Relative Navigation

GPS Subsystem Test

Purpose

Energy storage devices such as Lithium batteries and supercapacitors pose an explosion and/or leak risk in the near-vacuum space environment anticipated during the FASTRAC mission. A benchmark test was performed on the FASTRAC Orion GPS Engineering Model to determine its performance with all energy storage devices removed and isolated from the main board. This configuration more accurately models the environment which will be present aboard the FASTRAC spacecraft.

Description

The supercapacitor was eliminated from the Orion main board by manually cutting the leads and physically removing the component. The EPROM battery backup was eliminated by removing the connection between the Orion main board and the Orion interface board. To simulate the spacecraft as closely as possible, a new connector was fabricated for the Orion main board. This new connector had 6 different input lines:

1. +5Vdc external (simulates spacecraft bus)
2. Power ground external
3. Port 1 TTL TX
4. Port 1 TTL RX
5. Port 2 TTL TX
6. Port 2 TTL RX

The connector purposefully did not supply the Orion main board any battery backup power from the interface board. In fact, the interface board simply performed the function of a TTL to RS232 level converter for this experiment. The setup is shown below in Figure 1.

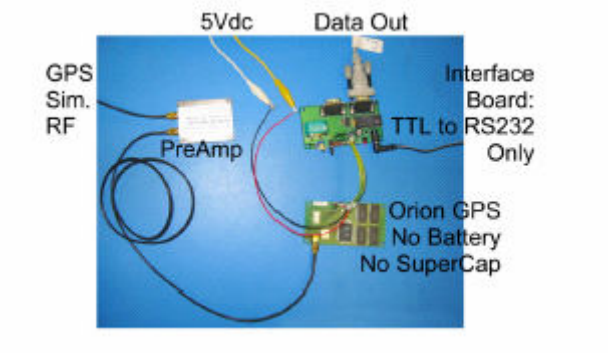

Figure 1: Experiment Setup

Procedure

A benchmark test was conducted following the procedures in Holt [1]. Since the engineering model was a ground test version, a command was given on startup, "RM2", which switched the receiver to "orbit" mode. Once the receiver had acquired satellites, raw packet data was collected using the *GPSMon* software developed by Sunny Leong at DLR. This data was then converted to RINEX and analyzed using MATLAB scripts described in Holt [1].

Timeline

December, 2004

Qualification Criterion

The results must be within the Holt [1] document errors.

Results

The results of this study related to acquisition times and receiver performance.

Time to First Fix

The receiver was given 20 minutes to acquire once "orbit" mode was initiated. No satellites were tracked during this period and no navigation solution was produced. At this point, a set of Two-Line elements was uploaded and the estimated time was input into the receiver. Acquisition of satellites then occurred within 10 seconds and a solution

within 20 seconds. The test was repeated with immediate upload of TLE and estimated time with similar results of 10 seconds for acquisition.

Receiver Performance

The data was analyzed using the method described in Holt [1]. Results are shown in Figure 2. This particular pair of satellite differences represents a high relative dynamics situation which approximates the worst case scenario for receiver tracking loop performance. Results are summarized and compared with Holt [1] in Table 1 below.

Table 1: Comparison of EM with Holt [1]

	Pseudorange	Carrier Phase	Range Rate
FASTRAC EM Benchmark	0.9296 m	0.7043 mm	0.08085 m/s
Holt [1]	0.9029 m	1.6478 mm	0.15123 m/s

Conclusions

The receiver performance characteristics were comparable or better than results achieved in Holt for the same PRN difference pairs. This demonstrates that removal of the supercapacitor and EPROM battery did not affect the measurement performance of the receiver. Further work is needed to improve the cold-start ability of the Orion, but aiding with TLEs and time estimates is well within acceptable operational procedures if no alternate methods are found.

Reference:

[1] Holt, G. “Benchmark Testing for Spaceborne Global Positioning Receivers,” Masters Thesis. The University of Texas at Austin. May 2000.