University of Nottingham
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EEEE1002 Applied Engineering Design

Session 4 Introduction

EEEE1002: An Introduction

Very Important: Module Engagement

- The purpose of the module is to acquire practical engineering skills
- Engagement is a compulsory requirement to pass the module
- When scheduled to be in a lab
  - Be in the lab by 09:00 and finish at 17:00
  - Lunch break should be limited to 1 hour maximum, between 12:00 and 14:00
  - Attendance will be monitored throughout the day
- **Non engagement may be penalised, unless supported by an EC claim & tutor informed**
- **This module needs to be passed. It can only be resat in attendance the following year i.e. it will add a year to the duration of your degree**

EEEE1002: An Introduction

What is EEEE1002?

- It is a practical ‘hands on’ engineering design module.
- It is worth 40 credits, rule of thumb…
  - 1 Credit = 10 hours of effort ∴ 40 credits = 400 hours
  - You will spend approximately 200 hours in the lab
  - Therefore significant effort required outside the lab
  - 200 hours in the lab, 200 hours outside the lab
- Non-engagement will attract a penalty
- It must be passed to progress to Year 2
- **The module can only be re-taken in attendance i.e. failing the module will delay your progression by one year**

EEEE1002: An Introduction

Module Aims

- Further develop your knowledge by putting into practise concepts covered in the lectures
- Develop Skills Required by Employers
  - Develops practical skills
  - Develops engineering ways of thinking
  - Develop effective approaches to project management
- Develop the ability to work independently
- Develop the ability to work effectively as a team

EEEE1002: An Introduction

Support throughout the module

- **3 x Academic staff running the module, offering in-lab and remote support:**
  - Steve Greedy, Sergiy Korposh and Adam Walker
- **4 x Teaching Assistants offering in-lab and remote support:**
  - Ahmed Aldabbagh, Richard Davies, Nat Dacombe, David Dewar
- **Technical staff as required**
  - Mark Birkin and Alex Ottway





