Popular Science Summary of Master Thesis [5]

Implementation and integration of slip and traction controllers for a three-wheel electric vehicle

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Since the first vehicles were developed, the automotive industry has been challenged with safety issues to enhance the safety of the driver and the passengers of the vehicle. One of those features is traction control systems that are able to detect whether a loss of traction has happened while driving and in the case that it does, it acts automatically by braking and cutting down the power of the wheel that is suffering the loss of traction. This Master Thesis continues the work of [3] and [2] carried out within OMotion AB, a Swedish start-up that designs and manufactures three-wheel electric vehicles [4]. The main focus of the Master Thesis is to integrate two controllers that were previously designed and to implement them in the vehicle and to test them on the real vehicle to evaluate the performance, as the controllers have previously only been tested separately. To develop a traction control system, the data that are going to be analysed by the control need to be accurate. The vehicle initially had procedures to acquire data that were performed manually or in a less straight forward way. The aim is to find processes or algorithms that process the data using automated approaches to obtain more precise and realistic values. One of these procedures is the calculation of the wheel's angle values. It is key to be able to have real-time data from the wheels to design a precise control and to have an accurate model to perform accurate simulations. Another one of these procedures that was not ideal was the conversion of the current of the motor to torque. It was previously done using a constant factor, but after some tests, it was seen that the factor was affected by the vehicle's speed and that it changed dynamically. Moreover, the vehicle has seen some physical modifications and some parameters of the model needed to be tuned again, as well as some devices that are part of the vehicle. Specifically, this concerned the gyroscope and accelerometer devices and the cornering and longitudinal stiffness parameters. During the Master Thesis, more devices needed to be tuned that were not thought of previously, such as the ABS and the steering wheel sensor. The process for tuning the devices was developed by doing experiments that provided updated parameters for each device. To integrate both controllers, a model was used to simulate their behaviour. A model is a mathematical representation of a real system. In this case, the real system is the vehicle OMotion2 and the model aims to mimic its performance while driving. The model has been used to simulate different scenarios. Once multiple simulations were run, it was concluded that the controllers worked as expected. To test that the procedures for the calculation of the wheel's angles were properly implemented, experiments were run, gathering data and contrasting the implemented data with data acquired from models. It was concluded that the procedure was properly implemented, but it needs to be studied further because the result did not match completely the expectations. The devices that needed tuning were properly tuned following the guidelines of OMotion. The full report can be found in [1].

Figure 1: OMotion2. Photo: OMotion AB

References

[1] URL: https://lup.lub.lu.se/student-papers/.

[2] Karlin, A. "Slip Control for a Three-Wheeled Electric Motorcycle". MA thesis. Department of Automatic Control, Lund University, TFRT-6128, 2021.

[3] Nilsson, J., Sandstedt, H. "Traction Control of a Three-Wheeled Electric Motorcycle". MA thesis. Department Automatic Control, Lund University, TFRT-6138, 2021.

[4] OMotion. *Technical Specifications*. Accessed: 2022-06-25. 2021. URL: https://omotion.se/.

[5] Zumarraga, B. "Implementation and integration of slip and traction controllers for a three-wheel electric vehicle". MA thesis. Department of Automatic Control, Lund University, TFRT-6182, 2022.