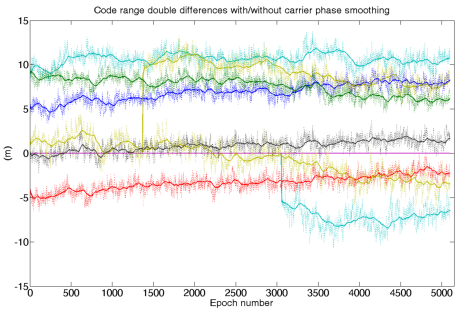
Fabian Knutti

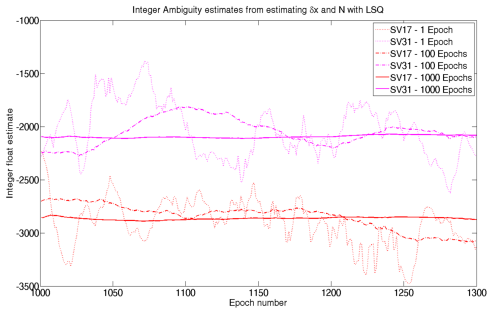
Graduate Candidate	Fabian Knutti
Examiner	Prof. Dr. Heinz Mathis
Co-Examiner	Stefan Hänggi, Armasuisse, Bern
Subject Area	Sensor, Actuator and Communication Systems

Matlab-Based Offline Carrier-Phase Differential-GPS Measurement System

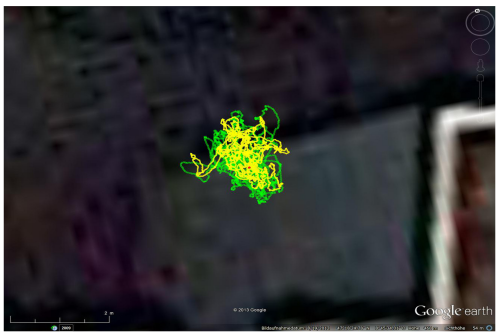
.



Code-range double differences with/without carrier phase smoothing performed with a Kalman filter.



Initial estimates of the integer ambiguities with least squares and data from two epochs spaced 1, 100, and 1000 epochs apart.



Position results: Standalone solution of receiver (green), differential solution with smoothed code ranges (yellow), and carrier phase (red).

Introduction: The initial accuracy of GPS was around 10m after its declaration as operational in 1995. The accuracy was primarily limited by the so called selective availability, which was discontinued in the year 2000. After this date the accuracy improved to around 1 to 3 meters. To further improve the positioning accuracy, carrier phase information must be used instead of the code signal. This allows for significant higher positioning accuracies with ionosphere- and troposphere delays becoming the limiting factor. To get position accuracies in the centimeter range, differential GPS techniques using at least two receivers must be employed. Currently there is no Matlab based software available which incorporates phase information for position determination.

Objective: The aim is to develop a prototype implementation of a processing software in Matlab incorporating carrier phase information to increase the final accuracy. An additional goal is to gain insight into differential GPS processing techniques and their difficulties. One of the major challenges when working with carrier phase information are the so called integer ambiguities. The integer ambiguities describe the fact that the carrier phase can be accurately measured within one cycle, but the total distance to a satellite incorporates an additional number of full cycles. This unknown number of full carrier-phase cycles is known as integer ambiguities.

Solution: To resolve the integer ambiguities, an initial estimate of the receiver position and therewith of the integer ambiguities must be obtained. In order to get an initial position estimate, the available code-range measurements are smoothed with the carrier phase information by means of a Kalman filter. The initial receiver position is then obtained as least-squares estimate from the smoothed code ranges. The determination of the correct ambiguities emerged as a highly demanding task. However, the position accuracy with carrier phase and ambiguities resolved is far superior compared to the code range solution.