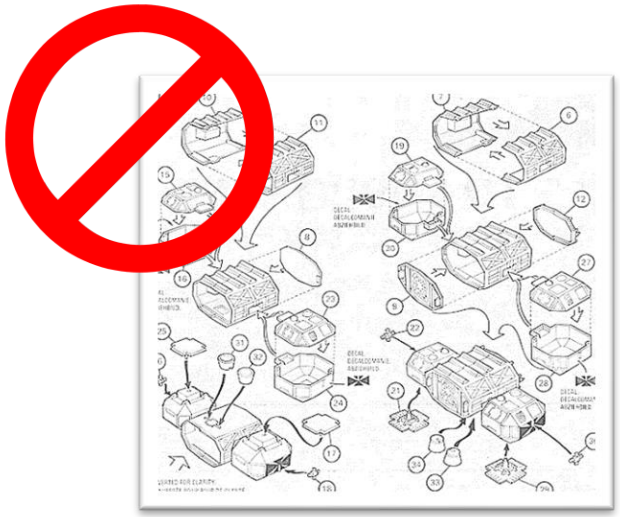


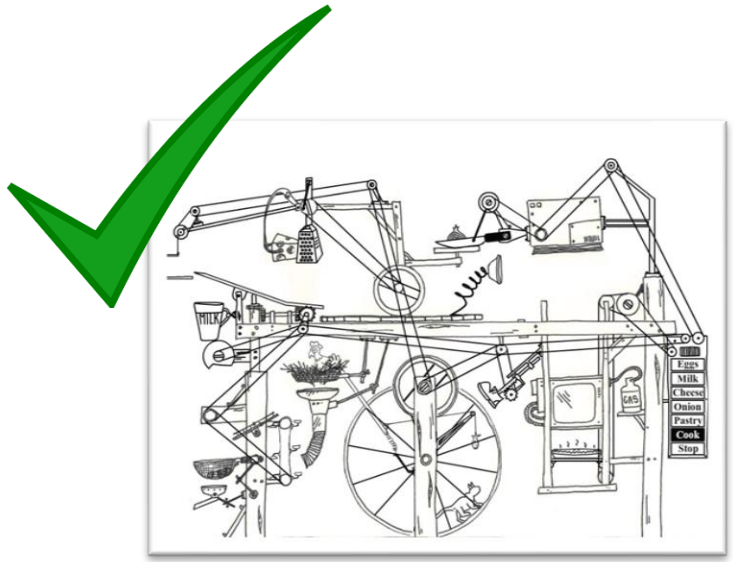


EEEE1002: An Introduction

Lots of support available, however

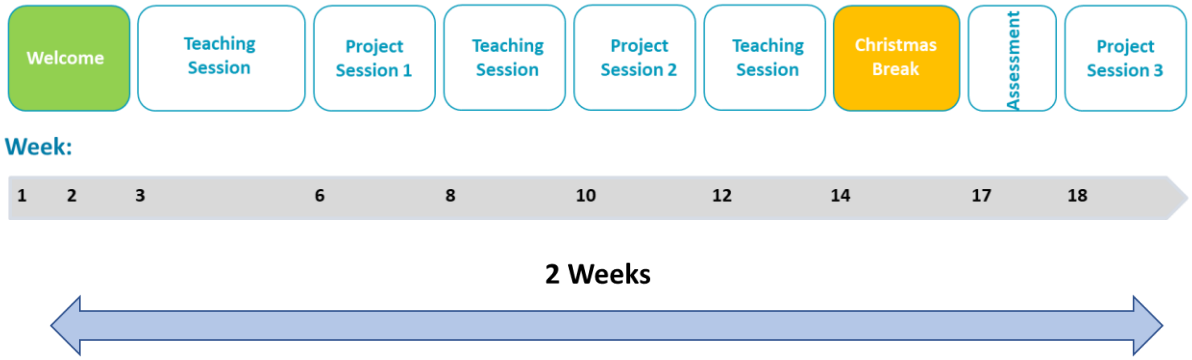
- This is not an ‘Instructional’ module
- No advance information (maybe a few hints…)
- We will help guide you in an Engineering approach
- We will not provide solutions





EEEE1002: An Introduction

Project Session Schedule



Project Session: First Week				
Practical Labs: Groups A and B – 09:00 to 17:00				
M	T	W	T	F
am	am	am	am	am
pm	pm		pm	pm
Self directed study: Groups C and D (plan for 32hrs)				
• Background research for EEEE1002 • 1-2-1 Personal tutorials • Revisit **all** modules: learning material and coursework requirements				

Project Session: First Week				
Practical Labs: Groups C and D – 09:00 to 17:00				
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• Background research for EEEE1002 • 1-2-1 Personal tutorials • Revisit **all** modules: learning material and coursework requirements				

- Project sessions span **two weeks**. One of these weeks will be spent on practical work and one will be spent attending face-to-face technical tutorials
- **Groups A and B** will have practical work in the first week of the two week sessions.
- **Groups C and D** will have practical work in the second week of the two week sessions
- During a practical week you will spend **4.5 days** in the lab
- In the non-lab based week you should devote this to self directed study for an equivalent amount of time (~32 hours).

EEEE1002: An Introduction

Changes for this year

- The platform is again a 3 wheel, 2WD vehicle
- Individual and group work
- Introduction of an IoT approach to enable vehicle to anything communications V2X
- We will have a group photo

The end game remains the same

Ultimate Goal: Development of an autonomous vehicle utilising computer vision to navigate

- SAE (Society of Automotive Engineers) Levels of automation:

