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**TRACKING VIDEO PIRATES:
NEW SYSTEM HELPS PINPOINT LOCATION
OF TRANSMITTERS WHICH JAM SATELLITES**

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Photography Available

When video pirate Captain Midnight beamed his message of protest into the Home Box Office satellite transmission system four years ago, company officials had no good way of determining exactly where the signal was originating.

Engineers at the Georgia Institute of Technology have now developed a system for pinpointing the location of ground stations that interfere with satellites, using a variation of techniques long used for radio navigation.

The new Satellite Interference Location System (SILS) should help satellite operators more quickly locate the source of accidental satellite interference -- as well as any future Captain Midnights. The work was industry sponsored.

"We have developed a system that allows existing spacecraft to measure the position of the ground stations that are uplinking to them," explained Dr. Paul Steffes, professor of Electrical Engineering at Georgia Tech. "We have developed two techniques whereby we can triangulate and infer the location of the ground stations."

The system could theoretically produce accuracy to within a fraction of a mile, but its real accuracy depends on the strength of the interfering signal and the amount of noise present, said Whit Smith, a graduate student who refined the techniques as part of his doctoral thesis.

The system uses a "Time Difference of Arrival" technique to infer the longitude of the ground station, and an interferometric technique to learn its latitude. The SILS can be used with geosynchronous communications satellites which orbit above the Equator in sync with the Earth's rotation.

The Time Difference of Arrival method uses information obtained from two adjacent satellites. Engineers measure the difference between arrival times of the interfering signal at the affected satellite and that of the weaker sidelobe "spillover" signal at the nearby satellite. This time delay corresponds to the different distances that the signal must travel to reach the two satellites.

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Because they know the precise location of the satellites, engineers can use trigonometric techniques -- similar to the Loran system used by aircraft or ships for navigation -- to infer the longitude of the ground station, Smith explained.

(A similar technique exists to locate ships or aircraft in distress. The key difference is that the distress signals are designed to be found, while the satellite interference signals are not, Smith noted.)

Obtaining information about the latitude of the ground station is more difficult, requiring more complex analysis of signals reaching two antennas on the same satellite.

Satellite transmissions are carried by microwaves which have distinct phases similar to the crests and troughs of ocean waves. By comparing the phase at which the same signal reaches the two antennas, engineers can use interferometry to determine the angle at which they arrived. Knowing the angle of arrival allows them to infer the latitude of the ground station sending the signal.

"Adding longitude and latitude," said Steffes, "allows us to know where the station is, and we have successfully located the source of interfering signals this way."

Finally, the system uses computer analysis techniques to display the potential location on a terrestrial map.

Though Captain Midnight gained considerable notoriety for his action, most satellite interference problems are of an entirely different nature, Steffes said.

"Most of the problems are due to situations where transmitters are turned on accidentally or at the wrong time," he explained. "Other problems can occur when antennas are not properly aimed."

Commercial FM radio stations can also leak over into satellite uplinks, while sloppy operation by television news crews can cause problems when they try to transmit to their stations or networks via satellite. In any case, the stronger signal can jam all transmissions to that satellite.

Technicians can track down the radio station by listening for its call letters, but finding the source of computer data or other nondescript interference can be difficult and time-consuming.

Smith and Steffes have tested their satellite interference location system using Georgia Tech satellite dishes and larger antennas at an industry tracking, telemetry and control site. They recently used an Atlanta television station's satellite news gathering truck to test the system.

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