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Tech Brief

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Development of an Enhanced Emergency Locator Transmitter for General Aviation

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Summary

Rowan University and Virginia Tech have developed an Enhanced Emergency Locator Transmitter (E^2LT) for general aviation craft. The E^2LT will supplement existing Emergency Locator Transmitter systems which broadcast a simple radio beacon in the event of an aircraft crash. However, unlike existing devices, the E^2LT device will transmit the crash site location and crash severity directly to Emergency Response Teams. This advanced emergency location system combines inexpensive crash sensors, web-enabled wireless communications and the Global Positioning Systems to transmit crash site location to an Emergency Base Station.

The objective of the E^2LT System is to reduce emergency response times

The purpose of the system is not only to shorten the time it takes for authorities to respond to the crash site, but to improve the quality of the response

Introduction

The Federal Aviation Administration requires that all general aviation aircraft have an Emergency Location Transmitter (ELT) on board before they can be registered or authorized for flight [FAA, 2000]. An ELT is designed to automatically transmit a radio signal that can be used to locate an aircraft involved in a crash. Over 10,000 lives have been saved worldwide since the deployment of this successful system in the late 1970s.

Conventional ELTs suffer from several problems which present serious challenges to Search and Rescue teams seeking downed aircraft.

- False Alarms. Only 3 in 1000 ELT alarms were triggered by an actual aircraft crash. The remainder are false alarms triggered by events such as a hard landing, equipment malfunction, or inadvertent manual activation. Search and Rescue teams, which must investigate all ELT beacons, expend a great deal of time tracking down non-emergency activated ELTs.

- Failure to Detect a Crash. In an actual crash, current ELTs only trigger in 70-80% of the cases. The result is that a substantial number of downed aircraft are either never found or are found long after any survivors have died.

- Poor Indication of Crash Position. Most ELTs installed in the fleet do not provide the crash location with sufficient accuracy. The National Transportation Safety Board (NTSB) estimates that the position accuracy with newer units (TSO C126-compliant) is only 1 to 3 nautical miles compared to 12 to 16 nautical miles for older units (TSO C91a-compliant). Some newer models encode GPS-location in their distress signals, but this technology is not yet widespread within the general aviation fleet.

Research Approach

Under the sponsorship of the New Jersey Department of Transportation, Rowan University and Virginia Tech have developed an Enhanced Emergency Locator Transmitter (E^2LT) for general aviation craft. The E^2LT combines inexpensive micro-machined crash sensors, web-enabled wireless communications, and Global Positioning Systems to transmit crash site location to an Emergency Base Station.

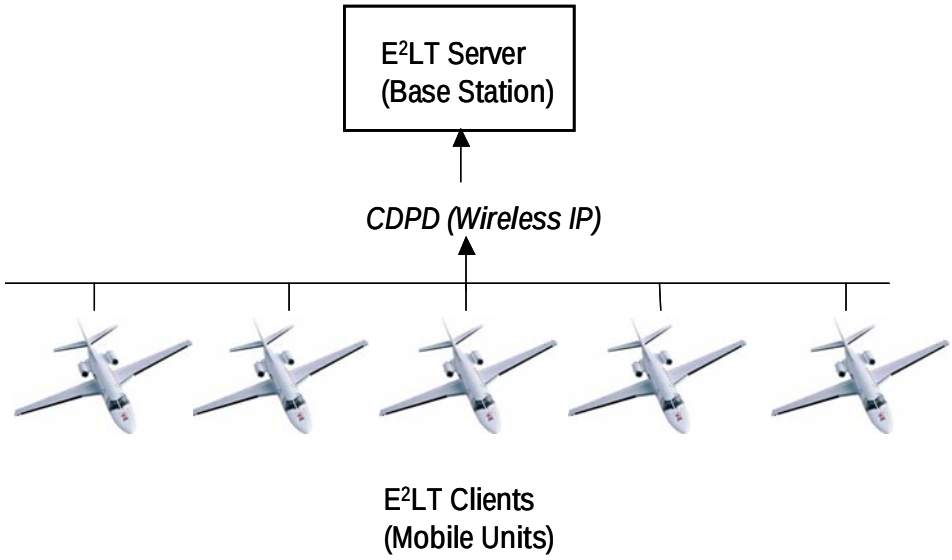
The system is composed of two major subsystems: (1) the Mobile Unit which is installed in the aircraft, and (2) the Base Station which is responsible for receiving distress calls from the Mobile Units and reporting their location to emergency response dispatch personnel. The Mobile Unit is responsible for detecting a crash, determining the location

