Sensors, Actuators and Control Systems in Electric Vehicles – part 2

Control systems in electric vehicles

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1. Introduction

- ✓ With the growing awareness of climate change and the depletion of fossil fuels, the demand for environmentally friendly transportation options is increasing.
- ✓ Electric vehicles (EVs) represent a key player in this positive shift, using electric energy instead of traditional fuels.
- ✓ With zero harmful gas emissions, electric vehicles offer a “cleaner” alternative compared to conventional vehicles.
- ✓ There are four types of electric vehicles:
  - Battery Electric Vehicle – BEV,
  - Hybrid Electric Vehicle – HEV,
  - Plug-in Hybrid Electric Vehicle – PHEV,
  - Fuel Cell Electric Vehicle – FCEV.

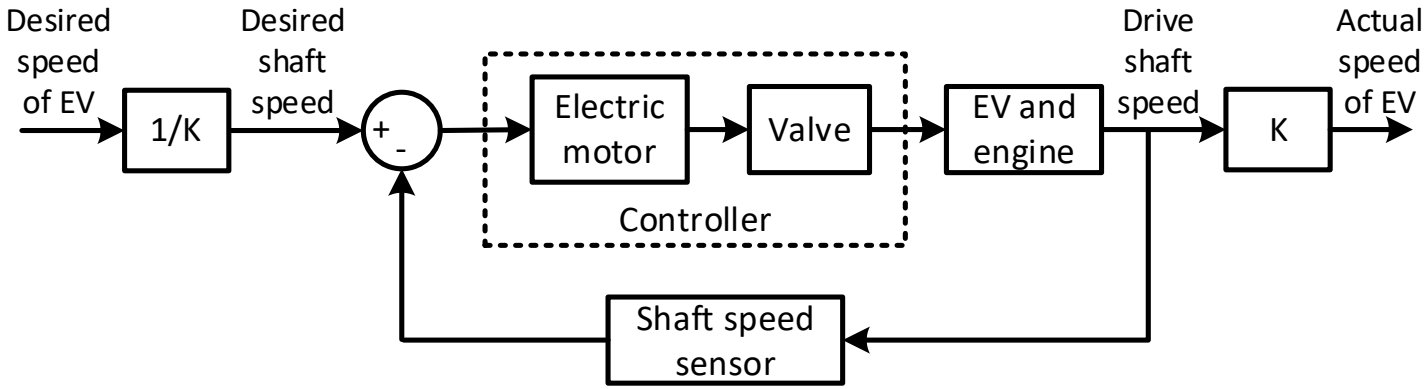
1. Introduction

- ✓ Control systems are of essential importance for improving the efficiency and performance of electric vehicles.
- ✓ The three key challenges in the electric vehicle design process are:
  - vehicle technology,
  - electric drive technology,
  - energy management systems.
- ✓ The effective selection of control techniques depends on accurate measurements and the assessment of electric vehicle operating conditions.

2. Types of Control Systems in EVs

2.1 Steering Control

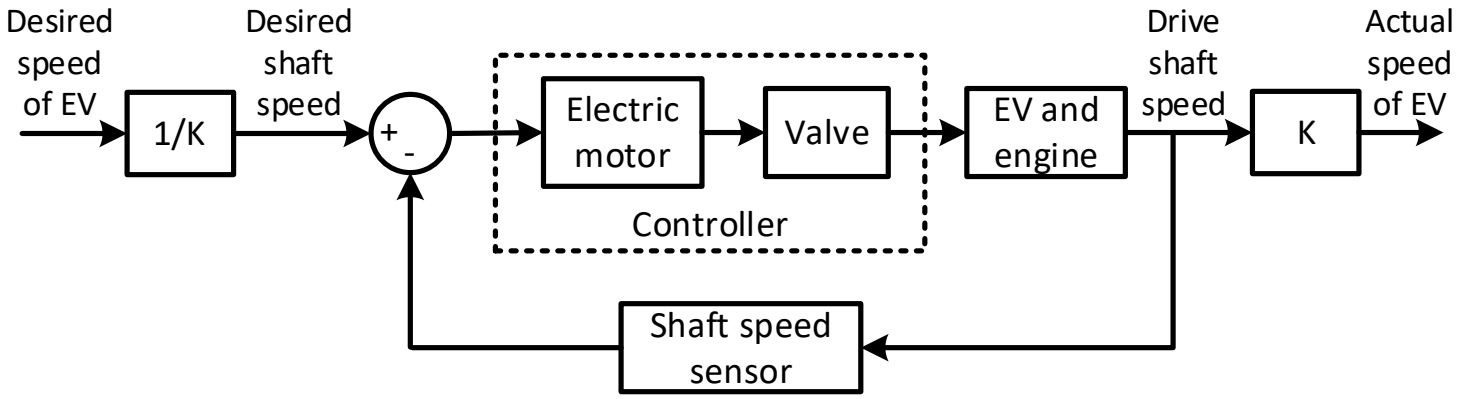
- ✓ It is a set of components that are responsible for giving directional change to the movement of the vehicle and maintaining the driving direction according to the driver's decisionržavanje pravca vožnje prema želji vozača.



