**Project plan**

***SSI-Disassembly***

*Fontys Innovation Lab*

***Eindhoven***

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| **Date** **:** **28-03-2024** |
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| **Author** **:** **Tim Spieringhs** |

#### Version

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| **Version** | **Date** | **Author(s)** | **Amendments** | **Status** |
| 1 | 29-02-2024 | Tim Spieringhs | Made the complete document for reviewing | In progress |
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**Communication**

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| --- | --- | --- |
| **Version** | **Date** | **To** |
| 1 | 29-02-2024 | Brice Guayrin for feedback |
| 2 | 14-03-2024 | Brice Guayrin for feedback |
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# Project Assignment

## Context

The HTES research group conducts applied research on systems in which robots and humans work together and use data and knowledge about their environment to act. We look at systems in the following four application areas:

⦁ Smart Industry - digitalisation of the manufacturing industry - data, work processes,

robotics.

⦁ Robotlab (Big Chemistry) - digitisation of chemistry - data, AI, robotics.

⦁ Smart Disassembly - digitalisation of de-assembly in return flows of products.

⦁ Air quality perception (AQE) - air quality perception for the living environment – measuring

with IoT, citizen science.

The research group looks at this from a technical ICT perspective, focusing on the use of modelling to determine and improve the architecture and the way systems are integrated. Research on modelling focuses on creating digital twins. Various technologies are used for this purpose, such as machine learning, Internet of Things, asset administration shell, digital product passport, intelligent agents.

Smart disassembly is one of the research areas of the HTES research group. Disassembly is about separating products, to get a product decomposed in its parts. It is a phase when remanufacturing, refurbishing or recycling a product. We perceive disassembly as a vital activity when reducing dependencies on critical raw materials and to reduce carbon footprint of manufacturing. Disassembly is of importance in the context of sustainability of the make industry in the Brainport region. Fontys HTES is powering the Fontys Centre of Expertise High Tech Systems and Materials to conduct applied research on Smart Industry. The HTES research group is also in the lead of a platform of Dutch UAS-professors (lectoren platform), <https://www.sia-projecten.nl/project/sustainable-smart-industry>

The HTES research group observes that (SME) companies in the manufacturing industry face with the challenge of making their production and materials more sustainable. Sometimes the disassembly of a product is perceived as easy when parts is just clicked together. Sometimes the disassembly is more difficult when parts are glued together, and also when thinking about how to determine and guarantee the status of the product components. Companies are looking for methods and tools to address the disassembly challenge. A disassembly line should help to get a better understanding. .

## Goal of the project

The project endeavours to enhance the disassembly program by advancing the identification and inspection stages. Previous efforts have primarily refined the sorting system utilizing a robotic arm. However, the current focus is to augment product identification and inspection capabilities. The primary objective is to develop a prototype capable of swiftly and accurately identifying products with minimal training requirements. Before proceeding with the prototype development, it is imperative to conduct comprehensive research on the available technologies and methodologies pertinent to this objective.

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Automatisch gegenereerde beschrijving

Figure 1 Disassembly Project Overview

## The assignment

Developing and implementing a vision system for the disassembly line requires a thorough analysis of multiple factors. This includes determining the necessary conditions for the vision system to operate effectively, such as considerations for distance to the object being observed. Additionally, the assignment involves devising methods for pattern matching specific product parts within the disassembly process.

Various aspects of vision approach need to be considered, including whether a 2D or 3D vision approach is most suitable, as well as integration of artificial intelligence techniques for enhanced recognition capabilities.

Choosing the appropriate camera setup is crucial, with options such as RealSense or ZED3 cameras being evaluated based on their suitability for the task at hand.

The actions that can be enabled by the vision results must also be addressed, such as utilizing vision information to facilitate the precise grabbing of product parts during the disassembly process.

The ultimate goal is to establish a vision system setup that serves as a demonstrator, capable of effectively detecting pre-defined product parts. This could involve methods such as inputting CAD-files or photos to identify desired components among a set of other items.

Through the demonstrator, it will be showcased that even seemingly 'random' product parts, like magnets or prints, can be accurately identified and managed within the disassembly process, thereby enhancing efficiency and effectiveness.

## Scope

Table 1 Scopes

|  |  |
| --- | --- |
| **The project includes:** | **The project does not include:** |
| 1. Researching computer vision methods | 1. Dissembling of a product |
| 1. Demos of computer vision methods | 1. Automatically sorting the product |
| 1. Prototype of a product identificator | 1. Automatically storing the product |
| 1. Prototype of a product inspector |  |

## Finished products

* Proof of concepts of computer vision systems that detect products that are functional enough to do tests on.
* A research to see which method(s) of computer vision work the most efficient in time and resources.
* Developed prototype that can detect products efficiently in time and resources.
* Developed prototype that can inspect a product on its current state efficiently in time and resources.

