Hochschule Karlsruhe (HSKA) - University of Applied Sciences

Geomatics **Fakultät für Geomatik**

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Master Thesis (Year: **2015**)
Development and analysis of a prototype sensor platform for measuring deformations on rail tracks

Referee
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Key Word
Rail, platform, MEMS, settlement, deformation, tunnel, Geomonitoring, Python

Summary

In recent years, the city of Karlsruhe is expanding in population and in industries. In order to improve the quality of life in the city of Karlsruhe, a tunnel is being built wich will shorten the travel time and increase the stability of the timetable.

The need to develop new urban transportation infrastructures has led to the on-going construction of a large-diameter tunnel under difficult conditions, such as the existence of sensitive structures within the area of influence of the tunnel.

This creates a high level of importance on the Geomonitoring of the area. Controlling all the suitable deformations.

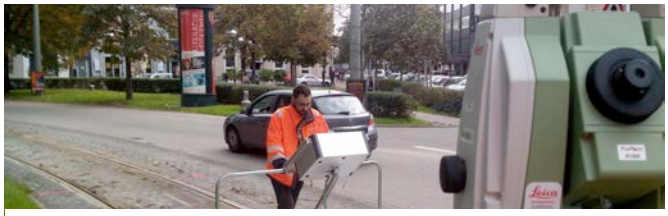


Figure 1: "El Carro" during a test

At the ground surface, the normal traffic of trams, cars and pedestrians is flowing while the tunnel is being constructed. To control that the ground settlement is between the safety limits this platform was developed.

The main sensor is a Shape Accel Array (SAA), a sensor system consisting of a chain of 16 3-axis MEMS accelerometers, for measuring three dimensional movements, and an odometer for measuring the distance increments.

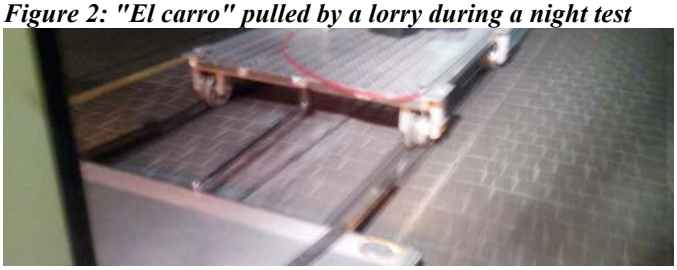
To control these hardware components a touch-screen computer is also installed in the platform. To provide power to the system a compact 12V battery is used. All the hardware components are attached to a standard rail platform.

The programming environment to develop the software is Python, which provides access to the hardware components and mathematical libraries for analysis and visualization.

To control the hardware and data fusion a functional & simple GUI was developed for the touch-screen computer. The software has three main buttons, start, stop and process data, for automatic computation. The option to process the data in post-process is also possible with a secondary GUI.

Figure 2: "El carro" pulled by a lorry during a night test

The platform needs a initial levelling to have reference points at the beginning and end.



The data from the odometer and the SAA are measured separately and joined afterwards. Then, in the first stage, a Bias calibration is always applied before the measurement starts by standing a couple of seconds, after the data is filtered with the help of a recursive Kalman filter, and then the measurements are processed with the computation of some cubic spline functions, each defined meters. These splines have 4 parameters that shall be computed.

The prototype is developed and the results are analyzed. The whole process was comprised of test, software development and even big changes to the mathematical process to reach the best possible result.