Information session Dynamical Systems Design Dynamics & Control Section

MARCH 30, 2022

Nathan van de Wouw

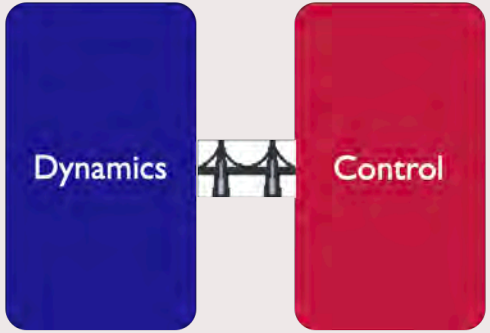
Department of Mechanical Engineering – **Dynamics & Control**

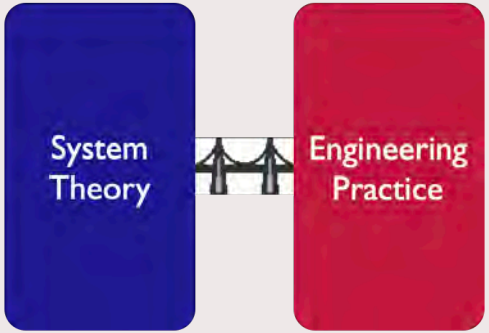
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Mission Dynamics & Control

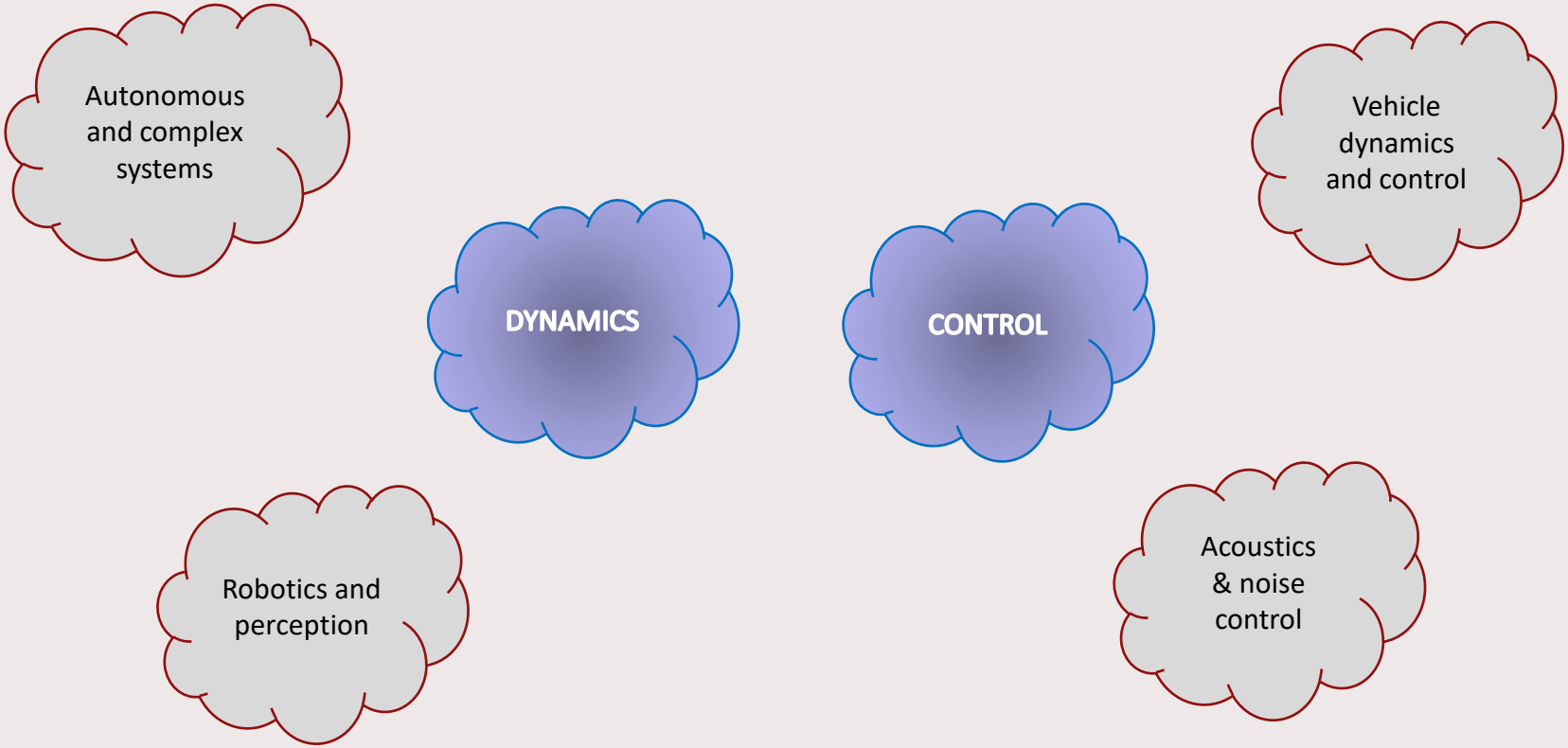
- Mission is to deliver top-level education and research on dynamical systems and control

