School of Mechanical Engineering
FACULTY OF ENGINEERING

UNIVERSITY OF LEEDS

MECH5170M
Connected and Autonomous Vehicles Systems

Module Introduction

Kris Kubiak (k.kubiak@leeds.ac.uk)

Overview

UNIVERSITY OF LEEDS

MECH5170M Connected and Autonomous Vehicles Systems

15 Credits Module

Lectures 22 hours

Tutorials 2

Practical 2 hour

Dr Kris Kubiak – k.kubiak@leeds.ac.uk

Objectives

On completion of this module, students should be able to:

1. Recognise the distinctions between Advanced Driving Assistance Systems (ADAS), connected and autonomous vehicles, and describe the main system components.
2. Assess and compare the functionality of various automotive sensors, as well as their operating principles, performance, and limitations.
3. Show their understanding of autonomy levels, path planning, and localisation.
4. Assess the performance and security of embedded automotive vehicle control systems.
5. Investigate methods for system validation and testing including hardware/software in the loop.
6. Demonstrate knowledge of the regulatory framework, approval processes, and ethical issues.

Learning Outcomes

On completion of this module, students should be able to:

1. Demonstrate in-depth knowledge and understanding of the autonomous vehicle system's design and functions.
2. Critically evaluate and compare different automotive sensors, working principles, performance, limitations, and sensor fusion strategies.
3. Select and analyse path planning algorithms and models, evaluate task allocation and judge its advantages and limitations.
4. Assess and critically evaluate embedded vehicle control systems in the context of connected and autonomous vehicle safety and security risks.
5. Understand and apply testing and validation strategies of sensors, models and programming code of autonomous systems.
6. Demonstrate knowledge and understanding of regulatory requirements, professional responsibilities, and the ethical implications of connected and autonomous vehicles.

Assessment

Coursework - Individual project 50%

Design of the self-driving vehicle

- Individual Report

2 hours on-campus in-person invigilated Exam 50%

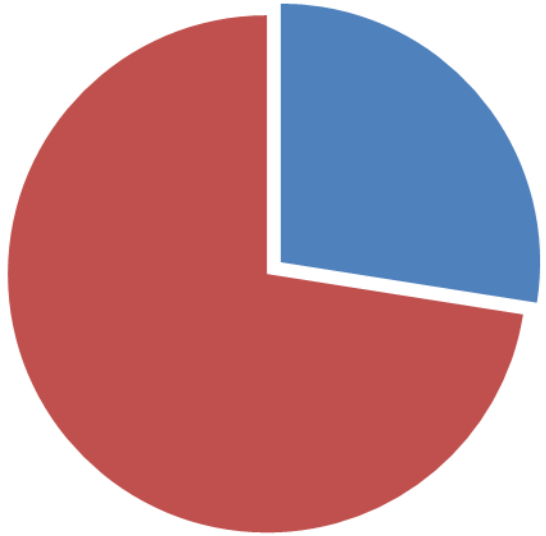
- Calculation based questions
- Descriptive questions

Teaching methods

Delivery method	Study Time
Coursework Assignment	40 hours
Tutorials, Practical	**2 hours**
Lectures Live	**22 hours**
Pre-recorded Lectures	**11 hours**
Exam	2 hours
Total Contact hours	**35 hours**
Self Study	**115 hours**
Total	**150** hours

Workload

Lectures and Tutorials 35 hours (Semester 1)



Individual work 115 hours

Lectures Draft Plan (11 weeks)

W1 - Introduction, Levels of autonomy, Regulation and legal requirements

W2 - Driving Assistance Systems, Connected and Autonomous Vehicles, Actuators, and automation

W3 - Sensors, sensor fusion, LIDAR and Stereo Camera, Machine vision,

W4 - Perception and visualisation, Localisation and path planning, Latency

W5 - Autonomy and decision making, Artificial Intelligence algorithms, Machine learning

W6 - Embedded Vehicle Control Systems, Python, Matlab, C++,

W7 - Safety-critical systems, MISRA C, Network and communication protocols, Cyber-Security

W8 - Embedded Vehicle Control Systems, Virtual Learning Environment, Digital Twin

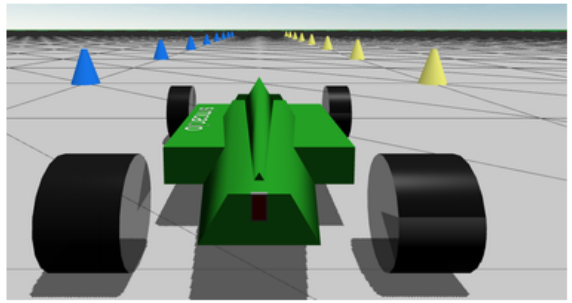
W9 - Software-in-Loop, Hardware-in-Loop, Sending the data through the CAN

