EL2425 – Automatic Control, Project Course

Slip Control

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1 Background

Autonomy of vehicles is on the rise: major automotive and technology companies are focusing their efforts on delivering cars that can transport and navigate themselves within real conditions.

The goal of this project is to explore and exploit the principles of Automatic Control on the F1/10 racing car in order for it to complete a racing circuit as quickly as possible under loss of traction. The project is carried out as part of the course Automatic Control, Project Course on the second period of the academic year 2016-17 at KTH and will be hosted at KTH's Smart Mobility Lab.

This document describes and illustrates the overall goals of the project, its organization, its milestones and various timeframes, as well as the working method that will be employed in order to ensure its quality.

2 Goals

The main goal of this project is to gain practical knowledge and experience in design and implementation of control systems through a smaller-sized F1 car. In the process of achieving this goal we will learn to work effectively in a project group, expand our knowledge in aspects of the usage of engineering tools or methods, and increase our oral and written skills with presentations and reports respectively.

From technical point of view, there are four goals throughout this project:

- Driving the car via tele-operation.
- Determining the kinematic model of the car.
- Achieving to drive the car to the centerline of a lane and maintaining that trajectory. This will be accomplished by means of PID and MPC controllers.
- Driving the car in a circular trajectory as fast as possible. This will be tried by means of PID and MPC controllers.
- Determining the dynamic model of the car.
- Controlling slip at high speeds via predictive control. The premise is driving as fast as possible, under high slip, within a closed circuit.

The details about achieving these goals are given in section 4 as milestones which are the crucial points of the project.

3 Organization

The project will be undertaken by 5 master students studying in the Systems, Control & Robotics master programme in KTH who are listed below.

Name	Role	email
Jonas Martensson	Examiner, Course Responsible	jonas.martensson@ee.kth.se
Antonio Adaldo	Teaching Assistant	adaldo@kth.se
Dirk van Dooren	Teaching Assistant	dirkvd@kth.se
Emma Tegling	Teaching Assistant	emmsjo@kth.se
Mohamed R.H. Abdalmoaty	Teaching Assistant (Team Advisor)	abda@kth.se
Alexandros Filotheou	Project Responsible (Team Member)	alefil@kth.se
Melih Guldogus	Project Responsible (Team Member)	guldogus@kth.se
Tengfan Lin	Project Responsible (Team Member)	tengfan@kth.se
Roberto Sanchez-Rey	Project Responsible (Team Member)	rosr@kth.se
Xuechun Xu	Project Responsible (Team Member)	chunx@kth.se

Tabell 1: Course responsibles and project participants

The responsibility about satisfying the milestones and tollgates are fairly distributed among project members. These assigned responsibilities can also be found below, in tables 2 and 3. For further details about exact dates, please refer to section 4 - Project Model.

Alexandros Filotheou	□ Project Planning □ MPC Design □ Kinematic Modeling and Simulation □ Implementation of Real-Time Control System □ Validation and Testing □ Documentation
Melih Guldogus	□ Smart Mobility Lab Key □ Project Planning □ PID Control Design □ Dynamic Modeling and Simulation □ Implementation of Real-Time Control System □ Validation and Testing □ Documentation
Tengfan Lin	□ Project Planning □ PID Control Design □ Dynamic Modeling and Simulation □ Implementation of Real-Time Control System □ Validation and Testing □ Demonstration

Tabell 2: Initial project responsibilities

Roberto Sanchez-Rey	□ Project Planning □ MPC Design □ Dynamic Modeling and Simulation □ Implementation of Real-Time Control System □ Validation and Testing □ Demonstration □ Submits the assignments □ Meets with supervisors at project reviews □ Keeps track of the overall progress of the project
Xuechun Xu	□ Project Planning □ MPC Design □ Kinematic Modeling and Simulation □ Implementation of Real-Time Control System □ Validation and Testing □ Demonstration

Tabell 3: Initial project responsibilities cont.

4 Project Model

The project's proposed time-plan is presented below. The project is divided into several phases, each with its own specific objectives, milestones, and timeframes. The specified timeframes are approximate, and subject to change. Tables 4 and 5 indicate the initial planning of phases, tasks, milestones and assignees.

