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LORAN-C APPROACH GUIDANCE PROJECT: CURRENT STATUS

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Abstract

There are four areas of work in the Loran-C approach flight test project (fig. 1). Current results provide performance data on the effects of Signal Noise Ratio, SNR, on the dynamic performance of the receiver filters for Loran-C data, and data on Loran-C grid deformation at a microscale of 100 meters.

The Loran-C receiver provides an LOP (line of position) Master and Slave transmitter at an angle θ to magnetic north (fig. 2). No transformation to latitude-longitude reference frame is required since this is the major source of Loran-C navigation errors.

A local coordinate frame is established centered at touchdown point on the runway with directions along and across the runway (fig. 3). The coordinate transformation is shown as a simple pair of equations which can be easily computed.

A Loran-C data collection system has been set up as shown in figure 4. The Loran-C data are sent directly to an Apple II computer with a 12-inch monitor. The system has been installed in various ground vehicles with a 24-inch whip antenna mounted on the roof. This serves as a mobile platform for micro grid surveys and investigation of receiver dynamics.

The effect of SNR on Loran-C precision is shown for two receiver filters of different frequency response (fig. 5). The standard deviation of Loran-C is less than 0.1 microsecond (100 feet) at positive values for SNR.

A set of ground level static readings of touchdown (TD) was taken around Hanscom Field and transferred to an accurate detailed layout drawing; this showed local distortions of the average TD values as shown in figures 6 and 7. Similar surveys on a grid on the athletic fields at MIT showed variations over 100 meter spacing.

It is not clear why these microdistortions exist. They may not exist if the Loran-C antenna were a few hundred feet in the air, which suggests a 3-D survey in the approach area (fig. 8).

A possible method for a 3-D survey of micro grid distortions of Loran-C signals is shown. There are difficulties in locating a balloon precisely when winds exist, and a more mobile system to move over the micro grid is desired (fig. 9).

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MAJOR AREAS:

- ALGORITHM DEVELOPMENT
- DISPLAYS AND PROCEDURES
- SENSOR BLENDING
- PERFORMANCE AND STANDARDS

PERFORMANCE - CURRENT TOPICS

- STATIC PERFORMANCE - EFFECT OF SNR
- DYNAMIC PERFORMANCE - FILTERS
- GRID MICRODEFORMATION

Figure 1. Loran-C approach nav - status.

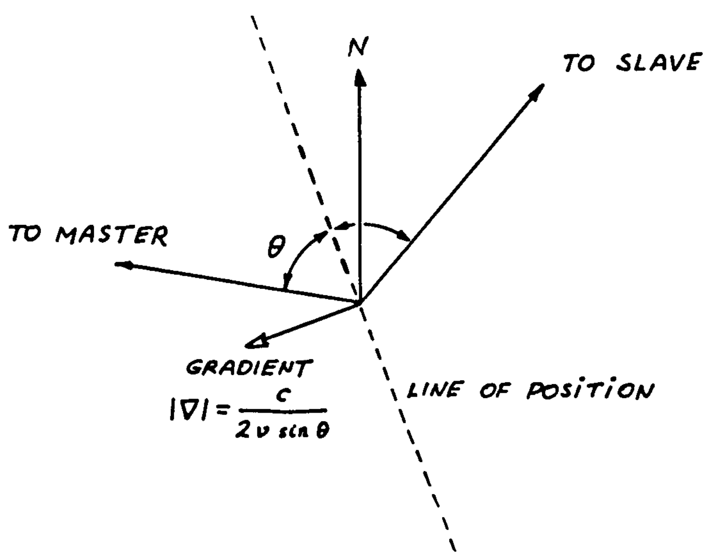
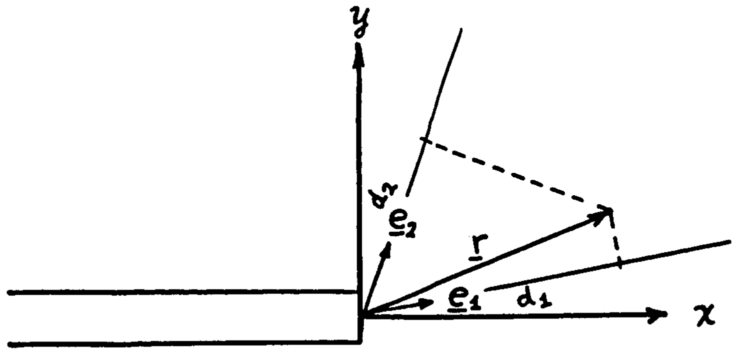


Figure 2. Local Loran geometry.



$$d_1 = \underline{r}\cdot\underline{e}_1, \quad d_2 = \underline{r}\cdot\underline{e}_2 \rightarrow \begin{Bmatrix} d_1 \\ d_2 \end{Bmatrix} = \begin{bmatrix} e_{1x} & e_{1y} \\ e_{2x} & e_{2y} \end{bmatrix} \begin{Bmatrix} r_x \\ r_y \end{Bmatrix}$$

$$\begin{Bmatrix} r_x \\ r_y \end{Bmatrix} = \begin{bmatrix} e_{1x} & e_{1y} \\ e_{2x} & e_{2y} \end{bmatrix}^{-1} \begin{Bmatrix} d_1 \\ d_2 \end{Bmatrix}$$

Figure 3. Coordinate transformation.

