University of Wisconsin—Madison

Bio-Med Students Employ Galil Controller to Help Paraplegic Surgeon Operate Again

SPOT being demonstrated by Michael Konrath — SPOT Project Manager.

It was on a sunny May day when then medical student and former lifeguard Garrett Cuppels dove after a man who had just jumped off the Falls Bridge in Philadelphia in an attempt to end his life.

Cuppels managed to bring the suicidal man to shore, but rescue attempts failed to keep him alive. Details of Cuppels' heroic effort were later revealed on NBC's Dateline and on The Oprah Winfrey Show. In spite of the tragic ending to the story, Cuppels went on to finish medical school and complete his training in orthopedic surgery at the University of Miami at Florida.

Then, tragedy struck again. In a freak accident, Dr. Cuppels fell from a three-story balcony, injuring his spinal cord and resulting in complete paralysis from the waist down. No longer able to perform standing surgeries, his career also came to a halt.

When five senior bio-engineering students at University of Wisconsin-Madison learned of Dr. Cuppels plight, they banded together as part of their senior project to build "a device that will allow him to go from a sitting position and then bring him into a standing position."

Supervised by Professor Amit Nimunkar, the team (and their area of focus) included James Madsen (wheels), Blake Marzella (programming), Bret Olson (base platform), Michael Konrath (instrumentation and project manager) and Justin Cacciatore (circuitry). The device, called the Standing Paraplegic Omni-directional Transport (SPOT), is intended to get Dr. Cupples back to work in the operating room.

In building SPOT, the team needed to make sure it could safely:

- Place Dr. Cuppels in a comfortable "standing" position with arms freed to perform the surgery
- Enable Dr. Cuppels to easily and precisely maneuver in any direction (including side-stepping) and stop on a dime

For maneuverability, the platform features four Mecanum wheels, each with their own built-in motor and brake system controlled via a CTI Electronics' joystick and a Galil DMC-4143 4-axis motion controller. The joystick outputs two 0–5 V analog signals to the DMC-4143 which is programmed to independently control all four motors so they can run at different speeds and move in different directions.

The Mecanum wheels are made up of a series of small rollers lined at a 45 degree angle. When all four wheels move in the same direction, the platform moves forward or backward. To rotate, the wheels on one side of the platform run in the opposite direction to those on the other side. Sideways (or side-stepping) motion is achieved by running the wheels on one diagonal in the opposite direction to those on the other diagonal. The ability to "side-step" is unique to Mecanum wheels, and is the top reason why they were specified.

"We're convinced this device will allow Dr. Cuppels to move any way along the operating table with minimal effort," said Marzella.

In addition to the precise control of the various motions, Konrath specified the DMC-4143 controller because its "programming was quicker and less complicated than the other choices. Galil's DMC code has a lot of shortcuts that reduce the amount of syntax required when compared to other languages. It also makes it easier to isolate problems and tune the controller."

"When it came down to it, we could automate just about anything with the Galil controller," added Konrath. "For example, we used four of the eight opto-isolated digital outputs to control the brakes, and the 'Brake Wait' or BW command to automatically enable the brakes when the motors are turned off and the device not in use. This is an important safety requirement."

"Additionally, since the multi-threaded capabilities of the Galil controller allow for simultaneous reading of the two 0–5 V analog signals from the joystick, we can update the jog speeds for each motor in ultra-tight loops," said Konrath.

While much progress has been made on the SPOT and over a thousand hours invested, there is still more to be done before it can be used by Dr. Cuppels to perform standing surgeries once again. Looking for donations and corporate support to complete the task, the five bio-engineering students remain committed to the project—and to Dr. Cuppels.

"Dr. Cuppels is going to be able to help thousands of people if we can get him back in the operating room and able to practice his craft until he retires," said Olson. ■

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