- The Dynamics and control group aims to bridge the gap
  - between ‘Dynamics’ and ‘Control’ and
  - between ‘System Theory’ and ‘Engineering Practice’





Main D&C groups/themes



People and topics within Dynamics & Control

Complex and Autonomous Systems

Dynamics and Control of Complex Systems


Nathan van de Wouw


Sasha Pogromsky


Hans Zwart


Idoia Cortes Garcia


Rob Fey

Mechatronics


Marceel Heertjes


Hamed Sadeghian

Cyber-Physical and Networked Systems


Carlos Murguia


Erik Steur

Emeritus professor


Henk Nijmeijer

Vibrations & Acoustics


Ines Lopez

Vibro-Acoustics and Noise Control

Robotics and Perception

Robotics and autonomous systems

Soft-robotics
Haptics/ pHRI


Irene Kuling


Alessandro Saccon


Ömür Arslan


Astrid Kappers


Bas Overvelde


Arturo Tejada Ruiz


Erjen Lefeber


Mohsen Alirezaei


Tom van der Sande


Igo Besselink

Vehicle Dynamics and Control

Vehicle Dynamics and Control

Engineering design


Paul Vrancken

Secretary


Geertje Janssen-Dols

Technical staff


Erwin Meinders

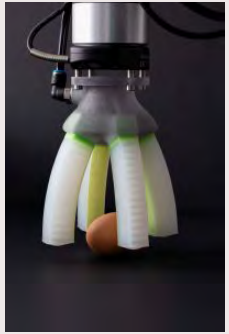
plus

~80 MSc students (you!)
~35 PhD students
~5 PostDocs

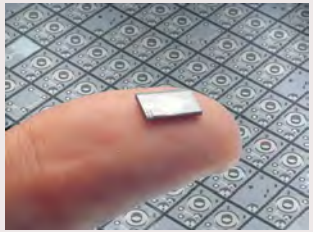
Application domains

Mechatronics

Autonomous cars



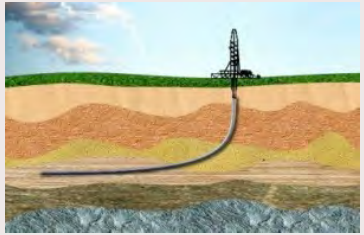
