Individual Project

Period 1 - Minor Internet of Things

In the first period of the minor you will work on an individual project. The goal for this project is to get familiar with a broad range of subjects that are important to designing and implementing Internet of Things solutions.

Components

Your project will contain the following components:

- An internet connected embedded device using sensors and things (link)
- A web-application, containing a back-end, a front-end and making use of a third-party API (link)
- A physicalisation: a physical model of measured data, using digital fabrication techniques (link)
- End-user research (link)

Together these components will form the final product for your individual project.

Project components

Embedded Technology

Artefacts

Product Technologies

You will make an internet connected device that has the following properties:

- At least one way to communicate the state of the application to the user
    - By using light, sound or movement
- It has to react to user input (using sensors and/or buttons)
- It sends data through the internet to a remote server
- It receives data through the internet to a remote server

Documentation

User guide
A guide to help the end-user to set-up the product in order to use it

Admin guide
A guide to help an informed user or administrator to set-up the device so it is ready for an end-user to use it.

Architecture overview
A schematic overview of the software-components that make up the product and how they are connected.

Wiring diagram
A schematic overview of the hardware-components and how they are connected. Unexperienced students can use Fritzing, experienced users are required to draw a schematic in an EDA of their choice (EagleCAD, KiCAD, EasyEDA, etc.)

Bill of materials
A list of hardware components used in your product.

Development Process
A description of your plan (or steps taken) during the development, resources used (tutorials, guides, examples etc.) and what you learned (**new** knowledge and skills acquired) during this part of the individual project.

Grading criteria

Grade	Criteria
Excellent >8	● All technologies are present ● At least two of the chosen technologies used surpass the level of the classroom assignments ● All technologies are of professional quality ○ The device works flawlessly ○ Device is made permanent by milling a PCB and soldering ○ Code is of professional quality ■ Well commented ■ Clear variable names ■ Object oriented techniques used whenever necessary ○ The documentation is professional enough to be bundled with a sold product and is tested with the target audience: ■ Can an average user set-up and use the product? ■ Can an educated user set-up the product without help from the developer?
Good 7 to 8	● All technologies are present ● At least one of the chosen technologies used surpasses the level of the classroom assignments ● All technologies are of good quality ○ The device works ○ Device is made semi-permanent by using perfboard and soldering ○ Code is of good quality ■ Well commented ■ Clear variable names ■ Makes use of methods/functions/procedures ○ The documentation is good enough to be bundled with a sold product
Sufficient 6-7	● All technologies are present ● None of the chosen technologies used surpass the level of the classroom assignments ● All product technologies are of decent quality: ○ The device works ○ The code works ○ The documentation is good enough for the end-user and administrator to set-up and use the product
Insufficient <5	● Documentation is present, but not prepared with care: ○ many punctuation errors, ○ no proper language used, ○ unreadable text, ○ pictures that are blurry, ○ no headings in the document ● The product does not work ● The product is not able to ○ send or receive data from the internet ○ detect user-input ○ visualize product status (using light, sound or movement)

Web-application development

Artefacts

Product

Develop a web application that connects and interacts with your embedded device. You can use a technology stack of your choice. The web application should consist of the following:

- A **back-end** (server component) used by your front-end and embedded device for sending, retrieving and storing data (also part of requirements of embedded technology).
- A **front-end** (website) which displays data and interacts with the embedded device through the back-end.
- An integrated **external API** that is relevant for your project (ie. Google Maps, Weather Service, Public Transport etc.).

Documentation

Architectural overview
An overview of components in your web application and how they communicate and interrelate.

Functional design
A detailed description of how the functionality works (or is supposed to work). For example (use case) scenarios, flow chart (from the user perspective), wireframes, screenshots,

Technical design
A detailed description of the web application that describes design choices, libraries or frameworks that were used. For example UML (class diagrams, sequence diagrams), flow chart (technical perspective), API documentation, ERD.

Development Process
A description of your plan (or steps taken) during the development, resources used (tutorials, guides, examples etc. with proper referencing (APA or IEEE)) and describes what you learned (**new** knowledge and skills acquired) during this part of the individual project.

