An Automated Flying-Insect Detection System

Real-time monitoring and early detection networks detect harmful flying insects.

Stennis Space Center, Mississippi

An automated flying-insect detection system (AFIDS) was developed as a proof-of-concept instrument for real-time detection and identification of flying insects. This type of system has use in public health and homeland-security decision support, agriculture and military pest management, and/or entomological research.

As shown in Figure 1 (top panel), insects are first lured into the AFIDS integrated sphere by insect attractants. Once inside the sphere, the insect's wing beats cause alterations in light intensity that is detected by a photoelectric sensor. Following detection, the insects are encouraged (with the use of a small fan) to move out of the sphere and into a designated insect trap where they are held for taxonomic identification or serological testing. The acquired electronic wing-beat signatures are preprocessed (Fourier transformed) in real-time to display a periodic signal. These signals are sent to the end user where they are graphically displayed as shown in Figure 1

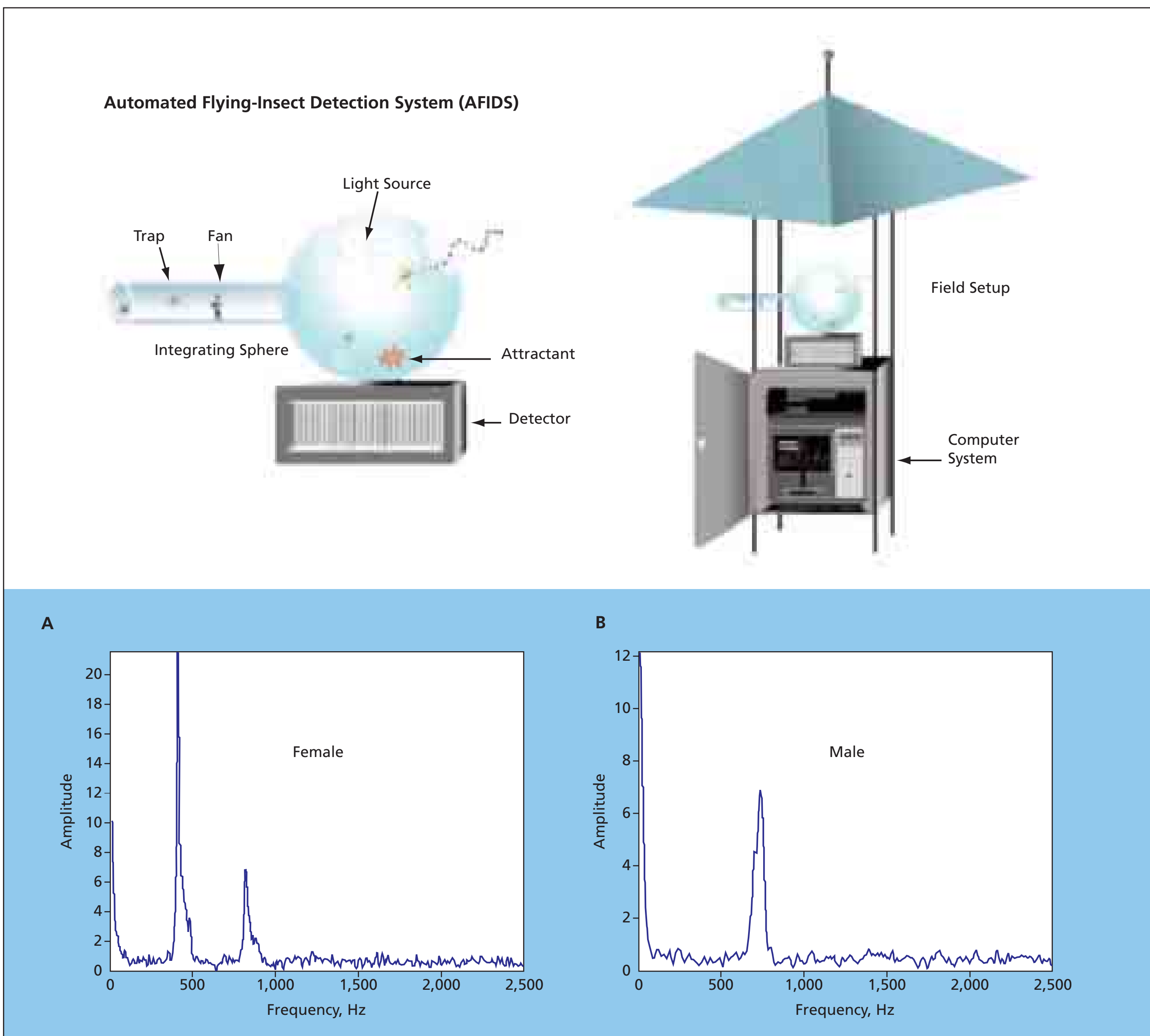

Figure 1. **AFIDS** is deployed as shown in the top panel. The bottom panel shows spectral plots of AFIDS acquired wing-beat signatures. The differences between female (plot **A**, 409 Hz) and male (plot **B**, 737 Hz) *Aedes albopictus* mosquitoes are apparent.

