

@ Researchers are developing self-guided, grenade-type projectiles using tiny devices that squirt out minute puffs of air to alter air flow around the munitions.

Smart Munitions

Researchers use synthetic jet actuators to steer 40mm projectiles in flight.

BY RICK ROBINSON

Large-scale smart weapons such as laser-guided bombs have helped reshape modern warfare. Now, scientists at the Georgia Tech Research Institute (GTRI) are taking an analogous approach with smaller-scale munitions by working on the development of self-guided projectiles.

The concept involves the use of tiny devices called synthetic jet actuators, which squirt out minute puffs of air. When these devices are embedded into the surface of a grenade-type projectile, they alter the air flow around it.

"What we're demonstrating here is that a technology called 'microadaptive flow control' can produce forces that can move a projectile enough to be used as a steering system," says project leader Jim McMichael, director of GTRI's Aerospace, Transportation and Advanced Systems Laboratory (ATAS).

Called SCORPION — for Self Correcting Projectile for Infantry Operation — this program, supported by the Defense Advanced Research Projects Agency (DARPA), has now moved well beyond the workbench phase. Working

jointly with Peter Plostins and his team at the U.S. Army Research Laboratory at Aberdeen, Md., GTRI recently demonstrated the feasibility of this projectile-steering approach on a spinning 40-millimeter projectile fired from an M-203 grenade launcher.

Synthetic jet actuators are derived from the work of Ari Glezer, a professor in the Georgia Institute of Technology's School of Mechanical Engineering. Some years ago, Glezer developed jets consisting of a minute vibrating diaphragm driven electrically by a piezo-ceramic element. These synthetic jets emit tiny vortices of air as their diaphragms vibrate. By essentially sucking in air and blowing it out thousand of times a second, they form a jet locally without the complex support apparatus conventional jets need.

By switching on an embedded synthetic jet for a few milliseconds, researchers can create an asymmetry in the air flow around the projectile. As the jet flow wraps around the projectile's tail, its effect is multiplied by a phenomenon called the Coanda effect. That in turn produces an air-flow change strong enough to alter the trajectory.

"The strength of this jet is not that high - it comes out at a velocity that's about half the speed that the projectile is moving forward," McMichael explains. "So it's not like a thruster; it's not like a rocket engine. It's a very small effect that is amplified by the Coanda effect."

BACKGROUND:
U.S. Army soldiers from the 4th Battalion, 11th Field Artillery Regiment perform calibration fires with a howitzer in Mosul, Iraq.



CONTACT:

Jim McMichael at
770-528-7826 or
james.mc michael@
gtri.gatech.edu

Small-scale, self-guided munitions could be useful to the infantry soldier in several ways. Like large-scale munitions, their increased accuracy would allow soldiers to increase both the effectiveness and the efficiency of a combat mission.

Kevin Massey, an engineer involved in SCORPION, observes that for foot soldiers already carrying more than 60 pounds of gear, being able to shoulder fewer rounds of ammunition would be a boon.

"If a round is ... three times more accurate, he can either carry around one-third as much ammunition, or he can engage three times as many things," he says.

Massey also envisions a soldier being able to aim and detonate a grenade-type round in mid-air within inches of a pre-determined spot. That could give infantry a powerful weapon against an enemy firing from around a corner or behind a doorway.

Such a super-accurate, steerable round could also improve battlefield security for infantry units, allowing them to be effective at greater distances from an enemy.

"It keeps the soldier farther from harm's way, increases the stand-off distance and makes his life safer," Massey says.

To control SCORPION's synthetic jets, GTRI scientists supplied a 40-mm test projectile with a set of electronics that they hardened to withstand the heavy forces generated during the launch tests. The onboard electronics created a complete system that researchers could pre-program to change trajectory during flight.

The current SCORPION projectile, which is basically a proof-of-concept device, lacks a full guidance system. If the military decides to pursue SCORPION, future program phases would likely add a guidance system that would allow operators to make corrections during flight and dictate the projectile's exact detonation point.

GTRI is working on a revised prototype that could lead to development of a practical SCORPION round, McMichael says. For one thing, engineers are changing the amount of space that the flow-control system uses inside the projectile.

"If you wanted to have a tactical system," he says, "you'll have to give some real estate back to other components that go on real grenades — like explosives."

A second SCORPION phase, now under way, is investigating the use of gas-generator actuators in the place of synthetic jets. Gas-generator actuators, which use minuscule explosive charges to create stronger forces than synthetic jets can, are being developed to steer higher-speed projectiles.

But the basic idea is the same, McMichael says. Though the gas-generator jets will be higher in strength, they still will steer the projectile by interacting with the air flow around the projectile rather than by using sheer jet thrust.

@ Read more at: gtresearchnews.gatech.edu/reshor/rh-ss06/scorpion.html



PHOTO COURTESY OF JIM MCMICHAEL

BELOW: Tiny devices called synthetic jet actuators, which squirt out minute puffs of air, can be embedded into the surface of a grenade-type projectile and alter the air flow around it. Georgia Tech Research Institute engineers recently demonstrated the feasibility of this projectile-steering approach on a spinning 40-millimeter projectile fired from an M-203 grenade launcher.



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