Kinematic Measurement Systems
Summer Semester 2018

Lab 6+7 Project

Team Laboratory

Closed-Loop-Systems for a Construction Machine Simulator

Date of first submission:	*Date of renewed submission:*

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Testat	1. control	Resubmission until	2. Control

1 Introduction

For several years, the Institute of Engineering Geodesy, University of Stuttgart operates a construction machine simulator to evaluate the performance of different sensors as well as filter and control algorithms. The system is able to guide a model vehicle (scale 1:14) on a predefined trajectory automatically. The automatization was realised by the implementation of a closed-loop-system. Because of the modular design of the complete system, it is easy to exchange the controllers as well as the measuring sensors. Further components of the simulator are: the remote control, an A/D-converter, a laptop with the control software and the particular measurement sensor. The sensors for this lab will be the tachymeter Leica TS30 and the GNSS device Leica Viva GS15. The software is split into two components. The control program for the tachymeter respectively the GNSS determines the position of the sensor respectively the position of the moving model vehicle within a reference network. This position is transmitted to the second program, the so called control module, which controls the steering of the model vehicle. This program determines the lateral deviation *e(t)* of the measured position to the reference trajectory *w(t).* The steering angle, as regulating variable *u(t),* is calculated subsequently. The reference trajectory is stored in a data base (as discretised points). The design of the software is shown in Figure 1:

