Robo-forklift keeps humans out of harm's way

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Robotic forklift. Photo by Jason Dorfman

(PhysOrg.com) -- Researchers in MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) are working on a better way to handle supplies in a war zone: a semi-autonomous forklift that can be directed by people safely away from the dangers of the site.

Currently, when supplies arrive at military outposts in war zones such as Iraq, people driving forklifts unload the pallets and put them into storage, and later load them onto trucks to take the material to where it's needed. These forklift operators must often scramble for cover, slowing the work and putting them at risk.

When completed, the new robotic device will provide a safer way to handle pallet-loaded supplies of everything from truck tires to water containers and construction materials, says Matt Walter, a CSAIL postdoctoral researcher with a lead role in the project. The device is designed to operate outdoors on uneven terrain such as gravel or packed earth.

In Iraq, it has not been uncommon for workers to "have to abandon the forklift three or four times a day because they come under fire," Walter says. "A lot of the work could be automated," thus alleviating people's exposure to danger, "but it's a very difficult task."

HEAVY LIFTING IN HOSTILE TERRITORY

The forklift is designed to operate autonomously with high-level direction from a human supervisor who could be physically nearby, or safely ensconced in a remote bunker. In an initial training phase, the forklift learns the basic layout of the storage depot facility, such as where the reception area ism where incoming supply trucks arrive with a load of pallets ready to be stored, and where the storage areas are for those pallets to be deposited. The forklift can then be commanded to transport pallets from one place to another within the depot.

Determining which pallets to pick up and where they need to go requires guidance from a human supervisor, at least for now. The supervisor's tablet computer, wirelessly linked to the forklift, displays the view from the forklift's forward-looking video camera. Using stylus gestures on the image, the supervisor indicates the truck to be unloaded, the pallet to be engaged next, and perhaps where on the pallet to insert the forklift tines. The supervisor also speaks to the tablet, indicating the desired destination of the target pallet. As the system gets more sophisticated, the supervisor would need to do less and less, eventually simply gesturing and saying "unload that truck," for example.

But to ensure that it can always carry out the necessary tasks, if there's ever a problem with the automated system the machine reverts to a conventional manned forklift whenever someone climbs into the operator's cabin.

TESTS UNDER WAY

Research began with a small test platform rigged with forklift tines and a variety of sensors and computers that was used for a series of indoor tests and is now continuing with a full-scale prototype being tested outdoors on the MIT campus.

The work is part of several projects at CSAIL focused on "the development of situational awareness for machines," explains Seth Teller, professor of computer science and engineering and project lead. Situational awareness, Teller says, involves the use of sensing, motion, inference and memory to acquire "a model of the spatial layout of the world and its contents, to allow us to plan and move purposefully in the world." Humans develop these internal maps of their surroundings without even thinking about it, but "machines can't yet do it automatically."

In developing the robotic system, the CSAIL researchers have made extensive use of computer code developed for other projects, including the autonomous vehicle MIT entered in the 2007 DARPA Grand Challenge auto race, in which unmanned cars navigated roads without human intervention, Teller says. That work has been reported in papers in the Journal of Field Robotics, and the forklift project itself is the subject of a paper being submitted for publication at an upcoming robotics conference.

Among the tasks the robot must carry out automatically is avoiding unexpected obstacles, especially people who may be walking around in

the area. That turned out to be less of a challenge than expected: "It is possible to detect moving people using laser range scanners," Walter says. "Things get much harder if people are trying to trick the system by hiding or standing very still," Teller notes.

The forklift project has involved about 30 faculty, staff and students (including postdocs, PhD and MEng students, and UROPs) from MIT's CSAIL, LIDS, and Courses 2, 6 and 16, as well as from Lincoln Laboratory, Draper Laboratory and BAE Systems. It has been funded by the U.S. Army Logistics Innovation Agency.

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