Phase calibration and attitude determination of a 2 by 2 phased array GNSS antenna

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NTRODUCTION

Measuring the carrier phase in the global navigation satellite system gives us far more accuracy than measuring the code phase. This is due to the higher frequency of the carrier. It has been vastly used to improve timing, positioning, multipath mitigation and attitude determination in the area of GNSS receiver design. In this paper a software receiver has been used to measure this observable. The software receiver provides us with raw IF data, i and q samples in the tracking loops and also the receiver replica of the carrier. These three available data have been used to introduce three independent approaches to measure the carrier phase. It is shown that these approaches are consistent and the result is used to calibrate a planar 2 by 2 antenna located in the four corners of a rectangle. This is previously done using anecoid chamber in [1]. Finally the results are used in the context of attitude determination of this platform.

HARDWARE AND EXPERIMENTAL SETUP

In this paper a NordNav quad front end software receiver is used. The four antennas are placed in the four corners of a square rectangle with half a wave length distance between each pair. All the experiments are conducted on the real GPS signal received at the roof top of the Electrical Engineering building of the University of New South Wales.

DIFFERENTIAL CARRIER PHASE MEASUREMENT USING C/NO

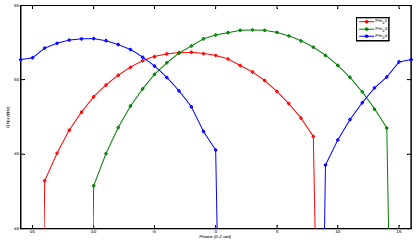

Figure 1

$$(\frac{S}{N})_{eff} = \frac{S}{N} + \frac{S}{N}e^{j\theta} = (\frac{S}{N})(\left|(2\cos\frac{\theta}{2})\right|)$$

DIFFERENTIAL CARRIER PHASE MEASUREMENT USING RECEIVER LOCALLY GENERATED CARRIER

The receiver locally generated carriers are used to determine the differential carrier phase measurements (Figure 1)

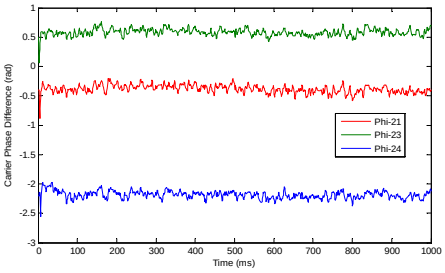

Figure 2

DIFFERENTIAL CARRIER PHASE MEASUREMENT USING THE I AND Q MEASUREMENT IN THE RECEIVER

In this method, the receiver generated in phase ($\cos(\omega t)$) and quadrature phase ($\sin(\omega t)$) carrier for antenna 2 is taken to calculate the i and q data for all of the for antennas raw IF data ($x_i, i = 1,...,4$). Then I and Q samples are calculated [2]. These samples are finally used to calculate the carrier phase difference between the four antennas. The results are the same as shown in Figure 2 and Figure 1.

CALIBRATION AND ATTITUDE DETERMINATION

The relationship between the azimuth and the elevation of each satellite and the carrier phase measured of each of the antenna signal can be calculated by [3]:

$$\varphi_1^f = \varphi_1^0$$

$$\varphi_2^f = \varphi_2^0 - \pi\sin(azim)\cos(elev)$$

$$\varphi_3^f = \varphi_3^0 - \pi\cos(elev)(\cos(azim) + \sin(azim))$$

$$\varphi_4^f = \varphi_4^0 + \pi\cos(azim)\cos(elev)$$

By receiving the azimuth and the elevation from the ephemeris data, and measuring the carrier phase difference using each of the proposed methods it is possible to now determine the phase bias (φ_i^0) and the attitude of the platform.

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