Use of a Digital Driving Twin to Teach Development Skills in the Field of Autonomous Driving

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1. INTRODUCTION

In today's rapidly evolving technological landscape, traditional teaching methods are insufficient to prepare students for the demands of modern industries, particularly in fields like autonomous driving. The "learning factory" model presents an innovative solution, integrating academic instruction, research, and industry collaboration. By simulating real-world business structures, such as those in the automotive sector, the learning factory provides students with hands-on experience in developing driver assistance systems, digital twins, and autonomous driving functionalities. Through this interdisciplinary approach, students are exposed to practical, project-oriented tasks that mirror the complexities of real industrial challenges, thereby equipping them with essential skills for the modern workforce [1, 2].

The learning factory, exemplified by the Wildauer Maschinen Werke (WMW), aligns academic programs with industrial processes, facilitating specialized training in areas such as mechanical engineering, business informatics, and logistics. One key aspect of this educational model is the use of 1:14 scale vehicles equipped with sensors and actuators, allowing students to develop and test autonomous driving systems in a realistic setting. Additionally, advanced tools for software engineering and AI-supported project management enhance the practical learning experience, fostering collaboration and accountability among students [3].

2. METHODOLOGY

The learning factory model incorporates advanced simulation environments, including CARLA and AirSim, which are critical for the development and testing of autonomous driving functionalities. CARLA provides pre-built digital environments and integrated traffic simulations, while AirSim offers flexibility in custom environment creation, making both platforms suitable for hands-on student projects [4, 5]. These platforms are integrated within the WMW infrastructure, enabling seamless communication between virtual and physical entities, thus supporting real-time testing of autonomous systems.

A significant feature of the learning factory is the implementation of a digital twin, which connects the virtual and real-world environments, allowing for the real-time interaction between simulated vehicles and those on the physical test track [6]. This setup offers students the opportunity to test and validate systems under mixed conditions, where simulation and reality converge. Additionally, AI-driven techniques, including neural networks and Generative Adversarial Networks (GANs), are used to automate the creation of complex simulation scenarios, accelerating both testing and development processes.

3. RESULTS AND CONCLUSIONS

The learning factory has demonstrated significant educational and practical benefits. Students gain hands-on experience in managing the lifecycle of autonomous driving technologies, from conceptual design to operational deployment. By working within a simulated corporate structure, they develop interdisciplinary skills, collaborate across various academic programs, and solve real-world challenges. The use of advanced simulation environments and the digital twin allows students to engage in realistic and risk-free testing of autonomous systems, particularly in safety-critical scenarios such as emergency braking and lane-keeping assistance [6].

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The integration of AI and automation in scenario generation enhances the efficiency of the learning process, allowing students to explore the iterative nature of engineering in a dynamic, practice-oriented setting. Furthermore, the collaboration with industry partners, such as the Volkswagen Group, bridges the gap between academic theory and industrial application, fostering the transfer of research outcomes into real-world solutions [7].

In conclusion, the learning factory model represents a forward-looking approach to higher education, preparing students for the technological challenges of the future. Through its interdisciplinary and technology-supported framework, the learning factory equips students with the skills needed to thrive in digitalized and automated industries. The continued development of technologies like digital twins, augmented reality (AR), and real-time data processing holds great potential for further enhancing the educational experience, making the learning factory a key tool in the advancement of both education and industry.

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