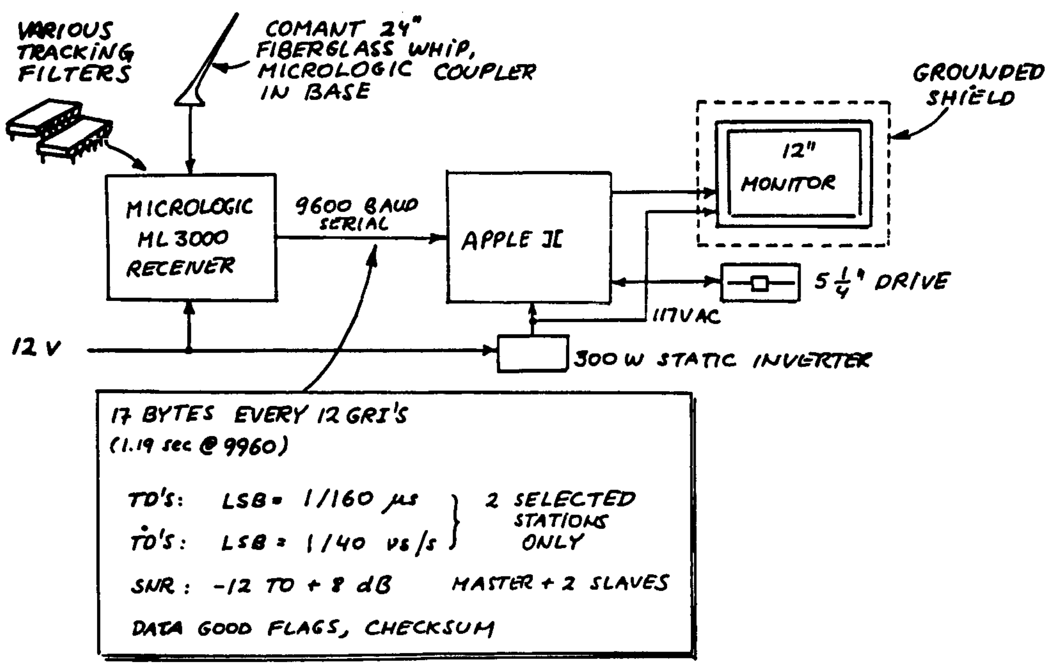


Figure 4. Loran-C data collection setup.

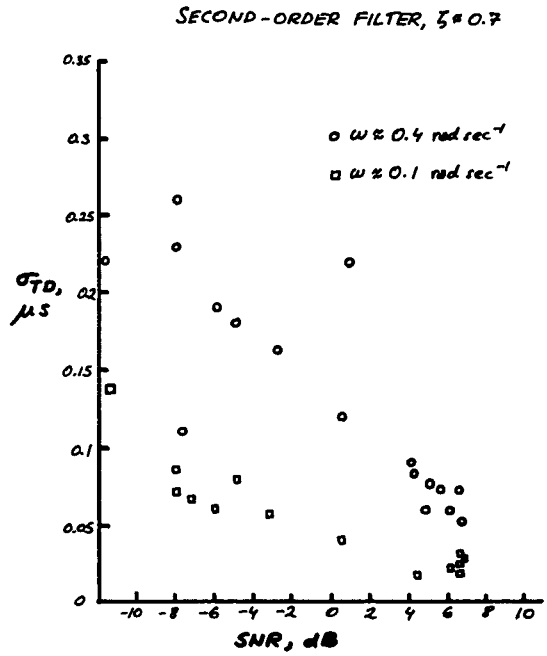


Figure 5. Short-term variation in TD.

