Middleware Services for the Propulsion Drive System Digital Twin of Software-Defined Electric Vehicles

Summary

Within this PhD project, the PhD candidate will explore the Digital Twin (DT) concept and the services it offers by implementing DT in an actual application, using Software-Defined Electric Vehicles (SDV) as an example. The department will provide the necessary experimental hardware and software to evaluate the performance of DT and to develop new services. Platforms available in TalTech e-Vehicles research laboratory will facilitate this evaluation.

Research field:	Electrical power engineering and mechatronics
Supervisor:	Prof. Dr. Anton Rassõlkin
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

The candidate will be tasked with developing, verifying, and implementing appropriate models for the proposed system. Additionally, they will be responsible for enabling a seamless transition network between Cyber-Physical Systems (CPS) and Digital Twins (DT) to facilitate efficient simulation and analysis. Ensure data integrity, reliability, and low-latency transmission to support real-time data exchange.

The main tasks of the thesis are:

1. Understanding of the main concept of CPS, DT, and middleware

- Conduct a comprehensive literature review in the field of middleware used in DTs to gain a deep understanding of the concepts, applications, and integration.
- Analyze current trends, methodologies, and challenges in the field to identify research gaps and potential areas for innovation.

2. Research into state-of-the-art technologies and methodologies

- Identify and review state-of-the-art technologies and methodologies related to CPSs, DTs, and SDVs.
- Explore recent advancements and emerging trends in these areas, including modeling techniques, simulation tools, scaled demonstrators, and integration strategies.
- Investigate and explore communication protocols suitable for real-time data fusion and acquisition in propulsion drive system.
- Determine areas where further development or customization is needed to align with the specific requirements of SDV proposed system.

3. Development and integration of the communication methods for middleware services

- Establish protocols for data storage, ensuring scalability and accessibility for subsequent modeling tasks.
- Ensure data integrity, reliability, and low-latency transmission to support real-time data exchange.
- Selection of the most suitable protocol based on criteria such as latency, reliability, and scalability.
- Verification and validation of the transition network's efficiency.

4. Evaluate the effectiveness of the proposed methods

- Conduct rigorous evaluations of the developed models and methods in relation to practical application scenarios using experimental data and simulation results.
- Assess the performance, accuracy, and scalability of the implemented DT, comparing it against established benchmarks.

- Identify strengths, limitations, and areas for improvement, providing recommendations for further refinement and optimization.

The applicants should fulfill the following requirements:

- Master's degree in electrical engineering or mechatronics
- Experience with common scientific software (e.g. Matlab, Octave, ROS, ROS2, etc.)
- Experience with common research support software (e.g. Office 365, Mendelay, LateX, etc.)
- Practical experience with IoT devices
- Practical experience with electrical drives
- Practical experience with publishing and presenting research works (e.g. conference papers)
- Very good command of English
- Fluent Estonian language skills in written and oral are eligible

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