## Research questions

**Objective:** To develop a computer vision approach for recognizing product parts.

**Main Question:** What computer vision approach can be used to properly detect product parts - in the context of product disassembly?

**Sub-question 0:** What are the existing approaches in the industry, and why have these been chosen?

**Sub-question 1:** How best to set up/focus the computer vision approach to make 'learning' a product as easy as possible (little resources, effort and time saving)?

**Sub-question 2:** How can we make it easier for computer vision methods to detect products?

**Sub-question 3:** How can we integrate identification data with manipulation tasks (robotic or human) and later tasks in the disassembly line?

# Approach and Planning

## Approach

In the context of the adopted Scrum framework, the team will conduct weekly standups instead of daily ones, and a stakeholder meeting will take place every week, with a sprint review occurring every three weeks.

## Test approach

The chosen approach involves implementing a code review method to assess the functionality of the code. Additionally, unit tests will be employed, and a test plan will be formulated to outline specific requirements that the code must fulfil.

## Research methods

The DOT framework will be applied, for subquestion 1 prototyping, product review and benchmark testing will be used. For subquestion 2 available product analysis, expert interviews and evaluation of best practices and pitfalls. For subquestion 3 prototyping, community research and expert interviews. Additional methods may be incorporated as necessary for every subquestion.

## 

## Time plan

Table 2 Sprint plans

|  |  |
| --- | --- |
| **Sprints** | **Plan** |
| Sprint 1 | Research the possibilities and see what has been done and what might work. Then talk with my product owner and show me my findings and then make a more specific research on certain possibilities. |
| Sprint 2 | Look around companies that have like wise products and see what they already have made. Also start learning about the methods I have to use. |
| Sprint 3 | Make a clear overview of all the pros and cons of possible computer vision systems. And one or more POCs of the more promising methods. |
| Sprint 4 | Several POCs of the possible computer vision systems that I found from my research. And testing these POCs against each other to find the more efficient ones. |
| Sprint 5 | Start of a prototype of the most efficient method that I found of the theoretical and practical research. |
| Sprint 6 | Further work on the prototype and showing the work to companies to talk about possible improvements. |
| Sprint 7 | Several tests of the prototype and improving it even more from these tests. |
| Sprint 8 | Bug fixing and finishing touches for a final demo. |

# Project Organization

## Team members

Table 3 Team Members

|  |  |  |  |
| --- | --- | --- | --- |
| **Name + Phone + e-mail** | **Abbr.** | **Role/tasks** | **Availability** |
| Teade Punter, +31 6 57934696, teade.punter@fontys.nl | Lector High Tech Embedded Software (HTES) | Product owner + Company supervisor | 0,5 days a week |
| Edwin van den Oetelaar, oetelaar.automatisering@gmail.com | Lector High Tech Embedded Software (HTES) | Supervisor & technical assistance | 4 days a week |
| Pim Veroude, +31885076624, p.veroude@fontys.nl | Lecturer-researcher​ | Second company supervisor | 5 days a week |

## Communication

I conduct weekly meetings with each team member to review my accomplishments from the previous week and outline my plans for the upcoming week. I have more frequent interactions with certain team members, namely Edwin and Pim, as I often seek their assistance and share information. Additionally, I plan to implement SCRUM every three weeks to present my work in an organized manner and communicate my overall semester plan.

# Finance and Risks

## Cost budget

The only thing being used from the company is a Lenovo Thinkbook valued at around 699 euros. Borrowed from the ISSD, the Innovation Lab doesn't need to spend on it themselves.

## Risks and fall-back activities

Table 4 Risks and preventions

|  |  |  |
| --- | --- | --- |
| **Risk** | **Prevention activities included in plan** | **Fall-back Activities** |
| 1. Company supervisor gets sick for a long time | n/a | Contact Fontys for a new company supervisor |
| 1. I get sick for a long time | n/a | Contact Fontys for extension of internship |
| 1. Robot arm stops working | Being careful with the robot arm | Ask the product owner for a new robot arm |
| 1. The camera for vision breaks | Be careful with the camera | Request a new camera from the ISSD |
| 1. My laptop breaks | Be careful with the laptop | Get a new laptop and pull my work from git |