Soft robots



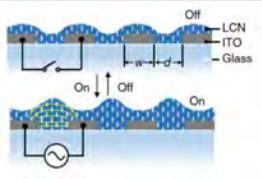
MEMS

Mechanical ventilation

Robotics



Geo-thermal energy

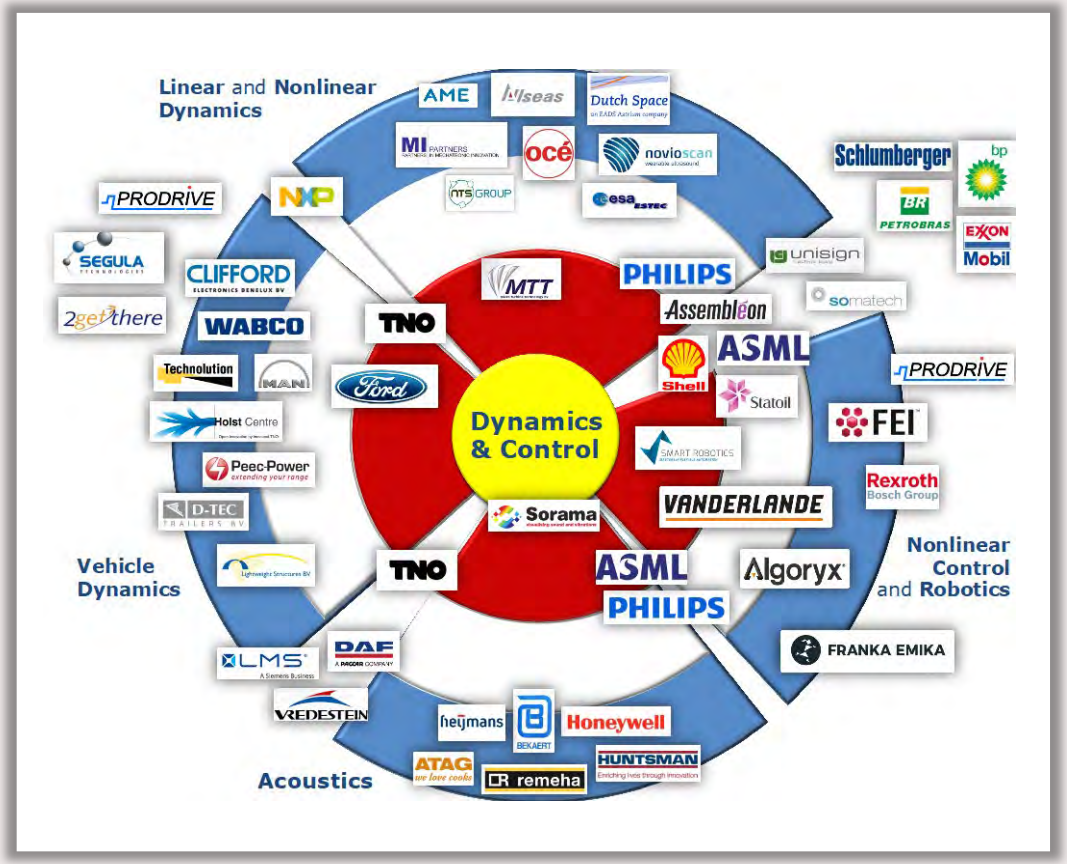


Smart materials

Digital twinning

Manufacturing

A visual impression of our industrial collaborations



Digital Twinning for high-tech systems

- Digital Twinning
  (collaboration with ASML, VDL ETG, Canon, ASM PT, …)

How to use physical modelling+data+(AI) algorithms to:

1- Automatically update models of dynamical systems
2- Optimize controllers
3- Improve fault detection

Industrial printer

Wafer handler robot

Hybrid and Nonlinear Control of Motion Systems

Linear motion systems (wafer scanners, pick-and-place machines, electron microscopes) are controlled by linear strategies. **How to achieve improved performance at lower cost using innovative hybrid control strategies?**

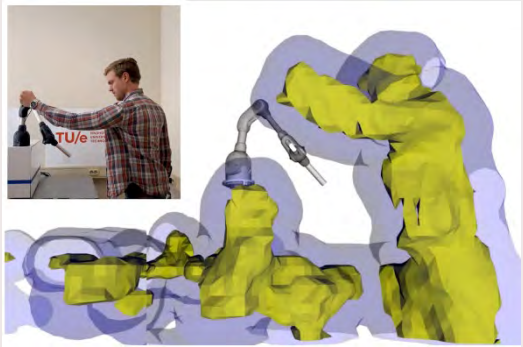
Wafer Scanners

Pick and place machines

Electron microscopes

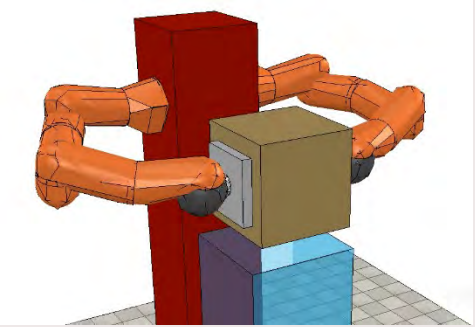
Physical Robot-Environment Interaction

- Advanced modelling and control of robot manipulator in **dynamic contact** situations (including **impacts**), for applications in logistics and construction.
- **Vision based tracking and collision avoidance**



