

# SYSTEMS & CONTROLS

## No-cable elevator uses VT switched reluctance motor drive technology

**E**CE researchers have built a 1:10 scale prototype of a cable-less elevator that would cost less than one-fifth the price of conventional elevator technology. The energy-efficient elevator technology has the potential to make home elevators more affordable, improve ship-board transportation, and even allow more than one cage in a shaft.

The elevator prototype was designed for weapons elevators in battleships and was funded primarily by the Naval Postgraduate School. The elevator uses an electric propulsion system based on the switched-reluctance linear actuator first developed in ECE laboratories for maglev transportation.

The elevator uses no cables and is propelled by a system comprising of stators along the shaft and translators on the elevator cage. It was designed so that increasing the lift force does not require more stators, just translators.

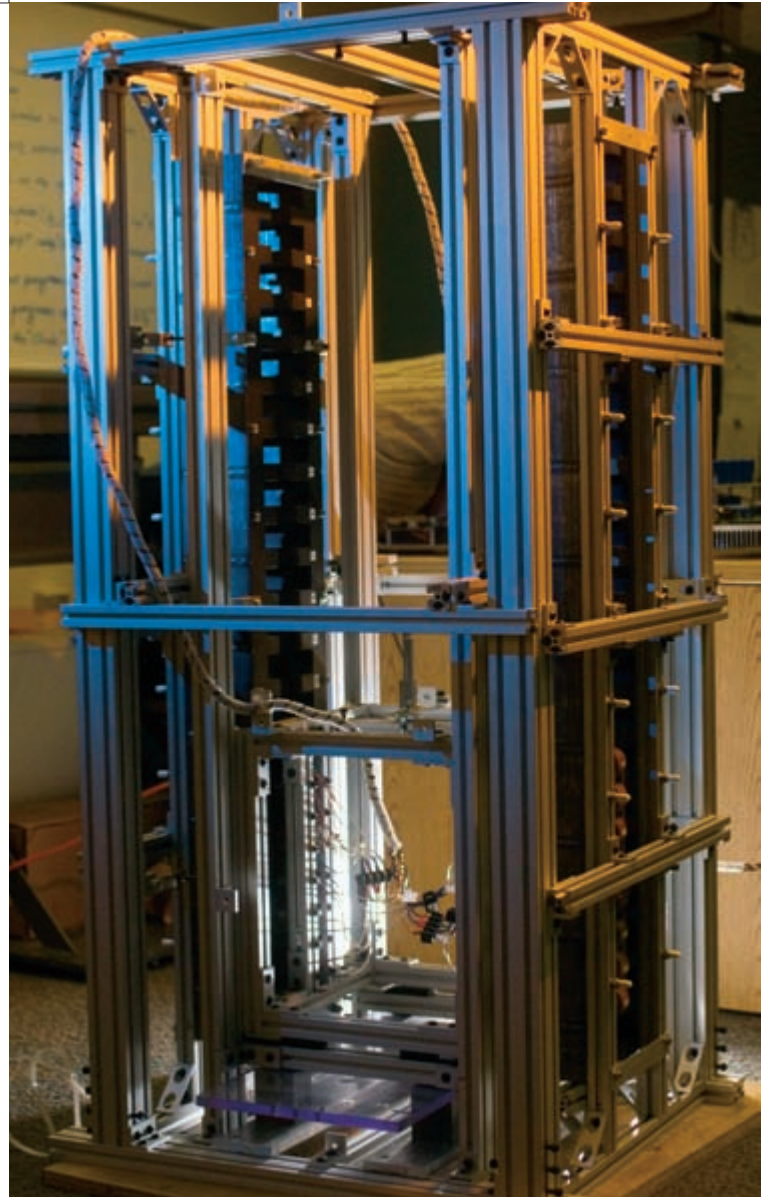
The control equipment is carried at the sides of the cage, instead of at the top, which is in the plenum space between floors in conventional elevator technology. “Carrying the control equipment on the sides of cage means the elevator does not need as much head room as traditional elevators,” said Krishnan Ramu, director of the Motion Control Systems Research Group that developed the system. “This means that tall buildings can fit more usable floor space. It also means that in home elevator systems, even a short, 7-foot tall basement can accommodate an elevator.”

Putting the control equipment on the cage also enables multiple cages in one shaft, according to Ramu. The shaft could be a circular system in a large building or ship, where the unoccupied cages travel horizontally above the top floor and beneath the bottom floor.

The project has taken more than four years from concept to prototype. “The control system was the most excruciating,” Ramu said. “We had to make sure we could accelerate and decelerate smoothly in all circumstances and that, in case of power interruption, the elevator would glide smoothly without harm to occupants.”

### FACULTY

William Baumann  
A.A. (Louis) Beex  
Pushkin Kachroo  
Douglas Lindner  
Krishnan Ramu  
Daniel Stilwell  
Chris Wyatt



A 1:10 scale prototype of an elevator that can operate inexpensively in smaller spaces uses Virginia Tech’s switched reluctance motor drive technology.