2. Types of Control Systems in EVs

2.2 Cruise Control

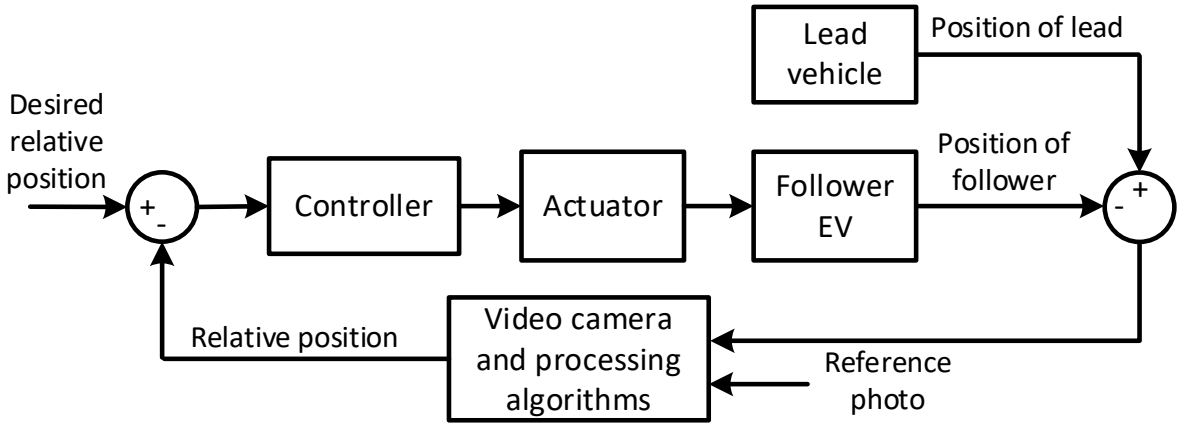
- ✓ Cruise control is a driving assistance system that allows the driver to set the desired vehicle's speed



2. Types of Control Systems in EVs

2.3 Adaptive Cruise Control - ACC

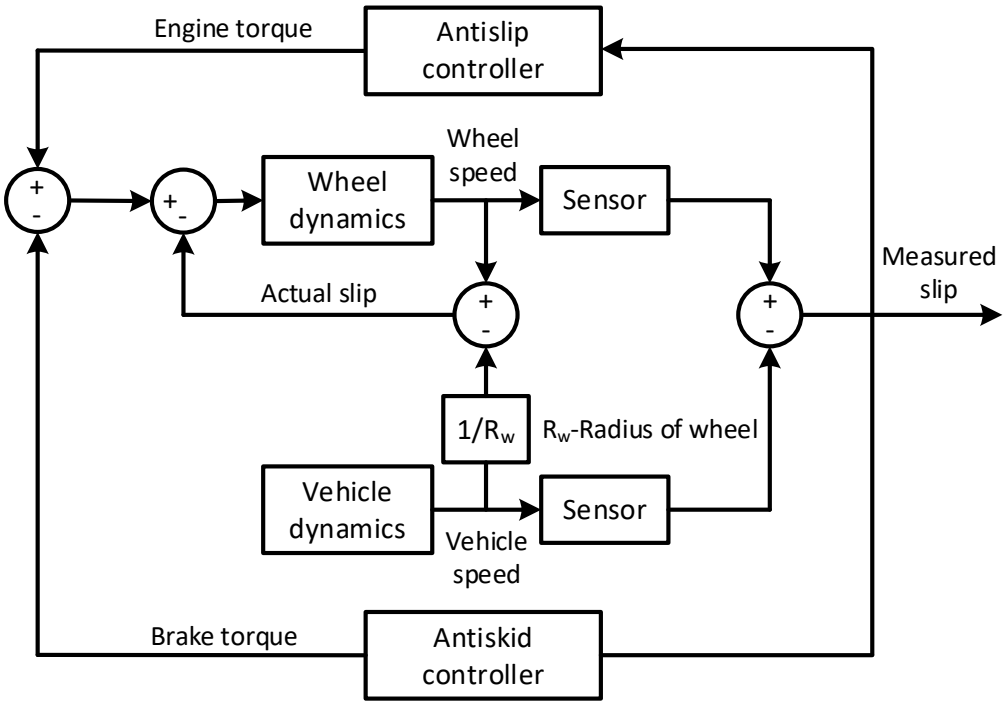
- ✓ Adaptive Cruise Control (ACC) is a system that adapts the vehicle's speed relative to other vehicles in front to maintain a safe distance.



