Senior Design Project in Electrical & Computer Engineering

Integrated Receiver Design for Marine & Aviation Navigation

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Project Background

The notion of getting lost has been forgotten with the use of satellites in space that allow people to find their position anywhere on the planet with an error of mere meters. The Global Positioning System (GPS) is a highly accurate, worldwide navigation system that is used by people on the ground, ships on the sea, and planes in the air. However, this seemingly perfect system does have faults that could lead to disaster. Tall buildings and steel structures attenuate the navigational signals and the system can be easily jammed. A potential terrorist could cheaply buy the necessary parts from a local electronics store to jam the signal for a fifty mile radius or with a little more planning build a system sending GPS receivers erroneous information. In addition waves from televisions and other commercial transmitters can cause inadvertent jamming of GPS within a 300-kilometer radius. These losses of GPS can have devastating effects on ships navigating in narrow channels and planes attempting to land.

Loran-C is another navigation system that uses high-powered, low frequency signals that are emitted from ground-based antennas. These signals provide complete coverage for the continental United States, are not as attenuated by man-made structures, and cannot easily be jammed. The Federal Aviation Administration (FAA), concerned about the consequences to airplanes with the loss of GPS, has recently tasked several agencies to develop a Loran-C receiver that could be integrated with other navigation receivers such as GPS sensors.

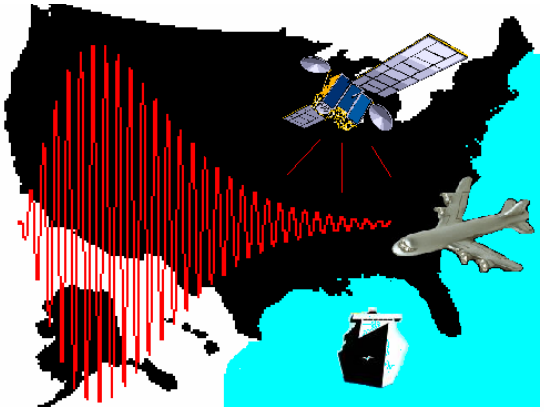
While Loran-C is currently approved for the en-route phase of flight, it is not approved for the most critical part of air navigation, the approach phase. Work is currently being done to improve the accuracy of the Loran-C navigation system. After completing the improvements Loran-C could be integrated with other sensors such as GPS receivers, inertial, Wide Area Augmentation System (WAAS), or Differential (DGPS). By using different types of navigation a more robust and tolerant position solution can be provided. Integrated receivers provide higher accuracy navigation with inherent redundancy.

NOVATEL GPS, WAAS, AND DGPS RECEIVER CONFIGURATION

The Problem

Given the accuracy of Loran-C and its characteristics, which type of sensor augmentation (WAAS or Differential) should be used for integration, taking into consideration the accuracy, precision, and reliability of the corrections. The second part of the problem involves the process of implementing Kalman filters for the actual integration of the Loran-C and GPS receivers.

Loran Signal, GPS Satellite and Navigation Users



Work Completed

Extensive test data has been acquired and analyzed using GPS, WAAS, and DGPS receivers from one fixed location. Fixes were plotted, ranges of error in meters were found, and 95% accuracy circles were plotted in order to assess the spatial variance in the accuracy of the positions. A plan has been developed to collect more data from various distances and bearings to a Coast Guard transmitter with two additional new WAAS and DGPS receivers (North Star and Furuno brand) added to the testing configuration. These new commercially available receivers ranging in price from $500 to $2800, in addition to three standard NOVATEL receivers, will enable us to test quality of fix position versus quality of receiver.

Goals

- **Continue testing for receivers while additionally taking into consideration correction data's signal strength, station location, and availability.**
- **Recommend type of receiver to be used in integration**
- **Begin work on Kalman filters for actual integration process.**