vision based collision avoidance

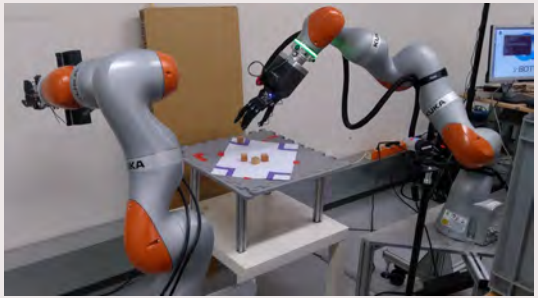
Optimal reactive QP robot control

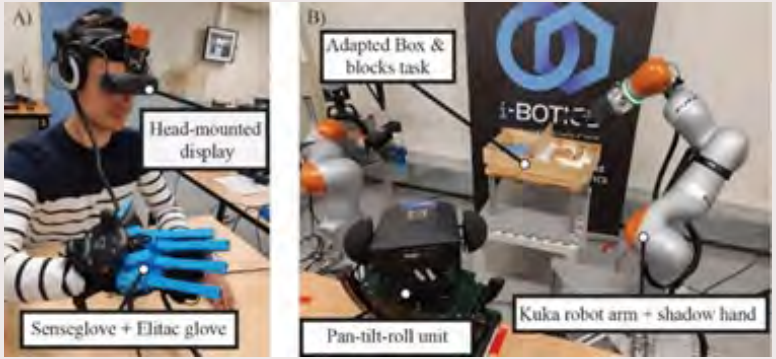


impact-aware manipulation

Dynamics and control of tele-manipulation

- Control and mapping of the fingers (dexterity)
- Mapping of the arm movements
- Delays (and how to deal with them)
- Haptic feedback
- Haptic shared control (with AI)
- Bimanual manipulation without collisions





i-botics.com

https://www.youtube.com/watch?v=QwfncoyckcY

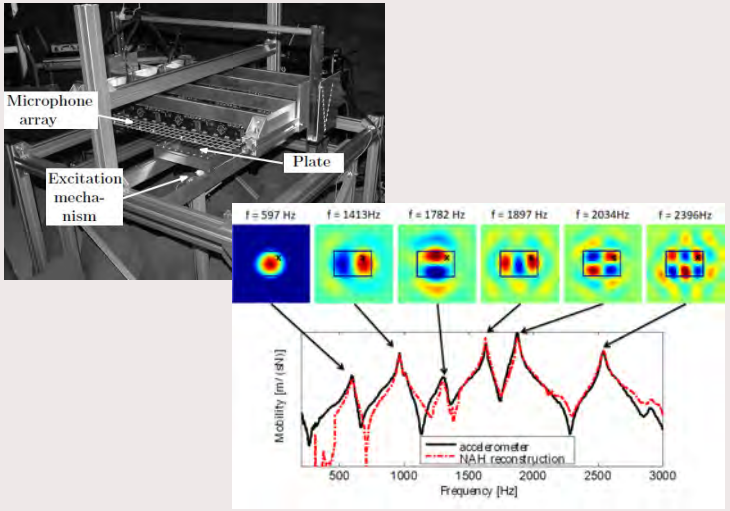
Mechanical Ventilation

- Mechanical ventilation
  (collaboration with Demcon, Erasmus MC)

  Research challenges:
  - How can we automatically identify patient properties to support doctors in diagnostics and treatment?
  - How to detect patient-ventilator asynchrony?

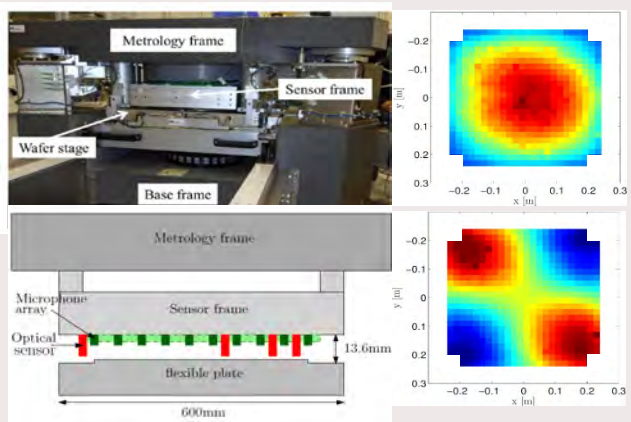
Contact-less vibration detection of mechatronic systems