2. Types of Control Systems in EVs

2.4 Traction Control

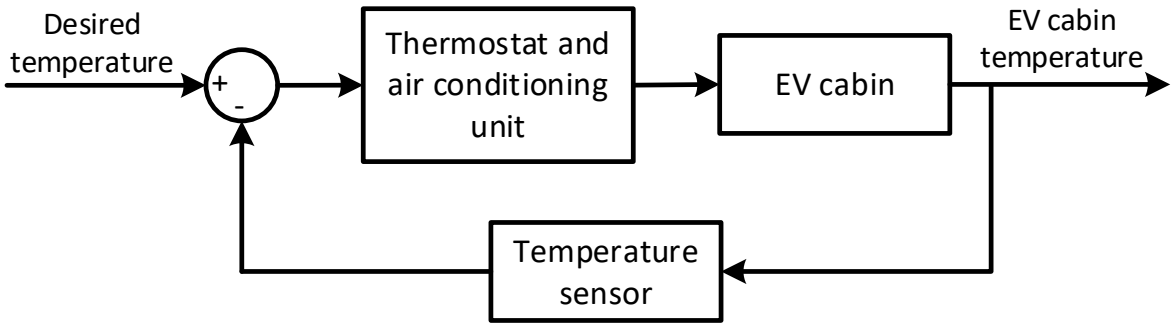
- ✓ The objective of this control is to maximize tire traction by preventing locked brakes and tire spinning during acceleration