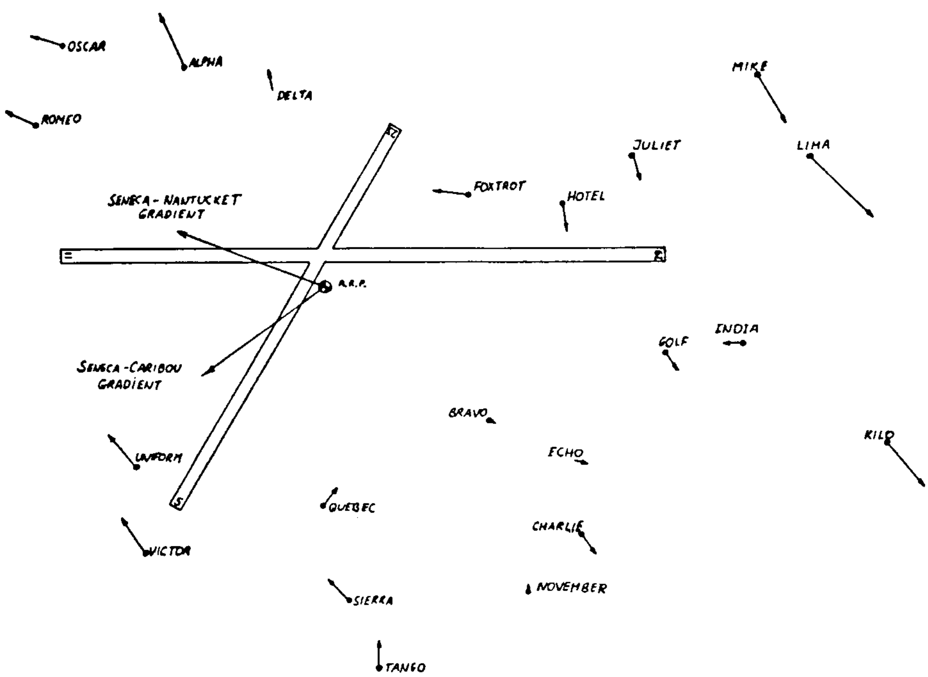


Figure 6. Hanscom Field ground-level survey.

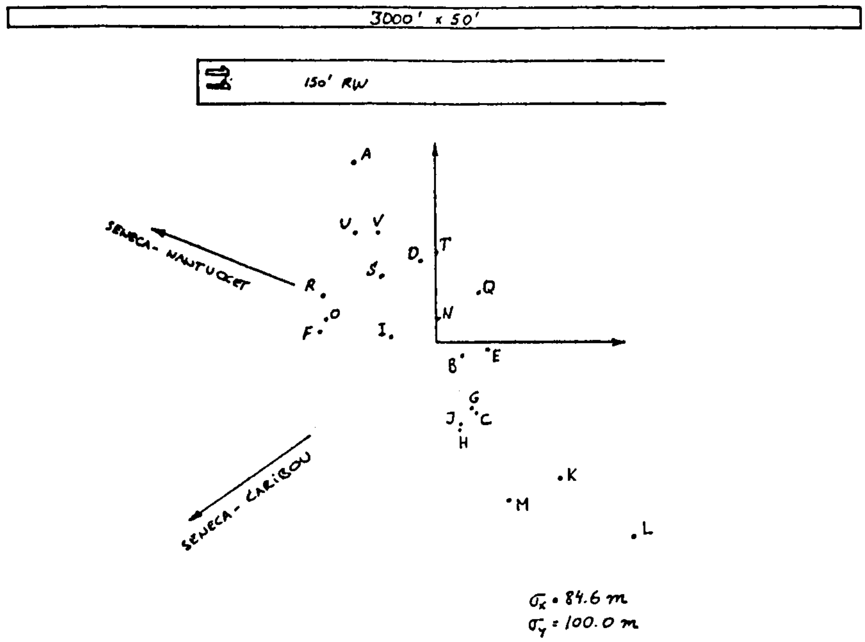


Figure 7. Summary of residual errors.

- EFFECT OF ANTENNA/VEHICLE ORIENTATION
- EFFECT OF SNR'S
- POSITION CORRELATION/CHARACTERISTIC LENGTH
- EFFECT AT ALTITUDE

NEED: DETAILED, POSSIBLY 3-D, SURVEY

Figure 8. Grid microdeformation - open items.

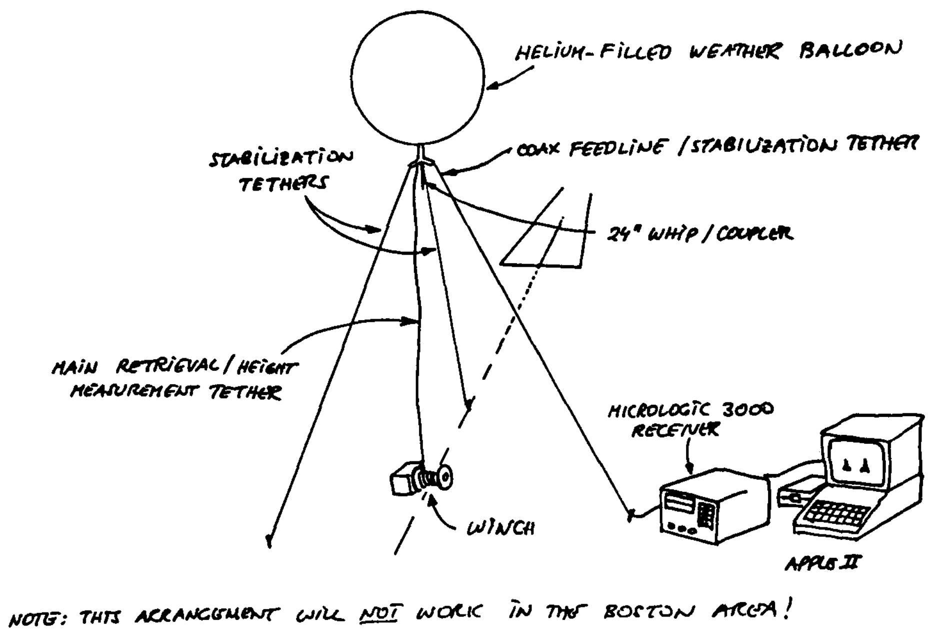


Figure 9. Balloon-borne antenna for 3-D survey.