Experimental modal analysis



Application: Smart Monitoring & Diagnostics

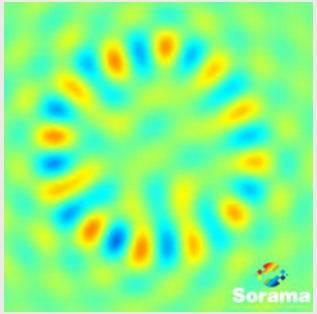
Direct mode detection

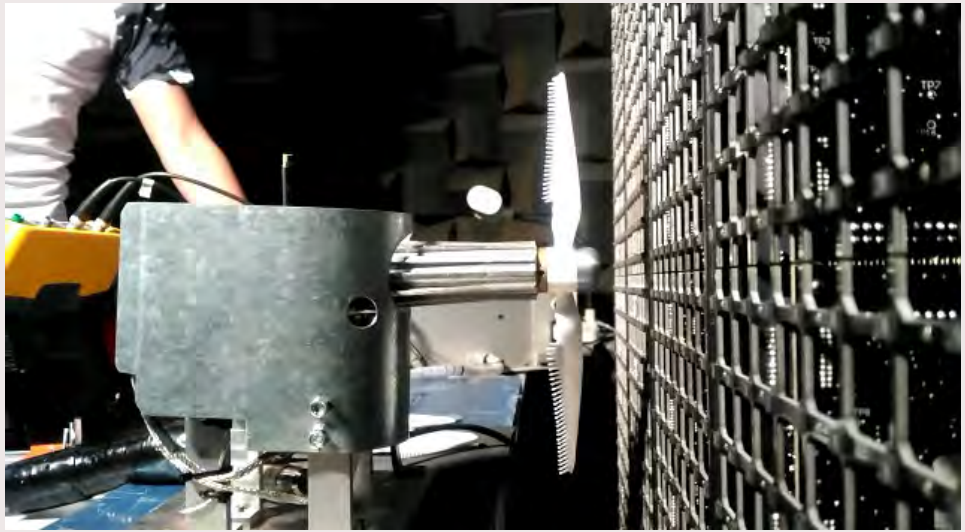


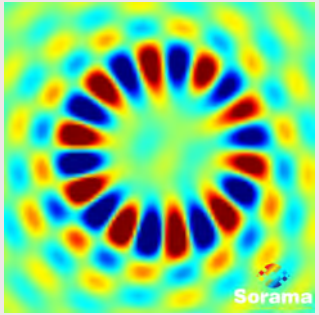
Accuracy: best/worst position

60 Hz	70/700 nm error at 3 µm amplitude
110 Hz	0.2/7 nm error at 100 nm amplitude

AI + sound cameras = Smart Monitoring

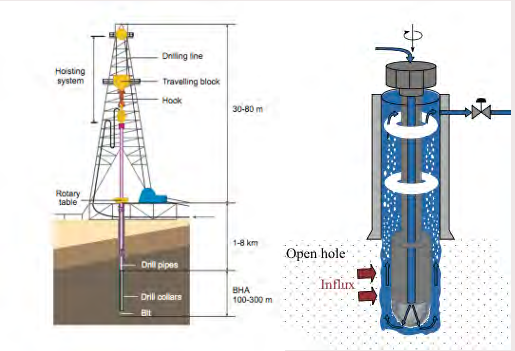






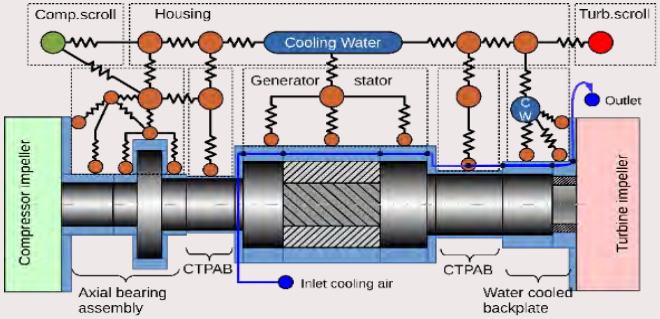
Reduced order modelling of complex systems

- Models of engineering systems becomes more and more complex (= multi-physics, large-scale, etc.)
- Complexity makes using models for design, optimization and control challenging
- **How to reduce the complexity (typically number of states/degrees of freedom) and while retaining accuracy?**



