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Master's Thesis Review

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Title: Control Laws for Autonomous Racing
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The thesis presents several methods to control a racing vehicle to track a given trajectory. Classical approaches that do not include on-line optimization are explored. Both longitudinal and lateral controllers are designed and finally a combined controller is proposed. Comparison of the methods is made by simulations. Error and control quality statistics are defined and the methods are quantitatively evaluated.

The text of the thesis is divided into nine chapters and three appendices. The first chapter introduces the problem. The second chapter lists objectives of the thesis. Chapter 3 nicely reviews related literature, including a historical overview and legislation around autonomous cars. Theoretical concepts are presented in Chapter 4 (kinematic and dynamic models of cars), and Chapter 5 (controllers). The core Chapter 6 gives the control strategies selected. Chapter 7 describes the simulations, evaluations and outcomes. Chapter 8 summarizes the results achieved and finally Chapter 9 concludes the thesis.

The thesis is very well written in a good English language. The text is well comprehensible even for readers outside of the control engineering field. Therefore, besides the technical contribution, the thesis has its didactic value. Author works extensively with literature, the list of references counts 88 items. The technical part is strong as well. I especially like the slip controller in the outer control loop (in Fig. 6.2) that balances the lateral and longitudinal acceleration based on the traction ellipse. The impact of the solution is measured by simulations achieving shorter lap times.

I do not see any significant weaknesses of the thesis. I would perhaps point the author to PhD thesis by Nitin R. Kapania from Stanford University, 2016, titled 'Trajectory planning and control for an autonomous race vehicle'. Some of the experiments were done on autonomous Audi TTS called 'Shelley'. And to another PhD thesis by Alexander Liniger from ETH Zürich, 2018, titled 'Path Planning and Control for Autonomous Racing'. I believe, both theses are strongly related and were somehow missed.

Nevertheless, this is a minor issue. Author clearly showed his competence, engineering skills and a great effort to produce a high-quality master's thesis.

In summary, I suggest assessing the thesis by

A – excellent.

Ing. Jan Čech, Ph.D.

Questions for the defense

1. Could you compare your controller with Model Predictive Controller (MPC)? What are the arguments in favour and against?