 2D laser scanners

A good navigation system is one of the fundamental requirements for using agricultural robots successfully. The system must be able to account for deviations in the shape and size of crops, crooked rows of differing widths, as well as other irregularities.

Standard GPS systems are not up to the job. For this reason, the Wageningen University and Research Centre developed a navigation process in which crop robots would be guided not by a GPS function, but instead by an LMS111 2D laser scanner from SICK Automation South Africa.



Agricultural robots with 2D laser scanners from SICK Automation.

The LMS111 2D laser scanners collect raw data and then filter the information they need out of this. A whole range of practical tests were performed during the growing season to check whether the system was functioning as it should. The results proved that it is indeed a reliable solution for navigating crop areas cultivated using conventional methods.

Summing up, Dr Frits van Evert from Wageningen University and Research Centre states, "We have invested a great deal of time and energy in this project. Just recently, our efforts put us in a position to publish our findings in a leading scientific journal. I would therefore like to express my sincere thanks to SICK for providing us with the laser scanner for our research."

Precision agriculture

Precision agriculture is on the rise but what does it mean? It is a practice that marks a move away from the model of subjecting every field to a standard treatment and instead takes a semi-tailored approach that considers the requirements of each crop. Custom sowing, fertilisation, pesticide application and disease control have the potential not only to save money, but also, reduce the impact on the environment.

However, the more efficient benefits that precision agriculture brings are unfortunately not yet enough to outweigh the performance of the large, fast farm machinery that saves significant quantities of manpower.

Recently, however, a solution to this problem has been introduced in the form of small agricultural robots that are able to work in fields 24 hours a day, slowing down or stopping as the situation demands, and operating almost entirely without human input.

The company and university believe that by using technology such as the 2D laser scanners for crop navigation, we can harness modern technology in a way that will allow people to collaborate with business even more intelligently, efficiently, and sustainably in the future. ❑