Pressure control in drilling

Electronics for automotive applications



Thermal modeling for motion/temperature control

Steering systems for future modular road transport

Longer heavier vehicles

Benefits:

- cheaper transport
- traffic reduction
- emission reduction

Challenges:

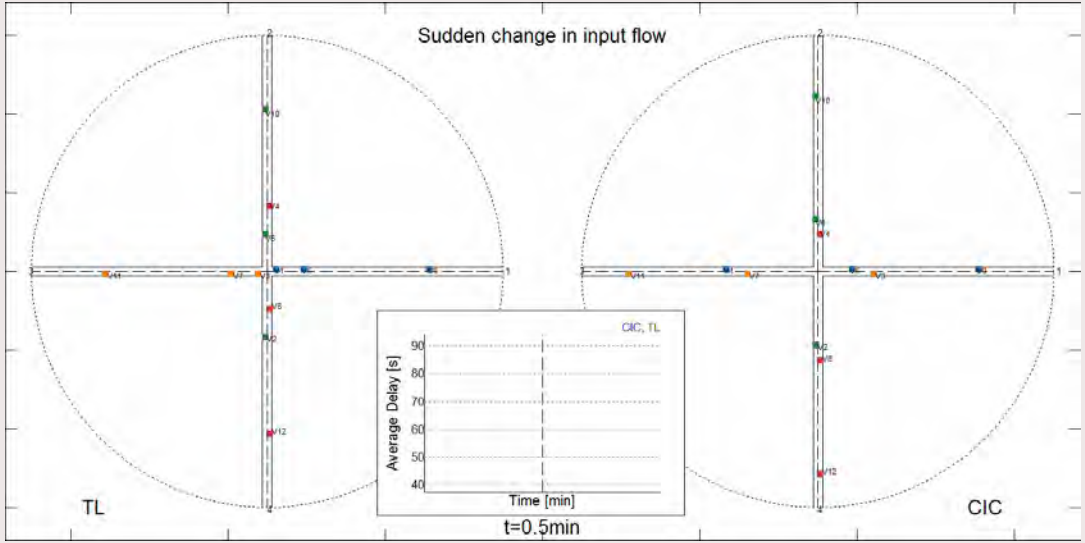
- speed manoeuvrability and high speed stability
- Active trailer steering control

Cooperative driving – intersection control

Cooperative intersection control (CIC):

Goal: improve traffic flow and safety at urban intersections

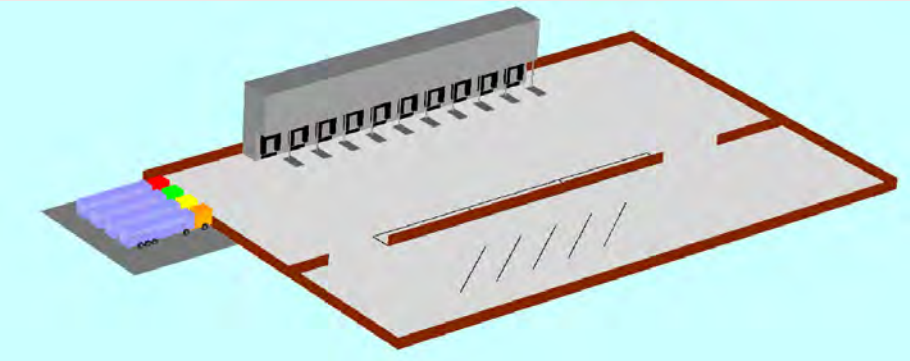
Four-way intersection scenario: comparison with traffic light control



Autonomous trucks

TU/e TruckLab

Warehouse simulation environment



JUMBO

Autonomous Truck System

For more examples of projects…

- https://tue.nl/dc

- **Personal webpages**
- **LinkedIn page:** https://www.linkedin.com/company/eindhoven-university-of-technology-dynamics-and-control/
- **Google Scholar pages** of our researchers are also excellent source of information to know what we are up to

Dynamics and Control

Section of the Dynamical Systems Design (DSD) division

MASTER EDUCATION DAY (MARCH 20, 2022)

Nathan van de Wouw - Professor

Department of Mechanical Engineering -- **Dynamics & Control section**

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY