MINISTRY OF EDUCATION
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Fundamental field: Engineering Sciences
Specialization: Mechanical Engineering

HABILITATION THESIS

- ABSTRACT -

DEVELOPMENT OF A VIRTUAL MODEL FOR THE AUTONOMOUS DRIVING SYSTEM

Assoc. Prof. Eng Călin Doru ICLODEAN, PhD
Faculty of Automotive, Mechatronics
and Mechanical Engineering
Technical University of Cluj-Napoca

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The habilitation thesis, with the title "Development of a Virtual Model for the Autonomous Driving System," highlights, on scientific basis and through good documentation, the main scientific and professional results that the author, Assoc. Prof. Eng. Călin Doru Iclodean, PhD, obtained from 2013 to the present, after conferring the title of doctor in the fundamental field of Engineering Sciences, the field of Mechanical Engineering.

The habilitation thesis also presents the author's academic, scientific, and professional career evolution, outlining the key career development paths that he followed in the global context of important and contemporary scientific discoveries in the field of Mechanical Engineering. Finally, in his habilitation thesis, the author highlighted his ability to organize and coordinate pedagogic and research activities during his academic career.

The habilitation thesis is organized into eight chapters, which include an introduction, scientific, professional, and academic accomplishments, plans for evolution and career development, references, a list of figures, and a list of tables that highlight the main topics addressed in the fields of interest, and also the results obtained from these activities.

The chapter "Abbreviations and notations" of the qualifying thesis contains a list of abbreviations and notations for the most commonly used terminology.

The Introduction chapter provides a brief overview of the qualifying thesis' content in addition to the latest advances in the development of autonomous driving systems. The chapter outlines the author's studies and research results, along with the goals he presented for the future development of his academic career.

The scientific, professional, and academic achievements chapter describes the author's professional career in terms of didactic, scientific, and academic activities. This chapter presents my university career to date and suggests enhancements for the future, based on the modern and contemporary need to adapt and streamline the processes that characterize higher education, through a combination of educational components, research, and institutional. This career will be defined by a tool that will be used, constantly updated, and adapted to the current requirements of the educational sciences and current research trends in order to improve the efficiency of training and transmission of these skills to students in the field of mechanical engineering. The author's desire has always been, is now, and will be in the future to focus primarily on the didactic process based on advanced educational methods, with visibility in the domestic and international academic environment, offering an up-to-date solution that can be implemented in university education, with benefits for the entire academic community.

Chapter 2. The main features of autonomous driving describe the rapid progress of autonomous driving in recent years, especially in information technology and the automobile industry. At the same time, the current technological solutions used by the major manufacturers of autonomous shuttle bus type vehicles are described, as are the methods of operating these vehicles on public roads or in private locations where they can move under test conditions.

The autonomous driving system is described beginning with the command-and-control unit, which receives information from the sensors and generates command and control signals for the main drive systems based on the specifications of the autonomous driving system's control algorithm and the vehicle's operating mode.

Another element discussed in this chapter is the harmonization of foreign regulations (United States, Europe, China, and Japan) governing autonomous vehicles, so that they can be active and operational on numerous public roads. The harmonization of law in the case of autonomous driving includes the autonomous driving system's obligation and legal coverage, cyber security protection, and insurance issues in the event of a traffic accident.

Chapter 3: Technical Characteristics of the Autonomous Vehicle describes the development of autonomous vehicles on electric vehicle platforms as a result of the reduction

of auxiliary systems for these models and the capacity to implement control over the movement of the vehicle. This chapter describes the constructive design for an autonomous vehicle with an electric propulsion system, including the functional characteristics of the propulsion system and sensor systems.

The communication systems required to equip an autonomous vehicle are described using the V2X (Vehicle-to-Everything) concept as the connections that ensure data transfer between autonomous cars and the intelligent environment. The concepts of vehicle-to-vehicle communication (V2V), vehicle-to-intelligent infrastructure communication (V2I), and vehicle-to-pedestrian communication in traffic (V2P).

Chapter 4 The autonomous driving system explains the capacity to drive autonomously using logical blocks made up of combinations of functions and attributes that characterize the environment's features as well as the static and dynamic items located in it. The autonomous driving system is defined as a hardware and software technological solution capable of driving the vehicle without the need for human intervention on command-and-control mechanisms (depending on the level of automation), with remote monitoring by a human operator.

The autonomous driving system's control algorithm is portrayed as a substitute for a human driver who, by fully delegating control over the vehicle's driving and complying with the behavioral criteria, guarantees that the vehicle moves in full safety. The decision-making algorithm presented in this chapter is founded on the following principles: perception of the environment in which the autonomous vehicle evolves, prediction/planning of its dynamic behaviors, and movement control based on the decisions made in the previous stage.

Chapter 5: The Virtual Model for the Autonomous Vehicle describes the computer simulation approach in a virtual environment, using a theoretical model and a digital image of an existing physical model that is meant to be created and enhanced through computer simulation. The complexity of the virtual model generated in this chapter must match to the reality of the real model being assessed, being as complex as required while being as simple as feasible, so that the conclusions acquired from computer simulations are supported by experimental data. The algorithm for developing the virtual model for the autonomous vehicle is divided into stages, with the goal of creating a new prototype for a new version of a virtual model for an autonomous vehicle based on the existing actual model.

Chapter 6 focuses on the continuation and permanent improvement of the didactic, scientific, and professional career in mechanical engineering in accordance with national and international standards.

Chapter 7: Final Conclusions presents the major role of autonomous vehicles in public transportation to develop efficient, safe, and sustainable transport, as well as the author's contribution to this emerging field through research contracts in autonomous driving and the scientific works that resulted from these research.