SAE Level	Name	Narrative definition		Execution of steering and acceleration/ deceleration	Monitoring of driving environment
Human driver monitors the driving environment					
0	No Automation	The full-time performance by the human driver of all aspects of the dynamic driving task, even when "enhanced by warning or intervention systems"		Human driver	Human driver
1	Driver Assistance	The driving mode-specific execution by a driver assistance system of "either steering or acceleration/deceleration"	using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task	Human driver and system	
2	Partial Automation	The driving mode-specific execution by one or more driver assistance systems of *both steering and acceleration/deceleration*		System	
Automated driving system monitors the driving environment					
3	Conditional Automation	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task	with the expectation that the *human driver will respond appropriately to a request to intervene*	System	System
4	High Automation		*even if a human driver does not respond appropriately to a request to intervene*		
5	Full Automation		*under all roadway and environmental conditions* that can be managed by a human driver		

https://en.wikipedia.org/wiki/Self-driving_car

- We will aim for SAE level 4 i.e. your vehicle should complete a course without human intervention

EEEE1002: An Introduction

On the route to autonomy: Sessions & Subsystems

1. Intro to test & measurement principles for electrical and electronic engineering and basic motion
2. Sensors & serial communications
3. Optical line following
4. **Vehicle to anything (V2X) communications**
5. Intro to computer vision
6. Big track challenge – incorporate one or more sub-systems to navigate a given route and complete technical challenges

- **Specific detail will be provided on the 1st Monday of each project session. Generic technical detail will be covered in the Monday seminars**

Session 4 V2X Communications

Assessment:

- **Following session 4:**
  - **20%:** Individual report on detailing work undertaken in sessions 3 and 4
  - **5% :** Group poster detailing technical design of vehicle
- Final coursework descriptions/requirements released on the 25th February 2022
  - Keep a detailed log book!
- **Coursework submission dates:**
  - **Poster: 3rd March 2022 at 15:00**
  - **Report: 10th March 2022 at 15:00**

Session 4 V2X Communications

Project Log (Session 2 onwards)

- Throughout this module you will be required to produce technical reports on the work you have undertaken
- It is therefore even more important from now on that you keep a log of the work you undertake, information to log can include:
  - Written notes that capture your approach/thinking
  - Circuit diagrams
  - Measurement data
  - Screen shots (hint: use PRINTSCRN or ALT+PRINTSCRN to capture screen shots or the active window and paste into a document, or paste into Paint and save as an image)
  - Photos
  - Key references (web links, .PDFs etc)

Session 4 V2X Communications

Vehicle to Anything (V2X)

- Describes communication between a vehicle and everything that it may need to interact with, to:
  - Operate safely
  - Operate efficiently
  - Maximise traffic flow
- Relies on wireless communications to provide:
  - vehicle to vehicle (V2V)
  - vehicle to infrastructure (V2I)
  - vehicle to network (V2N)
  - **Vehicle to Anything (V2X)**

Session 4 V2X Communications

Introduction to Session 4

- Session 4: Implementation of a communications system to:
  - gather data from sensors **on** the EEEBot
  - gather data from sensors **off** the EEEBot
  - send control data to the EEEBot
  - Work as a group to send and receive data to/from up to 4 EEEBots using a single remote terminal with a graphical user interface (GUI)
- Appropriate background information will be provided, but we are now starting to move away from guided work in preference to posing problems to be solved – many solutions to a single problem!