Project Phase	Milestone	Tollgate	Ready Date	Responsible
Project Startup		Team-building activity	2016-10-31	Roberto Sanchez-Rey
Project Planning (Report)	Project Plan Ready and Submitted		2016-11-04	Roberto Sanchez-Rey
Project Planning (Report)		Project Plan Approved		Mohamed R.H. Abdalmoaty
Handling Preliminaries	Get to know ROS		2016-11-07	All Team Members
Handling Preliminaries	Get to know git{hub}		2016-11-07	All Team Members
Handling Preliminaries	Get to know MOCAP and misc. sensors		2016-11-07	All Team Members
Implementation & Testing	PID Control for centerline following Done		2016-11-11	Tengfan Lin & Melih Guldogus
Implementation & Testing	PID Control for circular movement Done		2016-11-11	Tengfan Lin & Melih Guldogus
Modelling	Kinematic Model Done		2016-11-14	Xuechun Xu, Alexandros Filotheou & Roberto Sanchez-Rey
Implementation & Testing	MPC for centerline following Done		2016-11-23	Xuechun Xu, Alexandros Filotheou & Roberto Sanchez-Rey
Implementation & Testing	MPC for circular movement Done		2016-11-23	Xuechun Xu, Alexandros Filotheou & Roberto Sanchez-Rey
Project Follow-Up 1 (Report)	Project Review 1 Ready and Submitted		2016-11-24	Roberto Sanchez-Rey
Project Follow-Up 1 (Report)		Project Review 1 Approved		Mohamed R.H. Abdalmoaty
Modelling	Dynamic Model Done		2016-12-05	All Team Members
Implementation & Testing	Slip Control		2016-12-15	Tengfan Lin & Melih Guldogus

Tabell 4: Project plan: phases, milestones, timeframes and assignees

Project Follow-Up 2 (Report)	Project Review 2 Ready and Submitted		2016-12-15	Roberto Sanchez-Rey
Project Follow-Up 2 (Report)		Project Review 2 Approved		Mohamed R.H. Abdalmoaty
Project Close-Up (Report)	Project Final Report Ready and Submitted		2017-01-05	Roberto Sanchez-Rey
Project Close-Up (Report)		Project Final Report Approved		Mohamed R.H. Abdalmoaty
Project Close-Up (Movie)	Project Movie Ready and Submitted		2017-01-13	Roberto Sanchez-Rey
Project Close-Up (Movie)		Project Movie Approved		Mohamed R.H. Abdalmoaty
Project Close-Up	Source Code Ready and Submitted		2017-01-13	Roberto Sanchez-Rey
Project Close-Up		Source Code Approved		Mohamed R.H. Abdalmoaty
Project Close-Up (Presentation)	Final Presentation Done and Demonstration Performed		2017-01-13	All Team Members
Project Close-Up (Presentation)		Final Presentation and Demonstration Approved		Mohamed R.H. Abdalmoaty
Project Close-Up (Evaluation)	Individual Self-Evaluation Submitted		2017-01-16	All Team Members

Tabell 5: Project plan: phases, milestones, timeframes and assignees cont.

5 Working Method

Since the project will last about 10 weeks, together with the collaboration, the project management can also play an important role. To ensure the quality of the project, the following management methods should be taken into account:

- A daily meeting on the working day is required to give a short review of accomplishment of daily tasks, list the problems and exchange relative experience.
- A weekly meeting is organized to check the schedule progress, shortly summarize tasks in week unit and make a new plan when it is needed.
- A weekly meeting with supervisor is required, and reporting any problems to supervisor in time is always encouraged.

Dropbox is used to share common files, and Github for computer code. The newest files will always be uploaded in Dropbox and Github to ensure that everyone can see and edit it. Furthermore, this project will employ the Scrum working methodology. To this end, Trello will be used as the means of implementing Scrum. Simultaneously, there will be another folder for back-up, and all files can also be found in local computers. Although Facebook and email correspondence will be used, the members can and shall contact each other anytime, as face to face communication is considered the most efficient way to make a progress of project. How the meeting is organized has been stated as above.