2. Types of Control Systems in EVs

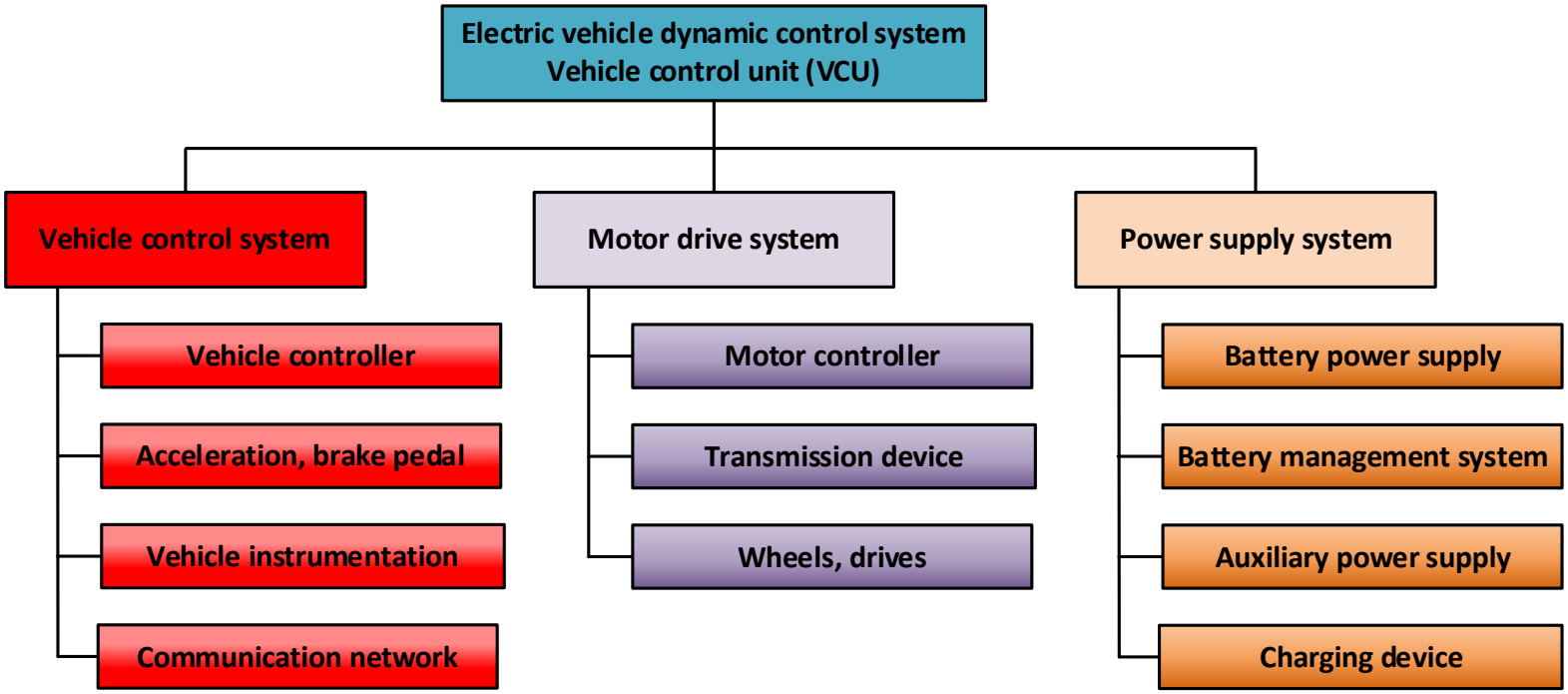
2.5 Temperature control

- ✓ Modern vehicles have thermostatically controlled air-conditioning systems for the comfort of the passengers.