of the crash, and communicating crash severity and crash site location to the Base Station.

FINDINGS

The research program has demonstrated the feasibility of an Enhanced Emergency Locator Transmitter (E^2LT) which eliminates many of the problems suffered by conventional ELTs installed in general aviation craft. A summary is provided below:

Mobile Unit. The Mobile unit contains a two-axis silicon accelerometer, embedded 12-channel GPS system, embedded Microchip PIC17 microcomputer, and embedded wireless modem. All components are mounted on a custom printed circuit board which was designed at Rowan, and constructed by an outside fabrication facility. A crash algorithm, a software module in the microprocessor, was developed to detect a crash while avoiding false alarms. The Mobile Unit must be able to distinguish between actual crashes and non-distress events, e.g. hard landings. To detect a crash, the microprocessor samples the accelerometer output at 1000 Hz (1 sample per millisecond).



General Aviation Crash Notification via Wireless Web

Base Station. In the event of a crash, the Mobile Unit and Base Station will communicate using wireless Cellular Digital Packet Data (CDPD) technology. CDPD is a wireless Web access technology which uses the analog cellular network. CDPD allows a direct TCP/IP link to be established between the mobile unit and base station.

Using this protocol, the base station is designed as a Web Server, and the Mobile Unit reports a crash to the Server via a wireless Internet connection The E^2LT system is expected to scale well to large fleets. Because of the high bandwidth of the Web, this approach greatly reduces emergency message congestion allowing emergency dispatchers to readily handle multiple emergency requests.

Performance Testing. The performance of the E^2LT Mobile Unit was successfully evaluated in a number of laboratory tests.

- Non-impact tracking tests
- Impact penetration tests
- Component testing of the E^2LT under crash loading

Most demanding was the testing of the E^2LT in a full aircraft drop test. In July 2003, the FAA granted permission to 'piggy-back' the E^2LT an FAA full scale aircraft drop test conducted at the William J. Hughes Technical Center. The E^2LT mobile unit, mounted in the tail of the ATR42-300 aircraft, successfully detected the crash and transmitted the coordinates of the FAA crash test site to the E^2LT base station.

The E^2LT worked successfully in the vertical drop test of a ATR42-300

Limitations. Operation of the wireless modem depends on the availability of wireless transmission towers, and hence can only be used in areas where wireless phone service is available. As a result, the E^2LT cannot be relied upon for emergencies taking place in remote places, such as over large water bodies. Additionally, GPS receivers are only useful if the antenna can lock on to a sufficient number of GPS satellites. GPS may not be available in areas of dense foliage. Due to these limitations, the E^2LT is intended as an accessory to existing ELTs, not as an independent system.

CONCLUSIONS

This research project has designed, developed, and tested an enhanced Emergency Locator Transmitter that combines wireless communications and Global Positioning Systems with a network of inexpensive sensors for crash detection. Efforts to date have successfully designed and constructed a working prototype system. Successful operation of the prototype has been demonstrated in establishing a wireless web connection between the Mobile Unit and the Base Station, and in a full scale aircraft crash test.

References

[1] Federal Aviation Administration, Regulation Part 91, Section 91.207 Emergency Locator Transmitters (ELTs) (December 22, 2000)

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