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A SYSTEMS APPROACH TO PARKING ASSIST SYSTEM: INVESTIGATING TEST AND VERIFICATION METHODOLOGY

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Presenter Resume

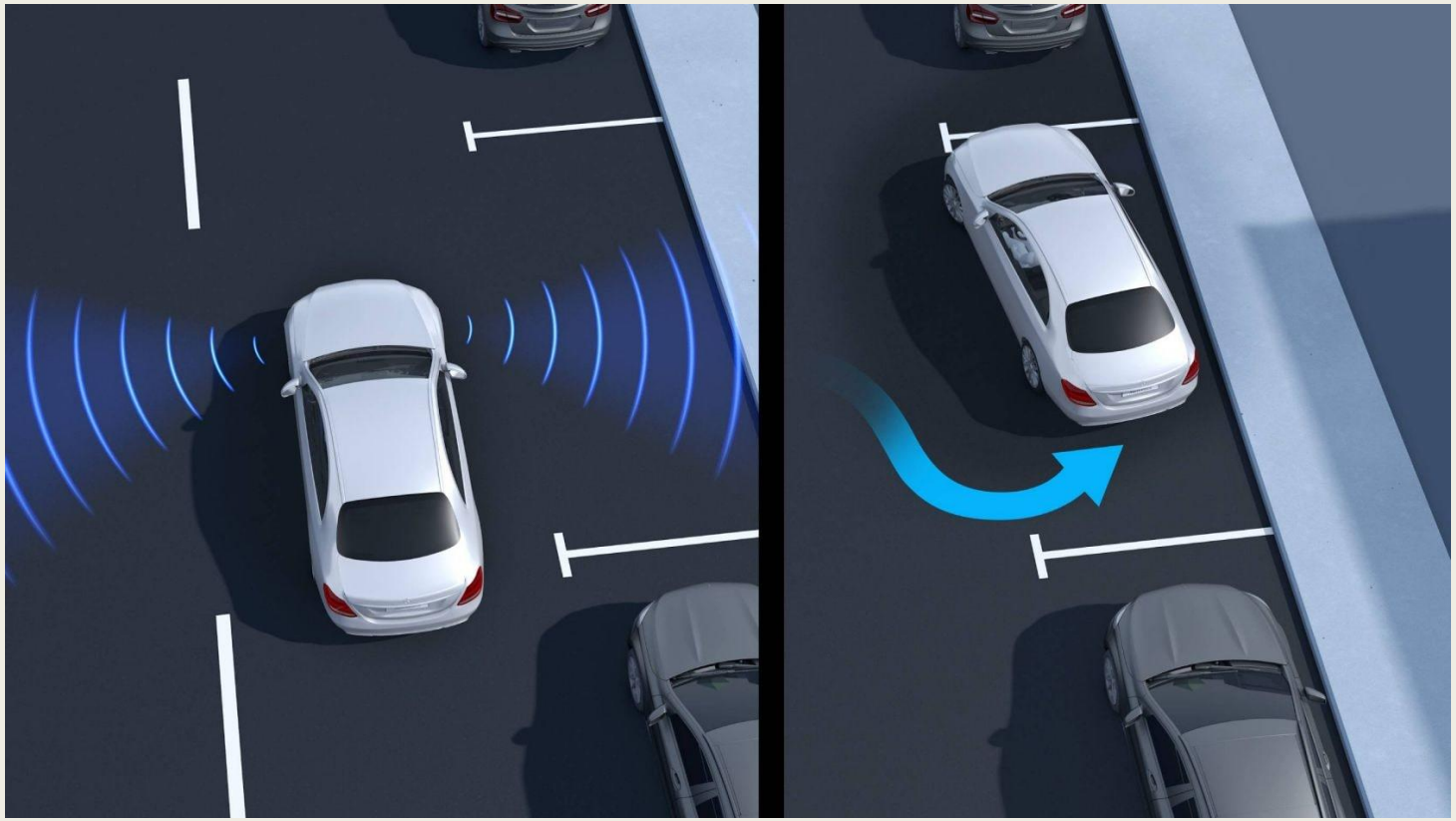
- Systems Engineering Industry master student at University of South-Eastern Norway. (Year 2 of 3)
- Working part-time as a project engineer/test engineer at Kongsberg Defence & Aerospace.
- Write documents (test specifications, test reports, system verification plan etc.) and test the systems both functionally and in environmental settings.
- Mechanical Engineering Bachelor degree from University of Derby, England (2017-2020).

Agenda

- Introduction
- Background and System Description
- Problem Context
- System Decomposition
- Test, Verification and Validation
- CATWOE
- Systemigram
- Conclusion
- Future Work
- References

Introduction

- Size and number of vehicles increased resulting in busier roads.
- Limited view, randomness and human behavior is unpredictable.
- Toyota introduced the ultrasonic back sensor as far back as 1982.
- First rear park assist system (semi-autonomous parking) was introduces in 2003.
- Nissan introduced the surrounding-view parking monitor in 2007.