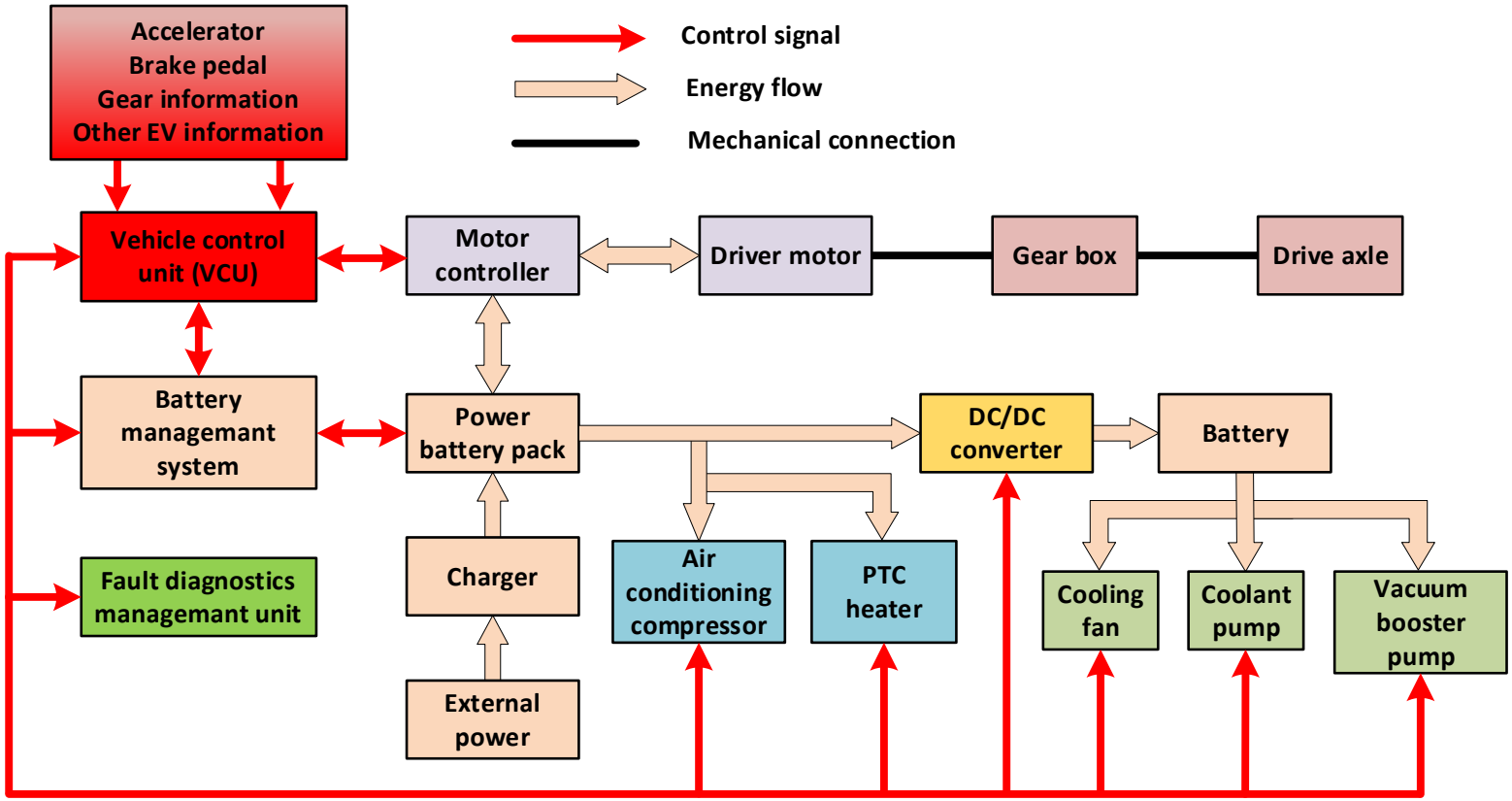
3. Integration of EV operation

- ✓ The EV dynamic control system integrates electrical, electronic, mechanical, chemical, and other nonlinear dynamic systems.
- ✓ The overall EV dynamic control system has a distributed hierarchical structure and can be divided into three parts: vehicle control system, motor drive system, and power supply system.



3. Integration of EV operation

- ✓ On the top layer, there is the whole vehicle controller or Vehicle Control Unit (VCU) which is the core component of the control system.
- ✓ On the second layer, there are secondary controllers for vehicle control, motor control, and battery management



3. Integration of EV operation

- ✓ The main VCU functions are:
  - Drive torque control,
  - Braking energy optimization control,
  - Vehicle energy management,
  - Fault diagnosis and processing,
  - Vehicle condition monitoring,
  - CAN maintenance and management of the network.

4. Challenges, Innovations, and Future Trends of Automatic Control Systems in EVs

- ✓ The major challenges faced by automatic control systems in EVs are:
  - Intelligent Integration,
  - Energy Management Complexity,
  - Mitigating Range Anxiety,
  - Standardization and Interoperability.

4. Challenges, Innovations, and Future Trends of Automatic Control Systems in EVs

- ✓ Some of the novelties in the domain of automatic control systems in EVs are:
  - The process of integrating machine learning algorithms,
  - The use of advanced optimization techniques ,
  - Proactive maintenance,
  - Investigating decentralized control architectures,
  - The utilization of AI to develop advanced driver assistance systems,
  - Integrating self-driving technology with electric mobility,
  - Utilizing real-time edge computing technologies,

4. Challenges, Innovations, and Future Trends of Automatic Control Systems in EVs

- Vehicle-to-everything (V2X) connectivity,
- Merging cutting-edge Human Machine Interface (HMI) concepts,
- Handling cybersecurity issues with connected EVs,
- Innovative control systems for smart charging,
- Implementing control strategies to maximize energy harvesting from sources such as regenerative shock absorbers and solar panels,
- Creating control systems that make wireless charging technologies more convenient and efficient,
- Optimizing temperature control within batteries and other essential components through the use of intelligent algorithms.

5. Conclusions

- ✓ EVs, in contrast to traditional internal combustion engine vehicles, offer a cleaner and more environmentally friendly option by significantly reducing emissions, thanks to their exceptional energy efficiency that further diminishes greenhouse gas emissions.
- ✓ To improve overall efficiency, solve operational issues, and maximize performance, the automotive industry is actively improving EV control systems.
- ✓ Control technology advancements maximize the sustainable potential of EVs by enabling their smooth integration with renewable energy sources.
- ✓ The automotive industry aims to continuously improve the control systems of EVs as it navigates challenges, embraces innovations, and anticipates future trends, paving the way for a more sustainable and efficient transportation future.