# Mini, high-speed AUV exceeds 15 knots

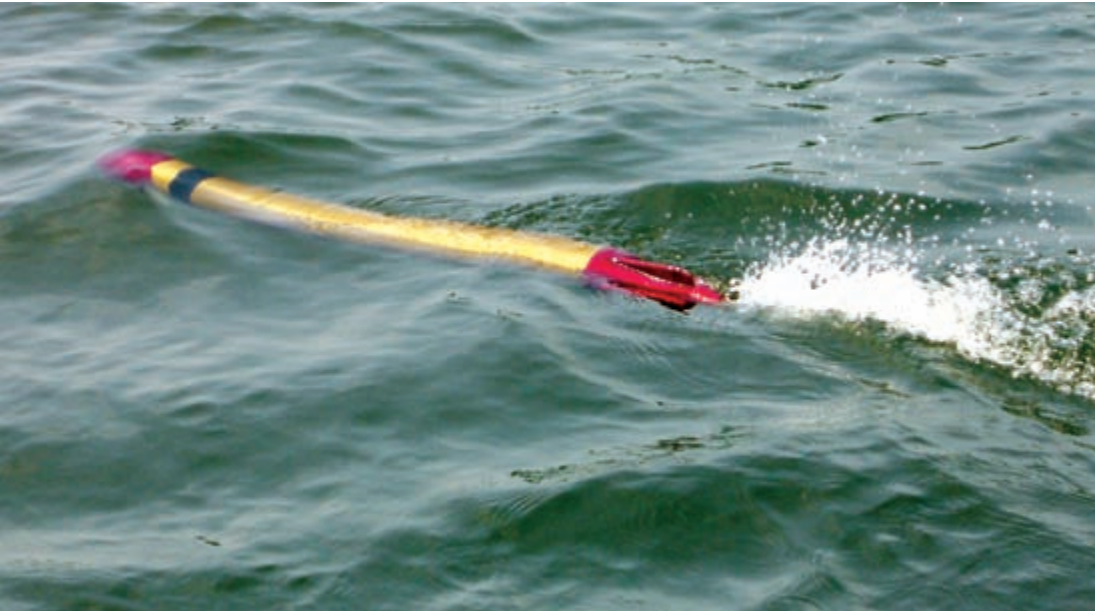
A very small, high-speed autonomous underwater vehicle (AUV) has been developed by ECE's Dan Stilwell and Wayne Neu of aerospace and ocean engineering. The high-speed AUV is approximately 39 inches long and 3 inches in diameter. It is capable of speeds greater than 15 knots; most AUVs operate at between 2-3 knots. The AUV was developed as a "crash project" directed by the

Naval Underwater Warfare Center in Newport, RI. The team went from concept to first successful demonstration in just 10 months.

The high-speed AUV presented a number of unusual design challenges. It is 50 percent heavier than the water it displaces. If it is not being actively controlled, the AUV sinks quickly to the bottom.

The most unusual feature of the high-speed AUV is that it does not possess a vertical separation between its center of mass and its center of buoyancy. Almost all submersibles are designed so that the heavy parts are near the bottom and the lighter parts are near the top. This means it naturally tends to stay upright. The high-speed AUV, however, has no passive stability. The team developed and is patenting a method of actively stabilizing the roll motion.

When the high-speed AUV is not in high-speed flight, it transitions into nose down hover. It can then transition back into high-speed flight.



# Anti-jitter technology for better rifle aim

Controls researchers are developing a new rifle system technology to enable the shooter to maintain better aim control under ergonomic disturbances.

The technology is expected to improve shot accuracy and dispersion under combat stress and to extend the effective range of small arms rifles, according to Douglas Lindner, the Virginia Tech lead on the project.

Called the INertially STabilized Rifle (INSTAR), the system's goal is to compensate for these physiological effects and improve the overall accuracy of the soldier by stabilizing the gun barrel relative to the stock taking out the human induced disturbances.

INSTAR operates similar to a video camera with a simple feedback control system that rejects any tracking commands at lower frequencies and compensates for the jitter disturbances due to breathing, heart rate, and muscle movement, etc., at higher frequencies.

INSTAR features a specially designed gun barrel suspension, compact high energy density piezoceramic actuators to effect gun barrel motion, inertial sensors to measure gun barrel motion and power, control, and signal conditioning electronics integrated into the multifunctional gun stock.

Lindner is collaborating with Chris LaWigna of Techno-Sciences, Inc. and Diann Brei of the University of Michigan.



**Autonomous Systems & Controls Laboratory**  
Director: Dan Stilwell  
[www.ascl.ece.vt.edu](http://www.ascl.ece.vt.edu)



**Digital Signal Processing Research Laboratory**  
Director: A.A. (Louis) Beex  
[www.ee.vt.edu/~dspri/](http://www.ee.vt.edu/~dspri/)



**Intelligent Control Group**  
Director: Pushkin Kachroo



**Motion Control Systems Research Group**  
Director: Krishnan Ramu