Background and System Description

- Evolving technology
- Sensors
  - Ultrasonic sensor (most common)
  - Electromagnetic sensor
  - Radar
- 360° View (Birdsview)
- Reverse AEB (Autonomous Emergency Braking)

Event	Fatalities	Injuries
Non-occupant in Non-traffic Crash: Backing Vehicle	99	2,000
Non-occupant Struck by Driverless Vehicle	5	<500
Non-occupant in Non-traffic Crash: Forward-Moving Vehicle	106	3,000
Total (approx)	210	5,000

NHTSA Non-traffic fatalities and injuries 2007 (D. Moore, 2021)

Problem Context

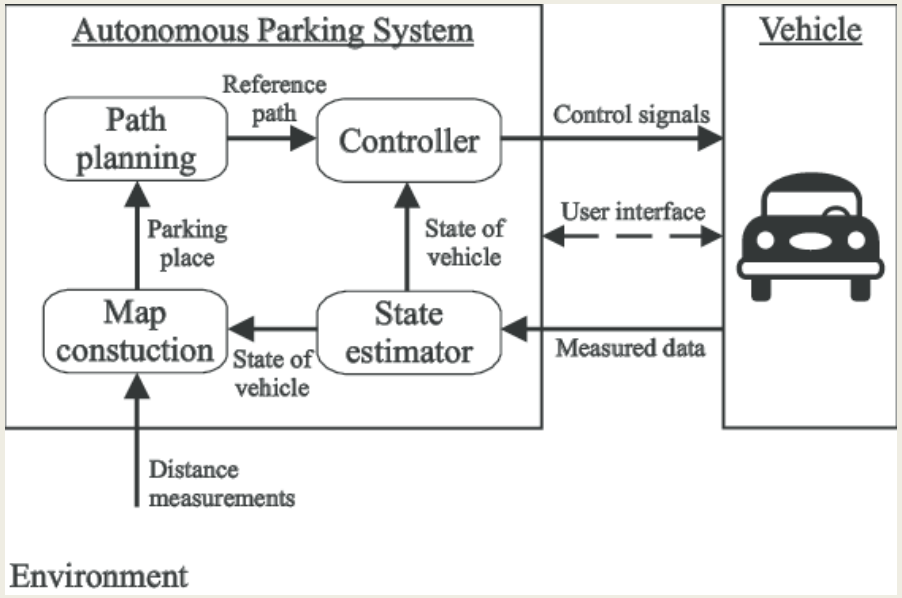
- Cars are getting bigger, traffic and the number of vehicles on the road is increasing.
- High demand for parking spaces.
- Parking lots are where one of five motor vehicle accidents happen in the US.
- Top causes of parking lot injuries:
  - Loss of focus on surroundings (other cars, pedestrians, or obstacles)
  - Backing out of a spot and not being aware of surroundings.
  - Pedestrians and other moving vehicles in the drives blind zone.

System Decomposition

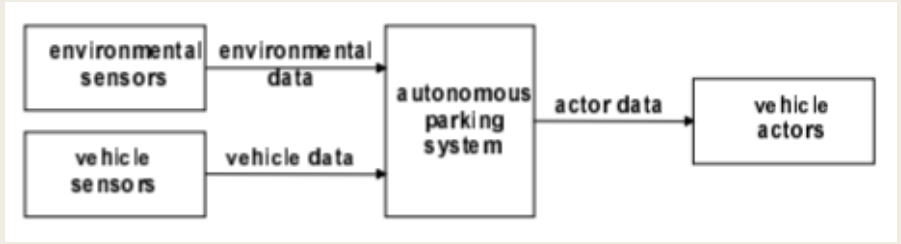
Conditions:

- Detect obstacles in the surrounding environment.
- Measure and estimate the distance to obstacles.
- Provide a planned route to park.
- Provide a real-time display to the driver during the parking sequence.

Components of the Parking Assist System



System Environment



Test, Verification and Validation

- Parking Assist Test Company (VBOX Racelogic)