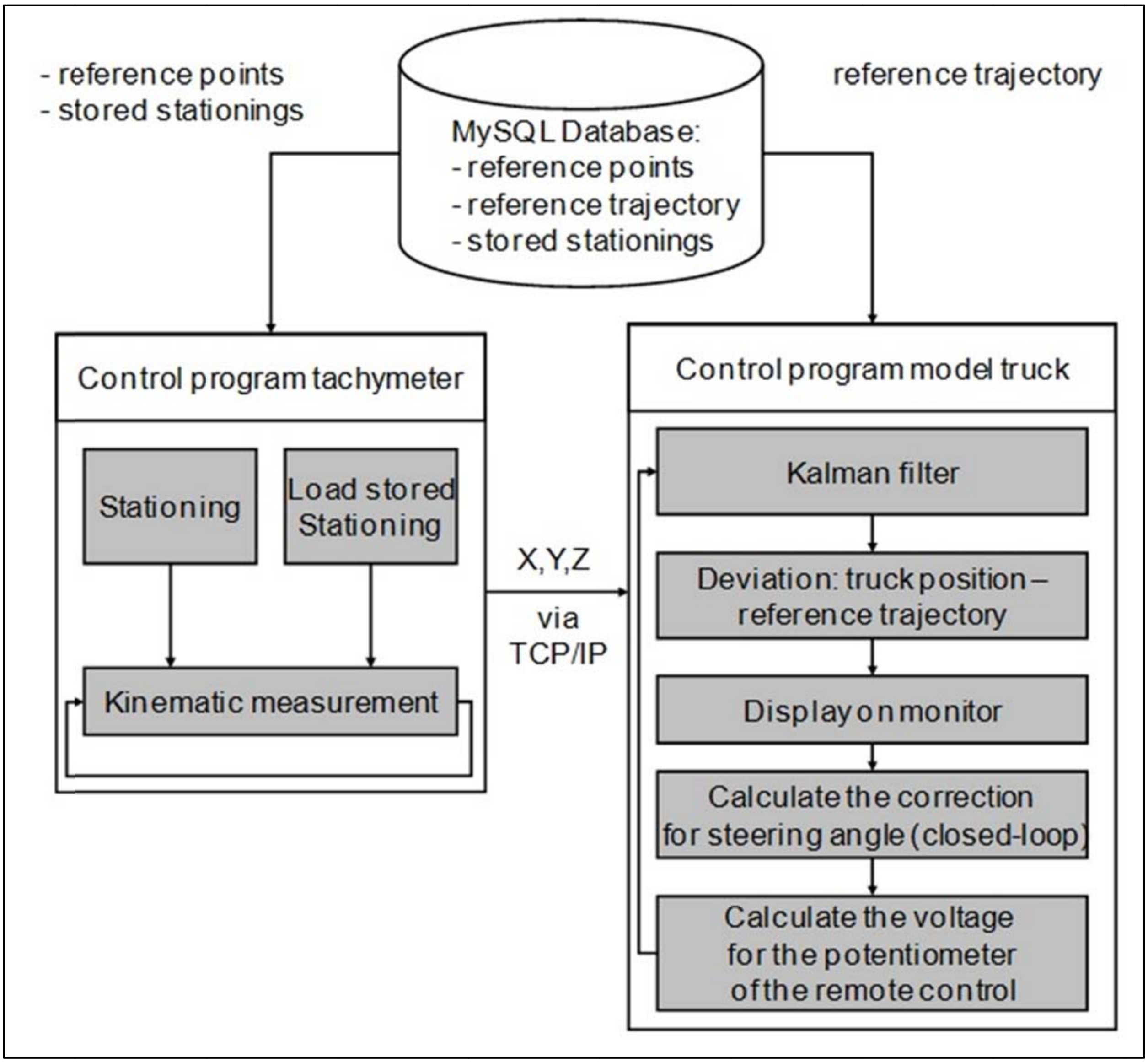

Figure 1: Software Design

2 Task

The objective of this lab is the analysis of different controllers as well as different sensors. For this purpose several test drives with different sensors and different controllers must be carried out. Afterwards the control quality for each controller and sensor has to be analysed. The control quality is represented by the RMS of the lateral deviation.
This project is divided into several work packages which are listed below. Finally, the results of all work packages have to be summarized in one final report.

STEP 1

Work package (WP) 1 - 6:

In those WPs, test drives with the tachymeter and the GNSS shall be performed. The used controllers (given in table 1) have to be described by considering particularly their behaviour and characteristic. The results should be represented numerically and additionally in meaningful figures. Furthermore the results should be interpreted with respect to the reached accuracy and the control quality by the analysis of the root mean square (RMS).

Table 1: *WPs and Controllers*

WP	Sensor	Controller	Parameters
1	Tachymeter	P	K_P=5
2	Tachymeter	PD	K_P=20, T_D=0.05
3	Tachymeter	PID	K_P=12.3, T_I=0.5, T_D=0.001
4	GNSS	P	K_P=5
5	GNSS	PD	K_P=20, T_D=0.05
6	GNSS	PID	K_P=12.3, T_I=0.5, T_D=0.001

STEP 2

WP 7:

All students of WP 1 - 3 have to compare their results and represent them in one table. Discussion on the results is obligatory.

STEP 3

WP 8:

All students of WP 4 - 6 have to compare their results and represent them in one table. Discussion on the results is obligatory.

STEP 4

WP 9:

In the last WP the results of WP 7 and WP 8 have to be combined and a final report has to be written.

3 Elaboration

The final report must contain all results and figures, the numerical values and tables. Please keep the following structure for the final report:

- Introduction
- Aim of the project
- Hardware-, Software description
- Measurement setup
- Results (all figures and tables)
- Discussion on the results

4 Overview WPs

Table 2: *WP Overview*

Work Package	Brief description	Number of students
WP 1	- Description of the sensor - Description of the controller - Test drives - Evaluation	3
WP 2	- Description of the sensor - Description of the controller - Test drives	3
WP 3	- Description of the sensor - Description of the controller - Test drives - Evaluation	4
WP 4	- Description of the sensor - Description of the controller - Test drives - Evaluation	3
WP 5	- Description of the sensor - Description of the controller - Test drives - Evaluation	3
WP 6	- Description of the sensor - Description of the controller - Test drives - Evaluation	4
WP 7	Comparison of results from WPs 1 – 3	Students from WPs 1 - 3 (10)
WP 8	Comparison of results from WPs 4 - 6	Students from WPs 4 – 6 (10)
WP 9	Final report	All students