Grading criteria

Excellent >8	Near professional, one or more of the following applies to work on top of fulfillment of the 'good' criteria: ● deployed to a 'real' hosting environment ● professional development tools used (ie. gitlab/hub, continuous integration, docker) ● elaborate use of front-end or back-end frameworks ● Front end is a proper single page application ● security by design ● coding standards and automation of code quality ● professional documentation practices (ie. instructions for use, standards) ● You provided compelling evidence of learning something new.
Good 7 to 8	● Complete working web application displaying multiple pieces of useful functionality, demonstrated on students own laptop or educational environment ● Back-end is self-coded or ready made solution is used (like Firebase), interfaces with a database or storage and generates the front-end. Some data is sent or retrieved from the backend through an AJAX call. In case of Firebase all functionality is created in the front-end. Applies basic security practices against SQL injection and/or cross site scripting where applicable. ● A real external API is used (JSON/XML/CSV) and the data is processed in either the back-end of front-end. ● Professional documentation that is useful for the next person working on this project. ● Development process supplies plausible explanations of learning as might be expected from your educational background.
Sufficient 6 to 7	● Complete working web application with single piece of functionality or partially working web application demonstrated on own laptop or educational environment (ie. glitch.com, codesandbox.com). ● Mostly static front-end which updates one or several values from a backend without much processing. (ie. single variable in firebase that updates in the front end when changed in firebase). Or used mostly examples from the workshops repeatedly. ● External API is largely based on documentation examples of the provider. (ie. google maps in iframe and variables changed in copy pasted code) ● Largely professional and readable documentation but essential information is missing for understanding the web application. ● Development process is described and sufficient, but no plausible explanation of learning. Or it is clear you rely on previously acquired knowledge.
Insufficient <= 5	● Student did not manage to do the assignment, or substantial parts were not working. ● Assignment does not demonstrate understanding of applied techniques: ○ resources that were used were not referenced (APA) or largely copied without substantial modification ● Language (Dutch or English) and structure of documentation are not understandable because of: ○ spelling/grammar/style errors ○ unclear language or document structure ● Development process is not clear or not present.

Physicalisation

Combining the digital with the physical world is an important aspect of the Internet of Things. In the physicalisation part of the project you will transfer the digital representations to the physical world. By transferring digital to physical, the abstract numbers become moldable and allow for generating new knowledge via hands-on manipulation and sharing and discussion. In this course we introduce digital manufacturing and design techniques for creating physical representations of IoT data.

Artefacts

Product

Create a physicalisation. You will use digital manufacturing (3d printing, laser cutting, etc.) tools to create a physical model of an IoT related dataset.

Documentation

Provide documentation and your design files.
Describe the following steps in your documentation:

1. DATA

- Choose an IoT related dataset and describe its properties and values
- What is/can be so interesting about this dataset

2. CONCEPT

- Work out your idea of the physical representation of your digital data.
- Write down your idea in 200 words
- Describe what for discovery can the user make that is unique about the physical versus the digital
- Make a sketch or impression of your desired physicalisation

3. DIGITAL MANUFACTURING & MATERIAL

- Choose your digital manufacturing technique and material
- Think about what properties of the material fit your concept best
- Think about the speed of creating with the device and the chosen material
- You do not have to do everything with one device, different devices can be used, also some handwork is allowed
- Keep your concept, design and material realistic and feasible, a realised simple physicalisation for the assessment is better than no physicalisation.

4. DESIGN

- Prepare your data and create your design for your chosen digital manufacturing technique(s) and material(s)
- Describe the mapping between the dataset and the properties of the final physicalisation.

5. PROTOTYPE - MANUAL MANUFACTURING

- Realise a prototype of your design using manual manufacturing technique(s) that are in line with your chosen digital manufacturing technique(s) and that are available to you. The goal is to test if your idea and design can work, it does not have to look perfect.

6. CREATE

- Realise your design with your digital manufacturing technique(s)

0. OPTIMISE

- Throughout the process favor speed and quick results over beautiful design.
- Descripe what optimalisations you have made to work faster. e.g. 3D print in 1 hour instead of 10 hours.

! FAILURES

- Log your failures (at least 4), explain for each failure:
- what went wrong
- how you tried to solve it
- how you would approach the problem next time

Grading criteria

Grade	Criteria
10	<u>Student is a pro</u> ● 2 or more digital manufacturing technique are applied to compose a physical structure ● digital manufacturing techniques are applied in a professional way. e.g. ○ kerf is determined, ○ correct power/speed settings, ○ correct layer height, ○ correct infill, ○ no supports left, ○ correct orientation ● the physical structure is clean and strong, could be representing an actual product ● an IoT dataset is used in a meaningful way ● the physicalisation is applied in a meaningful way ● Physicalisation is self-explanatory
9	either technique is applied very professionally and a decent implemented idea, or very professional implemented idea and one or multiple applied decent digital manufacturing techniques ● at least one digital manufacturing technique is applied to compose a physical structure ● digital manufacturing techniques are/is applied in a professional way. ○ e.g. kerf is determined, ○ correct power/speed settings, ○ correct layer height, ○ correct infill, ○ no supports left, ○ correct orientation ● an online/IoT dataset is used in a meaningful way ● At least two of these criteria are met: ○ the physical structure is clean and strong, could be representing an actual product ○ the physicalisation is applied in a meaningful way ● multiple digital manufacturing techniques are applied ● Physicalisation is self-explanatory
8	either the technique(s) applied is very professional, or the implemented idea is very professional ● at least one digital manufacturing technique is applied to compose a physical structure ● digital manufacturing techniques are/is applied in a professional way. e.g. kerf is determined, correct power/speed settings, correct layer height, correct infill, no supports left, correct orientation ● an online/iot dataset is used ● At least two of these criteria are met: ○ the physical structure is clean and strong, could be representing an actual product ○ an online/IoT dataset is used in a meaningful way ○ the physicalisation is applied in a meaningful way ● Physicalisation is self-explanatory

