# On airplanes, fiber optics poised to reach new heights

September 18 2006

F-16 Aircraft. Courtesy Andrews Air Force Base

In an effort to provide safer and more reliable components for aircraft, researchers have invented an optical on-off switch that can replace electrical wiring on airplanes with fiber optics for controlling elevators, rudders, and other flight-critical elements.

Fiber-optics technology has already transformed life on the ground by replacing copper wire to transmit voice calls, Internet traffic, and other telecommunications. Now, engineers are preparing an important new fiber-optics application for liftoff, with their prototype switch ready for testing on real-life aircraft. The technology also has potential applications on the nation's highways, as a "weigh-in-motion" sensor for measuring the weight of fast-moving commercial trucks without requiring them to stop on a scale. The research is described by Zhaoxia Xie and Henry F. Taylor of Texas A&M University in the current issue

of *Optics Letters*, a journal of the Optical Society of America.

Xie and Taylor's new optical device is simple, but vital for an aircraft: it's an on-off switch. It senses the press of a button from a pilot. Such switches are usually electrically based and require electrical wiring which could get complex and bulky with the many buttons in cockpits and throughout an aircraft. But a system based on a single optical fiber could potentially sense presses from hundreds of buttons simultaneously by detecting light signals coming from different buttons.

The crucial component of the Texas A&M switch is called a fiber Fabry-Perot interferometer (FFPI). It consists of two parallel mirrors. When white light passes through the mirrors, some of it bounces between the mirrors, and some passes through. These light waves combine or "interfere" to produce a pattern. The interference pattern changes if the distance between the mirrors changes.

In the Texas A&M design, a small plank-like object, known as a cantilever, is bonded to the interferometer. The cantilever, in turn, is attached to a switch. Pressing the switch creates a force on the cantilever, which causes it to bend, changing the spacing between the mirrors and thereby altering the interference pattern. The altered interference pattern provides a signal to indicate that the switch has been pressed. This information can be transmitted optically to the desired part of the airplane. A network of other interferometers and lasers filters out fluctuations in temperature and other disturbances so that only the pressing of the button registers as a valid signal.

Using fiber optics to transmit signals has specific advantages for aircraft. A fiber-optics system is lightweight and does not take up much room. It is immune from lightning and electromagnetic interference. It also is a safer alternative for planes as it is not susceptible to causing fires. At least 26 accidents or serious incidents in aircraft since 1983 were caused

by fires or other failures related to electrical wiring systems, according to the Federal Aviation Administration.

The fiber-optic approach is intended for both military and commercial aircraft. It could either be incorporated into new designs or retrofitted into existing aircraft. Voice communications equipment in newer aircraft is already fiber-optics based, says lead author Xie. Therefore, integrating other aircraft instrumentation into a single optics package could save weight, space, fuel, and construction costs on future aircraft.

Lockheed Martin has been among the supporters of this research. The next step is to test this system on a real airplane.

According to Xie, the technology also has potential applications for other modes of transportation.

"Due to the sheer value of car and truck traffic on our highways, current weighing systems using slow and cumbersome static scales aren't a viable option. Therefore there's a strong demand for an economic, effective and reliable 'weigh-in-motion' system," comments Xie. In the FFPI weigh-in-motion system, the optical sensors would be bonded in a groove of metal bars to measure the strain induced by the truck wheels passing. This could provide an alternative to cumbersome and time-consuming stops that trucks must currently make in highways, she says.

Source: Optical Society of America