W10 - Testing and Validation, Road testing, Future of autonomous vehicles

W11 - Regulatory framework, Ethical challenges, Revision

Path planning algorithm - https://leedsgryphonracing.com/simlab

Step 1. Circuit data



In this step a circuit data was created based on your Student ID.
Take this data as an input for your path planning program.
Cone type can be 1 for a yellow (right) cone and type 2 for a blue (left) cone.
Data Format: cone_type, position_X, position_Y

```
3,150,100
2,149,109
2,147,117
2,143,125
2,138,132
2,132,138
2,125,143
2,117,147
2,109,149
2,100,150
2,91,149
```

Download

Step 2. Driving control sequence

Your task is to create matlab, python or C program to plan the path to drive around the circuit created in step 1.
Required Data format: time(s), steer(angle), power(%), brake(%),
Example 1 strait acceleration for 3s: 3.0,0,100,0,
Example 2 strait breaking for 3s: 3.0,0,0,100,
Example 3 turn left for 1s: 1.0,-35,50,0,
Example 4 turn rightfor 2s: 2.0,35,50,0,

```
3.0,0,100,0,
```

Practical

UNIVERSITY OF LEEDS

Path planning algorithm - https://leedsgryphonracing.com/simlab

https://simcar.io

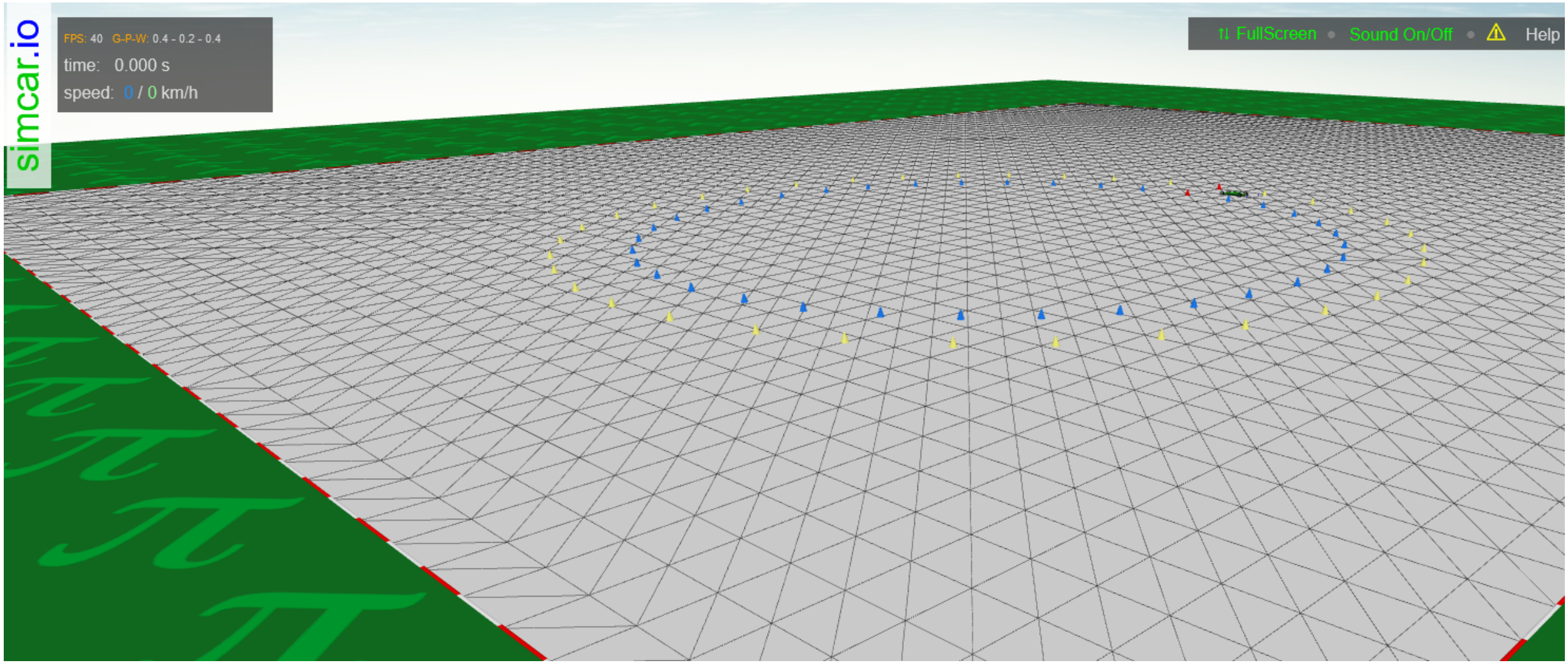
Step 3. Create XML script for simulation at https://simcar.io

```
<scenario version="0.1">
<ground type="flat"/>
<camera type="1"/>
<geom type="cone" size="1" color="1.0, 0.0, 0.0"
pos="150,100, 0.5"/>
<geom type="cone" size="1" color="0.1, 0.5, 1.0"
pos="149,109, 0.5"/>
<geom type="cone" size="1" color="0.1, 0.5, 1.0"
pos="147,117, 0.5"/>
<geom type="cone" size="1" color="0.1, 0.5, 1.0"
```

Create Download

Simcar VLE

UNIVERSITY OF LEEDS



ANY QUESTIONS ???