INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT OHIO UNIVERSITY, 1986

Richard H. McFarland
Avionics Engineering Center
Department of Electrical Engineering
Ohio University
Athens, Ohio

INTRODUCTORY REMARKS

Several important goals were achieved with the work supported by the Joint University Program during 1986. Among these goals is the first DC-3 flight with a Navstar Global Positioning System (GPS) receiver collecting positional data and allowing comparisons with simultaneous collected data from the Long Range Navigation system Loran-C. The principal purpose for this instrumentation was to learn of the detailed characteristics evident in the Doppler frequency shift from signals being received onboard an aircraft in flight (ref. 1).

This work was correlated with a thesis effort by a student who demonstrated the feasibility of using a despread spectrum technique to obtain positional information from GPS without knowledge of the code (ref. 1). By using Doppler information rather than range measurements one can also obtain positional information. The theory was mechanized by building a correlator and delay line which allowed a demonstration in the laboratory that the concept was indeed valid. The student has subsequently taken a position with an organization which is interested in extending this work.

Work with both GPS and Loran-C at Ohio University motivated the study of the use of Loran-C to augment the GPS capability. Especially in the present time frame when there are but a few satellites in orbit, additional navigational data are desirable, and these can come from a Loran-C station. This augmentation is expected to be useful for monitoring and integrity checking of GPS signals.

A completion of the Digital Autonomous Terminal Access Communications (DATAC) work has been achieved. This began with a student intern in residence at Langley Research Center. More systems in aircraft dictate more efficient and effective communications between units. The Airlines Electronic Engineering Committee of ARINC has evaluated comments concerning such a data bus which they consider as having the potential for improving integrity such that no single point terminal failure would significantly degrade the integrity of the data bus.

A continuing effort has been under way in collecting Loran-C data (ref. 2). The purpose of this is to learn of the variations in positional information as a function of the seasons and weather. Quantifying the grid shifts in the Ohio area has been achieved (ref. 3).

An investigation is beginning on the use of automatic data transfer from ground stations to an airplane. Particular emphasis is on handling weather data. A specific goal is for the system to be extremely efficient principally because of the limited radio frequency spectrum available for such use and the tremendous amounts of weather data that will soon become available with the central weather processor and Next-Generation Weather Radar (NEXRAD) systems that are now being developed.

Finally, work has begun on reliability assessment of avionics equipment. The need for high reliability is well known. Many current items used in aviation, general aviation in particular, are plagued by unacceptable high failure rates. The increase in the use of more complex avionics to achieve landings with lower and lower landing minima (Category III) makes it imperative to improve reliability. This will be stressed through design approaches (ref. 4).

This year has been fruitful and beneficial to the participants of the program. Ohio University continues to feel strongly that this Joint University Program and engineering investigation is extremely valuable to its students who have the opportunity to become thoroughly involved with contemporary engineering.

ANNOTATED REFERENCES

1. Laube, J. P.: An Investigative Study of Blind Despreading and Doppler Tracking Using Autocorrelation. Ohio University, Department of Electrical Engineering, Master's Thesis, June 1986.

   A simplified approach to detection of signals from an existing satellite navigation system is presented, which offers flexibility and possible use on several similar systems. A brief history and general overview are provided, developing the desirability of the technique described. The concept is presented analytically and experimentally verified. Results show conclusively that autocorrelation of a spread spectrum signal can occur, even when the signal is below the noise floor. The detection of this signal can provide Doppler information. This Doppler information can provide position data with low-complexity circuits. Knowledge of the signal spreading code is not necessary, which allows for inter system compatibility and freedom from losing code privileges due to government policy decisions.

2. Edwards, J. S.: FAA/OHIO University Loran-C Monitor. Ohio University, Avionics Engineering Center, Interim Data Reports No. 6 through 10, Report No. OU/AEC 1-86TM-TRIU104-108, April 1986.

   These reports contain Loran-C monitor data which are subject to further processing. The data are provided to interested parties as preliminary information only.

3. Lilley, R. W., and Edwards, J. S.: Loran-C Monitor Correlation Over a 92-Mile Baseline in Ohio. Proceedings of the WGA 15th Annual Technical Symposium, New Orleans, Louisiana, 21-24 October 1986.

Two Loran-C monitors, at Galion and Athens, Ohio, were operated over a one-year period, measuring chain 9960 Time differences (TD) and Signal to Noise Ratios (SNR). Analysis of data concentrated on correlation of short-term TD variations during the winter months of 1985-86, over the 92-nm baseline. Excellent correlation was found, with slight additional improvement possible if local temperature is also included in the analysis.

4. Alikiotis, D. M.: Discrete Markov Chain Compression Method. Ohio University, Avionics Engineering Center, Report No. OU/AEC 6-86TM TRIU109, June 1986.

This paper presents a method for dealing with the problem of the combinatorial explosion of the Discrete Markov Chains when a complex system is analyzed. A comparison between the standard Markov process or model and the Discrete Markov Chain Compression Method is also presented.