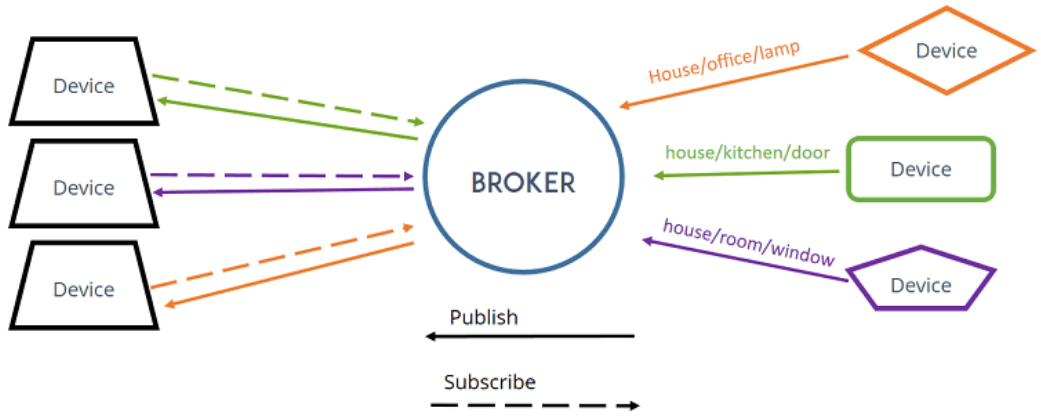
Session 4 V2X Communications

Elements of a ‘EEEBot V2X’ System

- **A Robot**
  - A microcontroller that can interface with other microprocessors and sensors (our EEEBot is ESP32 based with an Arduino NANO)
- **A Central Controller for the Network**
  - A Raspberry Pi 3 Model A+ (R-Pi)
- **A Communications Protocol**
  - Message Queuing Telemetry Transport, or simply, MQTT
