Fluorescent Barriers to Infiltration

Bill Wattenburg

Infiltration over long, unguarded borders is a serious problem worldwide in preventing hostilities, smuggling, and illegal immigration. The open borders that must be guarded often stretch for hundreds of kilometers or more, such as the United Nations–designated safe areas in Bosnia. Closer to home, the United States–Mexican border is an all too familiar example. Each day, more than a thousand illegal immigrants enter the United States, in spite of more than a thousand U.S. Border Patrol guards on duty. Many believe that massive illegal immigration from Mexico can only be stopped by draconian methods, such as closing several hundred kilometers of the most commonly crossed areas near border cities and roadways with elaborate security fences, barbed wire, and several thousand more guards with guard dogs. But then the chase would merely move to the other thousand kilometers of open border.

A major problem is identifying and tracking infiltrators who successfully cross long, unguarded borders and then disperse into the nearby countryside. But there is technology to help solve this problem, and in conjunction with present automated surveillance systems, it could be used to protect large areas. The scheme is called FTI for "fluorescent tagging of infiltrators." It involves laying down or "dusting" across infiltration routes narrow protection bands of invisible but harmless material that fluoresces when illuminated with laser or ultraviolet (UV) light. Fluorescent dust particles would be picked up on the skin and clothes of people and surfaces of vehicles passing through the protection bands. Thereafter, anyone or anything that picked up the fluorescent material could be detected by airborne surveillance systems and tracked for apprehension. Long protection bands could be created easily in open terrain with inexpensive crop dusting airplanes, and the bands could be moved frequently or renewed at relatively little cost.

With present surveillance technology, the only major effort required to begin field testing FTI systems is the formulation of appropriate, nontoxic, biodegradable fluorescent tagging materials from the many sources that chemists and biologists have already developed. The light detection and signal processing electronic packages required to detect these fluorescent materials already exist in many forms. Today, this detection scheme is quite workable in daylight with recently developed fluorescent materials and lasers. Existing commercial airborne laser scanning systems can monitor 100 km of border per hour with a 1-km-wide scanning path.

The idea of using fluorescent tags is certainly not new. Fluorescent tagging of people is often used for specific surveillance and identification purposes. (Fluorescent ink was applied to the hands of voters in the recent elections in South Africa.) Law enforcement has long used fluorescent dyes to identify thieves handling stolen currency. Legally, law enforcement officers should be able to question people who carry unique fluorescent markers that could have been picked up only by someone who had crossed a forbidden area.

Basic FTI experiments were performed in 1968 and reported to the Pentagon (*1*). Two kilograms of powdered waste fluorescent material (assumed to be mostly zinc sulfide) was scattered across a band 3 m wide and 30 m long (0.022 kg/m^2) in a field sparsely vegetated with grass and weeds about 20 cm high. A man then walked, crawled, or ran through the band at night. Two standard UV lights (200 watt) were stationed some distance away. The "infiltrator" could be detected by the naked eye up to 40 m away when he crossed the UV beams. It was concluded that detection was feasible without electronics up to 300 m with higher power UV spotlights, which could be made invisible to the infiltrator with cobalt glass filters. The infiltrator then changed clothes and shoes after crossing the band of dust but he was still identified close-up because fluorescent particles on his clothes and shoes had rubbed off on his hands while he was changing. The trace amounts of fluorescent material on his clothes were not visible to the naked eye.

Workable "dust" can be made from common materials such as zinc sulfide, halophosphates, or nontoxic crop fertilizers with small additions of the commercial fluorescent dyes used in cloth to make the colors appear brighter in sunlight. Even unrefined or commercial waste materials are usable for this purpose. Indeed, the question of whether fluorescent dust could be used to stop infiltration came to me while fighting a forest fire in 1967. I walked through a forested area that had been dusted by airplanes dropping solid fire retardant and later discovered that my work clothes sparkled under the UV lights in a barroom when I stopped to quench my thirst. Either the air-dropped fire retardant itself or, possibly, the fertilizer sometimes added to the fire retardant was fluorescent. My primary realization was that harmless fluorescent dust could be scattered on the ground fairly accurately and inexpensively by crop dusting airplanes.

Even with the waste fluorescent material we tested in the 1968 experiment, a typical crop duster planeload of 600 kg can cover a band 7 m wide and almost 4 km long (0.02 kg/m^2). Most illegal immigrants or drug smugglers crossing the arid stretches of our southern border on foot must use certain border zones close to roadways, pickup points, or cities on the U.S. side. These border regions comprise a few hundred kilometers, not thousands of kilometers. Crop dusting airplanes or farm tractors could lay down and renew fluorescent dust protection bands across these border hotspots at far less expense than any of our present procedures for continuously monitoring these large areas.

Detecting and tracking targets carrying unique fluorescent tags is feasible today. Oil companies have already developed airborne automated laser scanning systems to detect hydrocarbons on the surface over large areas. These systems use high-powered lasers to excite a broad spectrum of light emissions from natural materials. High-gain, multi-channel spectrometers resolve the backscattered light to identify specific target materials and their spatial patterns on the ground. These automated systems can scan 100 km^2/hour to detect telltale patterns of target material. However, if targets carry specific fluorescent tags, detection capability would be enhanced and laser requirements could be reduced (*2*). This means a border area 5 km wide by 20 km long could be scanned every hour by one small plane. Or, one plane on station (or a high observation point) could continuously scan an area of at least several square kilometers. These areas are comparable in size to many of the "hotspots" for illegal entry over our southern border.