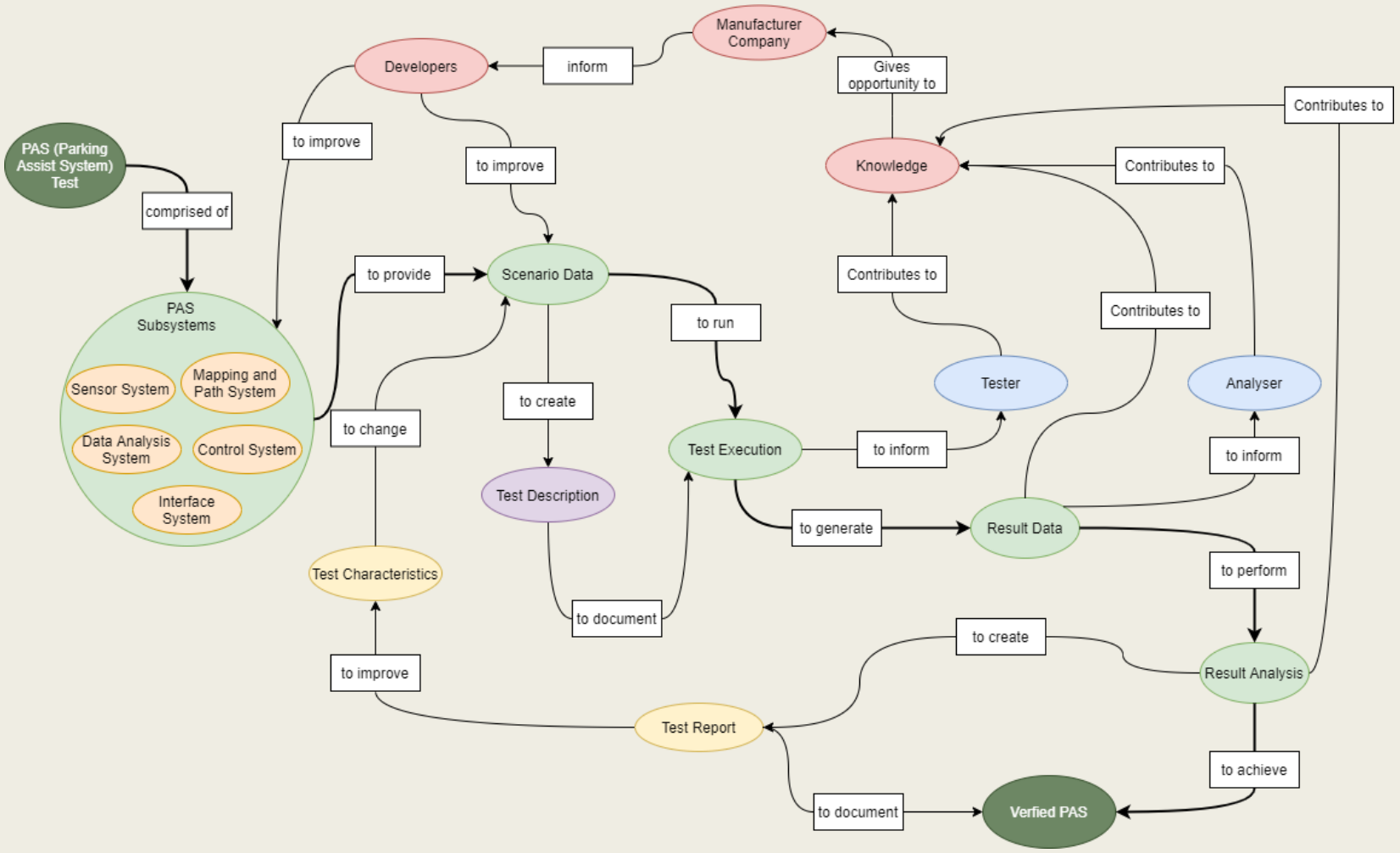
- BMW X5 Parking Assist Test
  - System performance tests in empty parking lot using other vehicles, suitcases and people as obstacles.
  - Parallel, perpendicular parking, and exit assist.

CATWOE

A framework for problem formulation

- A systematic way of formulating the problem
- The CATWOE approach illustrates the different actors and stakeholders and their perception on a topic. In this case the CATWOE approach is done from the company's perspective.

ASPECT	DESCRIPTION
CUSTOMERS – who are the beneficiaries/victims?	Drivers
ACTOR(S) – who are the implementers?	The car manufacturers (software, electronics, and test department)
TRANSFORMATION – what does the system do? What are the inputs and what transformation do they go through to become the output.	Signals and communication between different subsystems.
WORLD VIEW – what point of view justifies its existence to the customers? **What point of view makes this system meaningful?** **The big picture and its impact.**	Verify the subsystem. Validation of system that it works as it should.
OWNER – who has the authority to change the system?	Authorities like DMV (Department of Motor Vehicle in USA), DVLA (Driver and Vehicle Licensing Agency in England) or Biltilsynet in Norway can set requirements.
ENVIRONMENT – What are the external constraints?	Guidelines, rules, and regulation in the traffic. Randomness and human behavior.



Systemigram

A visual systems language

- A System diagram or Systemigram will be used to map the parking assist system.
- This systems thinking tool is used to explain the interactions between several, interrelated elements and is a great tool to get an overview over all the elements and decompose complex systems

Conclusion

- PAS is a priority technology
- Specific equipment and software to test and verify the system
- Small and complex system that has evolved since 2003 when the first rear parking sensors appeared.
- New way of looking at a complex system.
- For a system or problem that has a lot of agents, a better solution can be to look at all of the agents.
- Systems thinking gives us a framework for thinking holistically and suggests several tools and frameworks that help us think that way. CATWOE and Systemigram are two examples.
- CATWOE to summaries the problem definition.
- Systemigram to summarize the visual story of the system.
- Thinking this way will be helping the situation to be solved more inclusively.

Future Work

- Collect data and figure out the system dynamics.
- Make the system dynamics, and design of system in a systematic way.
- Use systems thinking approaches to see the system from other perspective.

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