- **A Central Controller & Graphical User Interface (GUI)**
  - Mosquitto MQTT running on the Raspberry Pi
  - Node-RED Dashboard

A Very Brief Overview of MQTT

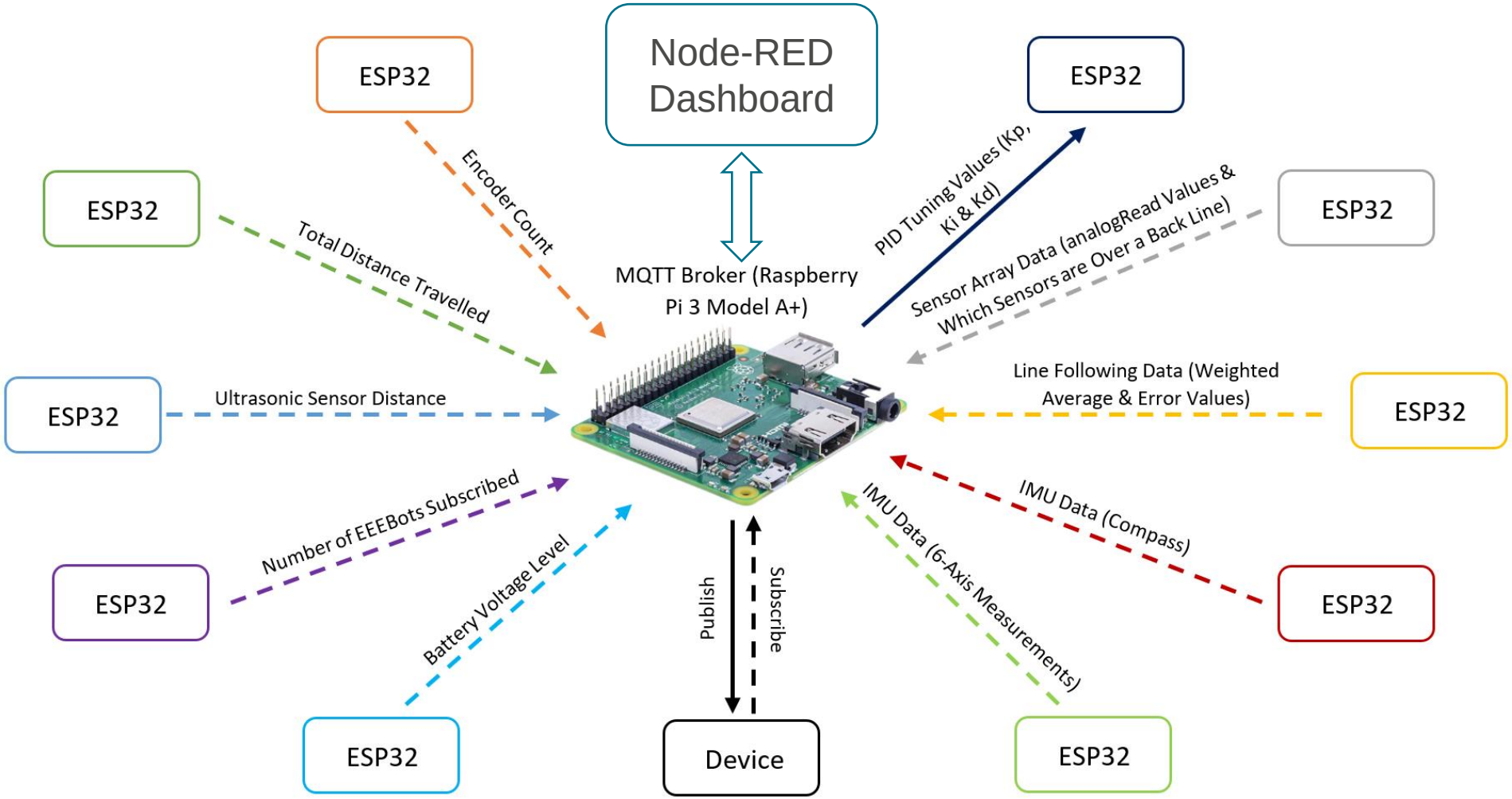
- Messaging protocol to exchange data between multiple devices
- Devices on a network **subscribe** to **topics**
- Devices on the network **publish messages** related to a **topic**
- Any device **subscribed** to the **topic** receives the **message**



