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| ESPACE |
| Receiver Technology |
| Signal acquisition and processing |

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|  | Abstract |

Before the navigation solution for the receiver position using Global Positioning Satellite (GPS) signals is obtained, the signal passes through the antenna, the front-end, baseband signal processing (Acquisition and Tracking). The latter two are employed in multi-channel hardware while the navigation solution itself is merely a software solution. In the following report, the basic design aspects of a GPS-receiver’s baseband signal processing is discussed. The acquisition process is simulated using MATLAB code and, by using downsampled digital receiver signals as well as generated GPS signals, the signal processing is examined. Among all, the conventional Time-Frequency-Space-Search and the Parallel-Time-Space-Search (FFT-IFFT) methods are investigated for acquisition. For this purpose, the Coarse Acquisition (CA) code is generated and correlation outputs are examined. The correlation principle is used for identifying the satellites from which measurements can be extracted. In reality, however, if a receiver has been operational, it may employ the GPS almanac message in its memory to fasten the process. Among the first unknowns in signal processing are code delay and Doppler shift (due to relative motion between transmitter and receiver). After having resolved this in the acquisition process, the tracking loops ensure that the internal replica of the receiver is best aligned with the incoming GPS signal in terms of code delay, Doppler frequencies and carrier phase. Usually, the code tracking is implemented using Delay locked loops (DLL) while the carrier phase tracking can be employed using either Phase locked loops (PLL) or Frequency locked loops (FLL). In the following report, the DLL and PLL have been examined.

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|  | Implementing a Sampled C/A code generator with code delay |

The GPS-satellites make use of Direct Sequence Spread Spectrum (DSSS) to spread the navigation data by using a pseudo-random sequence (PRN) which runs at a faster rate (chipping) and modulates the navigation data. For multiple access, the GPS-satellites employ Code Division Multiple Access (CDMA). PRN codes achieve both of these functionalities with limited hardware requirements (Linear Feedback Shift Registers, LFSR). Since the Chipping time of the PRN is more than the navigation message pulse duration itself, the bandwidth of the spread spectrum is much higher than the original signal. The ratio of and is called spreading factor.

PRN code has a spread spectrum similar to random bit-sequence but is deterministically generated. Most commonly used DSSS codes are Maximum Length Sequences (MLS) which are periodic with . The GPS signals use Gold codes which are generated with Modulo-2 addition (XOR) operations. The PRN codes have a desirable property in autocorrelation that it is high while the crosscorrelation outputs are low. Every satellite comprises of two shift registers, and , which generate a MLS of 1023 bits. The chipping rate is 1.023 MHz. And hence, the repletion time for a PRN code sequence is, very simply, nearly 1ms. An example of the generation process is demonstrated in Figure 1. The LFSR has XOR operation between 3 and 10 (Polynomial: for PRN:1. The feedback is a XOR operation on outputs from positions: 2, 3, 6, 8, 9 and 10 (Polynomial: ). The outputs from G1 and G2 are taken according to GPS specification and operated again with XOR operation to obtain the C/A code for a given satellite.

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| Figure | Implementation of PRN:1 code using Shift registers. |