LORAN and DGPS Signal Coverage Software

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Abstract

Prior research at the U.S. Coast Guard Academy has developed a preliminary software package that enables the Coast Guard to better design placement, power, and frequency allocation of groundwave radionavigation systems such as LORAN and Differential GPS. There are two software packages with one displaying the propagation patterns for DGPS beacons and the other software package displaying LORAN propagation patterns. The current project focused on further development of the DGPS software referred to as DGPS_Coverage. The software required improvements to its user menus and the feature of double coverage display. The improvements to the software will allow the Coast Guard's Navigation Center (NAVCEN) to evaluate DGPS_Coverage for replacement of the existing propagation software.

Introduction

As the nation attempts to implement nationwide differential GPS, several propagation issues arise. Will signal interference from sites on the same frequency reduce an antenna's effective coverage area? Will skywave propagation create long-range problems? In an attempt to answer these questions, DGPS_Coverage software was designed to model various antenna sites and their propagation patterns. The software also models the effects of skywave propagation on antenna sites with the same operating frequency. Overall, the project is part of an on-going effort to improve the management of U.S. Coast Guard Radionavigation assets.

Background

Prior research at the U.S. Coast Guard Academy has developed a preliminary software package that enables the Coast Guard to better design placement, power, and frequency allocation of groundwave radionavigation systems such as LORAN and Differential GPS. The preliminary software currently provides the necessary information, however, operating the software is difficult. Menus within the software are complicated and often lacking important information.

Captain Benjamin Peterson and Ensign Mike Danish designed the software using Millington's Method. The motivation and funding for the project has been from the FAA. The nation's growing desire for DGPS created a need for the system in commercial airplanes. Before the system is given a stamp of approval, the antennas must be tested. DGPS_Coverage software is the answer to testing the antenna sites and evaluating coverage areas before activating each antenna.

Objective

The DGPS and LORAN software design project will produce a user-friendly program to give graphical representations of the propagation patterns and potential coverage problems with existing DGPS and LORAN antenna sites. The DGPS software is near completion for review by

NAVCEN. The software requires easier to use menus and help functions to assist the customer. The LORAN software must be reviewed further, and additions to the software are required to enable the user to understand it. The DGPS software has taken precedence over the LORAN software due to the needs of the customer.

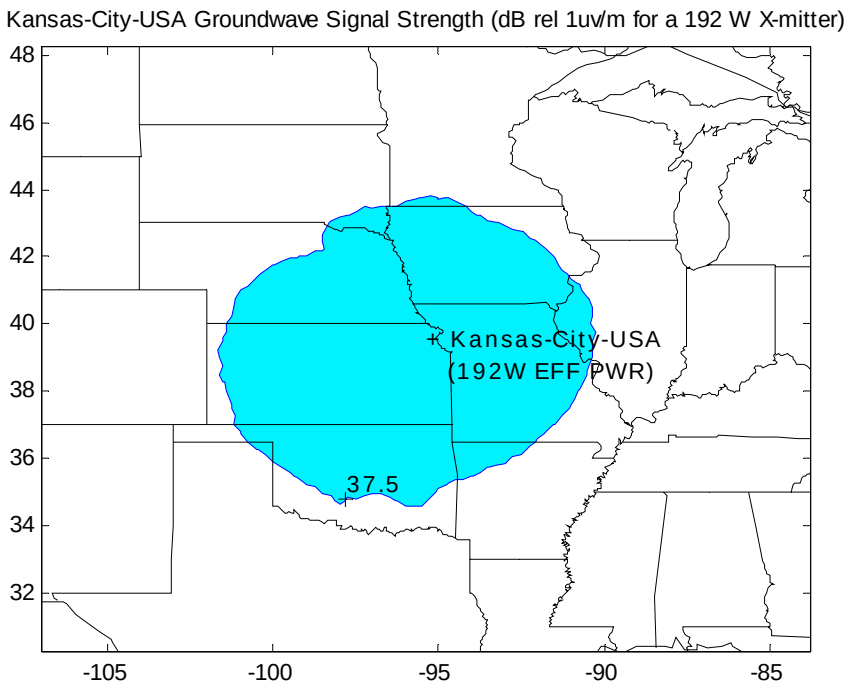
Technical Approach

The software needs improvements made to its operability. The software has undergone several revisions and the immediate goal is to modify the software so that it resembles software used by NAVCEN. The first step is to modify the master beacon list's identification numbers to resemble the national standard. Afterwards, changes to the software's graphs will be made. The current antenna site plots do not illustrate overlapping coverage nor allow the user to turn on and off sites without re-plotting the entire figure. There are numerous other small modifications that are necessary before the software can support NAVCEN. The second focus will be to verify the software against data and plots provided by NAVCEN. This portion of the project is crucial because it not only attempts to validate the DGPS_Coverage Software, but it may provide clues to terrain effects and errors in calculating antenna propagation patterns.

The LORAN software is in need of several improvements to its design. The basic program appears to work with few errors but understanding how to operate the program is difficult. The m-files will need to be compiled within a single m-file and several menus are needed to enable the user to understand the program. After the passing of the first milestone (review by NAVCEN), the LORAN software will be reviewed to utilize time between review and feedback from the customer.

Results

DGPS_Coverage Software has been modified to mirror the software used by NAVCEN in verifying coverage provided by an antenna site. The contour plots were eliminated and a single color is used to show the coverage area. This was done because the signal strength outside of the coverage area, signal strength less than 37.5 dB, is of little importance for evaluating DGPS coverage. The contour plots are useful in skywave analysis and they remain on this portion of the software. Overlapping coverage is also identified in the latest version of DGPS_Coverage. It is displayed by differing the colors of the areas with at least double coverage. While this part of the software functions for small groups of sites at a time, the goal is to display double, triple, even quadruple coverage for the entire United States. Other items added to the software were alphabetical searching for names of sites and error checking to ensure user's do not crash the program by trying to evaluate sites without the proper inputs. The error checking applies to sites listed with no effective power for the antennas. DGPS_Coverage cannot plot these sites and will terminate the program session when attempting to plot these sites unless the error checking was implemented. A GUI interface has also been added but is not necessary for the software to be used. It is optional to allow future versions of the software to design user specific GUI's.



The verification of the software results is an aspect of the project that is still being explored.

Conclusions

The DGPS software will aid the Coast Guard in correcting propagation problems before they occur. There is also a LORAN portion of the software being developed but the focus has been on the DGPS section due to its demand. A user specific GUI will aide the functionality of the software and improve ramp-up time in learning the software. The possibilities for aesthetic improvements are very broad and implementing them is a short-term project after the software is reviewed by NAVCEN. Further developments to the plotting of propagation patterns is necessary to increase the accuracy for models of real antennas.