A more specific example…

Session 4 V2X Communications

Example Overview of the EEEBot V2X System

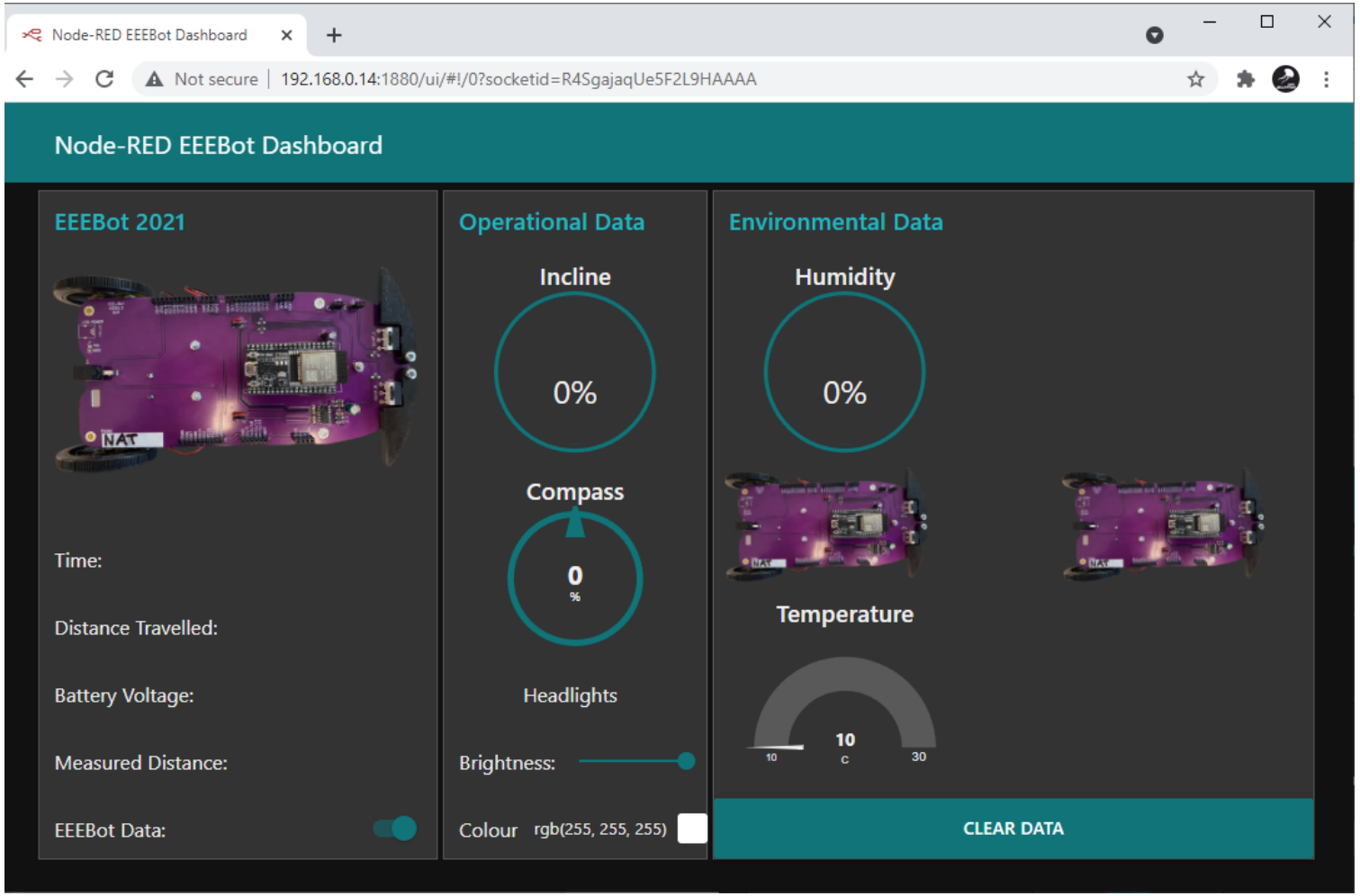


The list of example published/subscribed data is by no means limited to what is shown

Example Node-RED Dashboard GUI

- An example dashboard follows that illustrates both subscribed data and published data
- A range of components and sensors were used in this example – some of which you won't have on your EEEBot, be creative with what you do have!
- Additional GUI elements can be included such as buttons, titles, page sections, toggle switches, pictures and much more – there is plenty of tutorials on how to include these on the internet