Another system that could be used to detect and track fluorescent tags was recently demonstrated by Lawrence Livermore National Laboratory. A signal detection electronic package small enough to be carried in a backpack tracked the trajectory of a rifle bullet. The same electronics could be used for an FTI surveillance system that could be carried by a small robot airplane which stays aloft for long periods of time. Each robot plane with a laser scanner could continuously monitor an area at least 10 km long. If this system can track a rifle bullet, it should be capable of tracking even a hundred slow-moving, far away targets emitting unique fluorescent signals.

The author is a senior research scientist at the University Foundation, California State University, Chico, CA 95929-0246, USA.

As for the source of these signals, the ideal fluorescent dust would contain several fluorescent tags that emit light at different frequencies to provide a coded light signal that could be differentiated from background fluorescence. For instance, fluorescent dyes are available that emit in the near infrared (NIR). These are promising because very few natural materials exhibit NIR fluorescence. Background signals from vegetation would be minimized. Inexpensive semiconductor lasers can be used to excite these NIR dyes (3). In addition, there are polar organic fluorescent materials that stick to cloth, plastics, and plants. Rain will not easily wash them off vegetation. Indeed, the best of all fluorescent dust for this anti-infiltration scheme might look like "fluorescent strings," not dust particles—microscopic, slowly biodegradable, velcro-sticky fluorescent strings that stick to anything that passes by.

There are obvious countermeasures to this scheme, but they are not as easy to implement as one might think. How many times can one change clothes and bathe in the field? How does an infiltrator avoid multiple protection bands? If the individual uses a light source to locate the protection bands or to detect adhering fluorescent particles, his or her presence would be disclosed. At the very least, infiltration is seriously impeded or discouraged.

Animals crossing border protection zones would also pick up the fluorescent markers. However, the reality of interdiction in remote areas is that it usually takes place some distance from the actual point of crossing. The subsequent pattern of movement beyond border zone protection bands would discriminate between people and animals in most cases.

Cloud cover can prevent detection of distant fluorescent targets, just as other airborne surveillance systems are encumbered. But close-up detection from ground-based observation points is not significantly diminished. Wet conditions can even enhance the effectiveness of tagging targets on the ground if the right materials are used.

There is always the chance that fluorescent material could be transferred to another person by contact with a tagged infiltrator. But the purpose of an FTI system would be to interdict suspected infiltrators for positive identification before they disappear into population centers, not to search for suspected infiltrators in the general population where fluorescent material could be transferred to others by contact. In the case of legal immigrants accompanying illegal immigrants who are caught crossing our border, they must normally provide proper identification under present regulations. Even in warfare, detection of fluorescent tags alone should never be used to target suspects without other means of friend or foe identification.

The cost of welfare and health care for illegal immigrants in California alone is now several billion dollars a year. The cost is an estimated $10 billion a year for the nation. At the present rate of illegal immigration, this figure could double in the next 6 years while needy families of legal immigrants and native-borne alike will be denied the full government assistance they require to better their lives. In the final analysis, our democracy must decide now to deal with this social problem. FTI provides a viable technical option. Is it not worth field testing alternatives such as an automated airborne FTI scanning system compared with the long-term costs of illegal immigration at the present rate?

On average, 1300 illegal immigrants are apprehended every day along the 106-km border region around San Diego, California, alone. But while U.S. Border Patrol guards are arresting one group, another group within sight races across to populated areas a few hundred meters away. As many illegal immigrants successfully enter the United States as are apprehended each day. There is no punishment, so they simply try again if they are caught. They know that their chances for eventual success are good. This is an enormously expensive and never-ending game for our country.

The FTI system could be applied to the San Diego border region where most illegal immigrants flee across roadways or through canyons, dry creek beds, and hillsides where there are gaps in the security zones. These are relatively small areas that could easily be dusted with fluorescent material. Right now, guards on foot and helicopters with search lights must search the bushes and around the buildings of nearby populated areas for those who make it across the border. FTI could be an effective deterrent because illegal immigrants would soon learn that they would be tagged for easy apprehension. Most would not have the time or the means to remove fluorescent dust. Those who attempted to hide near the border on the U.S. side could be located far more easily with less chance of violating the rights of citizens in the area.

Most of the expensive hardware required for FTI experiments at San Diego is already available from government agencies. Basic experiments should not require additional personnel beyond the thousand trained officers on duty in this region. The helicopters and light planes now used for visual surveillance are quite sufficient airborne platforms for initial FTI experiments. Ordinary UV spotlights may be sufficient for low-altitude scanning. The hand-held light intensifying and nightvision devices used by border patrol officers could be used to detect many fluorescent targets. In this confined region, the most sophisticated airborne FTI scanning systems may not be necessary to locate and apprehend a large percentage of the 1000 to 1500 who now escape detection each day. The cost of a significant 6-month FTI experiment at San Diego should not exceed $500,000.

On a broader scale, workable FTI systems could dampen many violent confrontations around the world without putting so many of our own troops in danger, as we did in Somalia. Isolating combatants to specific areas and constraining their movements can take a lot of steam out of hostilities and protect civilians and peace-keeping forces alike. Defense perimeters could be protected and combatants isolated by FTI without requiring so many troops on the ground in many cases.

The aerospace engineers, systems analysts, and military strategists have given us quite impressive, though very expensive, surveillance systems. Now, it is time to give the chemists, biologists, astronomers, and, yes, even the farmers a go at finding more appropriate solutions for our peacetime problems.

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