7	student completed a decent assignment ● at least one digital manufacturing technique is applied to compose a physical structure ● digital manufacturing techniques are/is applied in a professional way. e.g. kerf is determined, correct power/speed settings, correct layer height, correct infill, no supports left, correct orientation ● an online/iot dataset is used ● At least one of these criteria are met: ○ the physical structure is clean and strong, could be representing an actual product ○ an online/IoT dataset is used in a meaningful way ○ the physicalisation is applied in a meaningful way ● Physicalisation is self-explanatory
6	● student just managed to complete the assignment ● one digital manufacturing technique is applied to compose a physical structure ● the physical structure is basic and ○ There are indications the digital manufacturing technique could be optimised. ■ e.g. determine kerf and/or speed/power settings for laser cutter ■ e.g. 3D print has supports included, is warped, should be printed on a different orientation ● a dataset is used but not an IoT dataset ● Physicalisation is self-explanatory
5	● everything is present, but not prepared with care: ○ e.g. many punctuation errors, ○ no proper language used, ○ unreadable text, ○ broken physicalisation, ○ half finished physicalisation, ○ pictures that are blurry, ○ no headings in the document
4	● documentation is partially present ● manufacturing technique used is standard example ● things are present, but not prepared with care: ○ e.g. many punctuation errors, ○ no proper language used, ○ unreadable text, ○ broken physicalisation, ○ half finished physicalisation, ○ pictures that are blurry, ○ no headings in the document
3	● documentation is partially present or missing ● manufacturing technique used is standard example ● things are present, but not prepared with care: ○ e.g. many punctuation errors, ○ no proper language used, ○ unreadable tekst, ○ broken physicalisation,

	○ half finished physicalisation, ○ pictures that are blurry, ○ no headings in the document
2	● documentation is partially present or missing ● there appears to not be used a manufacturing technique ● things are present, but not prepared with care: ○ many punctuation errors, ○ no proper language used, ○ unreadable tekst, ○ broken physicalisation, ○ half finished physicalisation, ○ pictures that are blurry, ○ no headings in the document
1	● documentation is missing ● there are no manufacturing techniques used

Design Thinking

Artefacts

Cultural probe - to be approved of by teacher in class before executing it
Poster containing

- Problem statement
- Explication of Cultural Probe
- Persona (with readable needs and goals)
- Research data
- Scenario
- Conclusion

Grading criteria

- Poster has a title, your name and student number on it, if not: no grading.
- Poster is printed in A2 format, full color.
- Any text in poster is effortless readable

Criteria	**Beginner 5.5 - 7**	**Intermediate 7 - 8**	**Pro 8>**
Problem statement	Full of assumptions, no (desk)research accounted for	Some deskresearch into problem accounted for	A lot of desk and/or field research has gone into problem statement and is accounted for, prior to probe.
User research	Probe consists of limited but various tasks, no long term study	Varied appropriate and multiple tasks in probe, clear research goals and metrics stated.	Varied appropriate and multiple tasks during a longer term. Behavioural patterns and insights can be derived from the tasks.
Target audience description	Believable persona given the problem, persona is given a face	The info of the persona is based on research evidence, needs can be derived from deskresearch	The info about the persona is based on own field research evidence and matches the research population
Research data	Very limited research population, but more than 6, Only textual description of outcome. No percentages used.	Metrics are shown in data, there is a visualisation of data, research population exceeds 10 people and is well described. No percentages are used.	Research population exceeds 25 people and is well described and the data has been statistically analyzed.
User interaction with product	There is a text only scenario with context description in which the basic interactions are described. The interactions can be linked to the persona's goals.	There is a visual contextual storyboard in which the basic interactions are outlined. These interactions can be linked to the persona's goals.	Both scenario and storyboard contain detailed interactions (including input - output moments of the user and the system, such as notifications, feedback, pop ups) that can be linked to the persona's goals
Conclusion	Conclusion answers the question whether or not your IOT artefact meets the user's needs but has arguments that cannot be validated by your research	Conclusion answers the question whether or not you IOT artefact meets the users needs and gives validated reasons why or why not	Conclusion answers the question whether or not your IOT artefact meets the users needs and gives validated reasons based on extensive research (minimum requirement for this is intermediate on user research and research data)