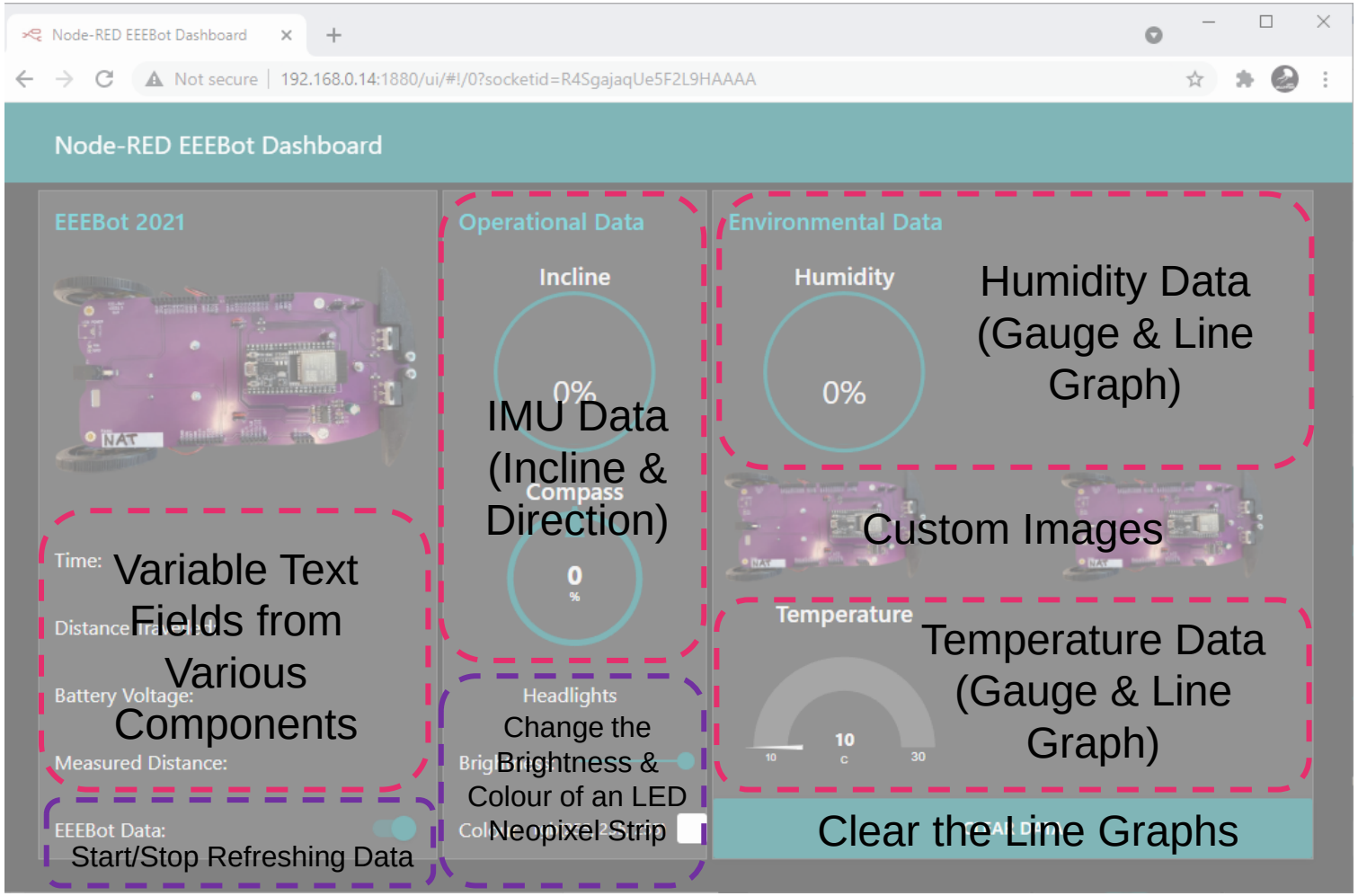
Example Node-RED Dashboard GUI



Example Node-RED Dashboard GUI

Published Data

Subscribed Data



Session 4 V2X Communications

Overview of the V2X System Requirements

- You will need to work as a group
- Each member of the group will be responsible for
  - equipping their own vehicle with a sensor that can send data to the central controller to be displayed via a GUI. **Each vehicle in the group must use a different sensor**
  - equipping their vehicle with a device that can be controlled from the central controller's GUI. **The device can be the same for all vehicles in the group**
- **Successful completion of the above is worth 70% of session 4**

Session 4 V2X Communications

Overview of the V2X System

- A further 30% is available if:
- At the end of the session the group presents a single vehicle equipped with a number of sensors and is capable of line following that sends/receives data to/from the central controller that can:
  - Display status of each IR sensor
  - Display the weighted average
  - Vary the PID constants
- Each of the above is worth 10%

Session 4 V2X Communications

Lots of Resources and Examples on the Web

[1] https://diyi0t.com/microcontroller-to-raspberry-pi-wifi-mqtt-communication/

[2] https://randomnerdtutorials.com/esp32-mqtt-publish-subscribe-arduino-ide/

[3] https://www.instructables.com/How-to-Use-MQTT-With-the-Raspberry-Pi-and-ESP8266/

These are just a few from the 1st page of a Google search

A Spanner in the works…

- The underlying network can make use of a wide area network (WAN) to support communications i.e. the EPS32 communicates with the R-Pi via the network router
- However, Eduroam isn't overly friendly when trying to connect all manner of devices. Therefore, once the R-Pi is configured as required we will use it as an **access point** so the ESP32 device communicates directly with the **R-Pi**
- You can switch between the above if, for example, you are using a network router you have more control over
- The above will be covered in more detail in the notes released for the start of the session

Session 3 Optical Line Following

How to succeed….

- Engage
- Make use of any support
- Pay attention to and use Moodle and the Teams site
  - Please use the Teams site to ask questions
- Talk to other students
- Above all – have fun!

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End of Session 3 Introduction