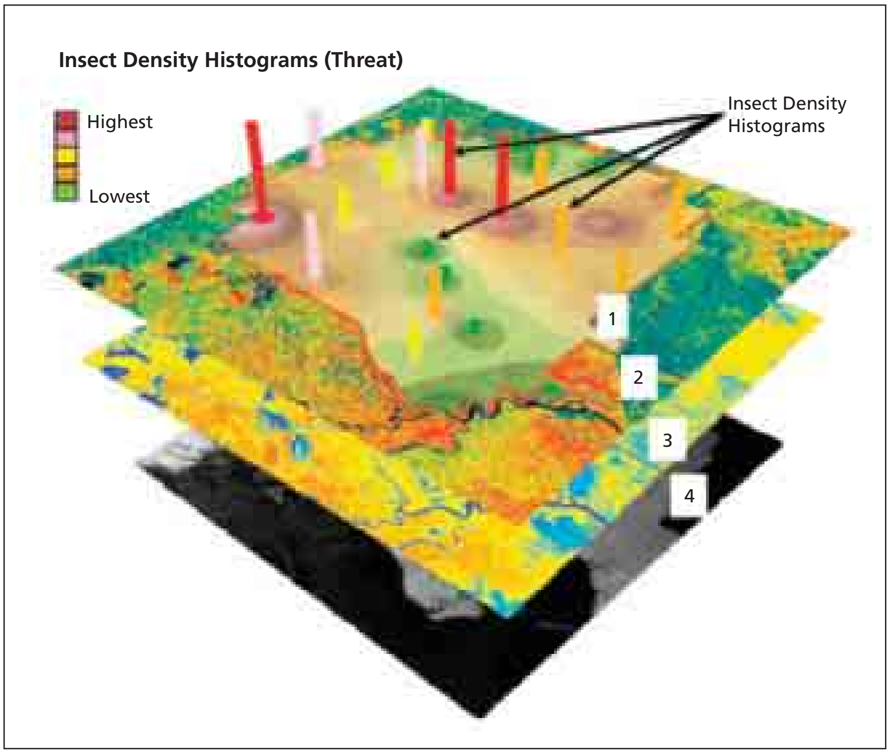

Figure 2. **Integration of AFIDS and GIS Data Layers** is illustrated for hypothetical military, civilian, or agricultural pest management. Data layers are as follows: (1) Hypothetical AFIDS insect density contours (histograms = threat intensity); (2) STAR-3i radar imagery; (3) ASTER Normalized Difference Vegetative Index; and (4) LIDAR digital terrain.

(bottom panel). All AFIDS data are preprocessed in the field with the use of a laptop computer equipped with LabVIEW™. The AFIDS software can be programmed to run continuously or at specific time intervals when insects are prevalent.

A special DC-restored transimpedance amplifier reduces the contributions of low-frequency background light signals, and affords approximately two orders of magnitude greater AC gain than conventional amplifiers. This greatly increases the signal-to-noise ratio and enables the detection of small changes in light intensity. The AFIDS light source consists of high-intensity AlGaInP light-emitting diodes (LEDs). The AFIDS circuitry minimizes brightness fluctuations in the LEDs and when integrated with an integrating sphere, creates a diffuse uniform light field. The insect wing beats isotropically scatter the diffuse light in the sphere and create wing-beat signatures that are detected by the sensor. This configuration minimizes variations in signal associated with insect flight orientation.

Preliminary data indicate that AFIDS has sufficient sensitivity and frequency-measuring capability to differentiate between male and female mosquitoes (Figure 1, bottom panel) and fruit flies (data not shown). Similar studies show that AFIDS can be utilized to detect discrete differences between two mosquito species, *Aedes aegypti* and *Aedes albopictus.*

When fully deployable, a wireless network of AFIDS monitors could be used in combination with other remotely sensed data and visually displayed in a geographic information system (GIS) to provide real-time surveillance (see Figure 2). More accurate and sensitive insect population forecasts and effective rapid response and mitigation of insect issues would then be possible.

This work was done by Timi Vann of Stennis Space Center and Jane C. Andrews, Dane Howell, and Robert Ryan of Lockheed Martin Corp.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00192.

Calligraphic Poling of Ferroelectric Material

Arbitrary patterns can be written relatively easily and inexpensively.

NASA's Jet Propulsion Laboratory, Pasadena, California

Calligraphic poling is a technique for generating an arbitrary, possibly complex pattern of localized reversal in the direction of permanent polarization in a wafer of $LiNbO_3$ or other ferroelectric material. The technique is so named because it involves a writing process in which a sharp electrode tip is moved across a surface of the wafer to expose the wafer to a polarizing electric field in the desired pattern. The technique is implemented by use of an apparatus, denoted a calligraphic poling machine (CPM), that includes the electrode and other components as described in more detail below.

A capability for forming poling patterns is needed for research on, and development of, photonic devices that exploit the nonlinear optical properties of ferroelectric crystals. Specific poling structures in ferroelectric crystals can be engineered to variously amplify or suppress these nonlinear optical properties to effect such useful functions as optical switching, modulation, frequency conversion, and frequency filtering.

Outside of industry, poling machines have been available to only a few research laboratories and have been typified by high costs and limited flexibility. Prior poling techniques and machines are suitable for generating relatively simple patterns (e.g., straight lines) but are not suitable for generating the arbitrary patterns required in some applications. Each of the prior techniques involves one or more of the following: expensive fabrication of electrically conductive masks, expensive holograms, a clean-room, high vacuum, and high temperature. In contrast, a CPM operates in air at room temperature with equipment readily available in a typical laboratory; hence, calligraphic poling costs less than does poling by the prior techniques.

In a CPM (see figure), the wafer to be poled is placed in the *x–y* (horizontal)