

**Closing report**

**Lapland University of Applied Sciences**

**Machine Learning and Data Engineering**

**Team 2**

**Robotics Project – DeskDash**

**Kojo Denkyi**

**Eemil Halkola**

**Maiju Karhu**

**Svetlana Emden-Bazhenova**

**Table of Contents**

1. **Project scope and description of the end result and outputs…………………………… 3**
2. **General assessment of project pass-through……………………………………………… 3**
3. **Workloads………………………………………………………………………………………… 4**
4. **Staff………………………………………………………………………………………………… 5**
5. **Experience with the tools and methods used …………………………………………….. 5**
6. **Experience with stakeholders …………………………………………………………………….. 5**
7. **Description of reusable solutions………………………………………………………………… 6**
8. **Assessments of the achievement of quality objectives……………………………………… 6**
9. **Summary of experiences…………………………………………………………………………… 6**
10. **Proposals for the development of** the **project course/studies…………………………….. 8**
11. **Project scope and description of the end result and outputs**

The DeskDash project aims to develop an autonomous indoor delivery robot for office environments. The robot is designed to transport small packages efficiently, reducing the need for unnecessary trips and enhancing workplace productivity. Leveraging advanced robotics platforms like Lidar, ROS 2, MicroRos, Jetson Orin, camera and ESP32, DeskDash integrates room mapping, pathfinding, and obstacle avoidance technologies to navigate autonomously within an office space.

**End Result and Outputs:**

* **Functional self-driving car:**

The project focuses on designing, developing, and deploying the DeskDash robot for logistical applications in office environments. The key outcome of the project includes:

1. A fully functional DeskDash robot capable of autonomous delivery;
2. Implementation of room mapping and pathfinding features;
3. Implementation of line detection and object detection features;
4. Real-time obstacle detection and avoidance.

* **Documentation:**
  + GitHub (https://github.com/RovSveta/DeskDash\_motor\_car.git)
  + Teams
  + AzureDevOps (<https://dev.azure.com/LapinAMKAzureDevOps/AI%20robotics%20project%20Team2/_workitems/recentlyupdated/>)
  + SCRUM
* Work\_amount\_follow\_up\_form\_\_SCRUM ([Work\_amount\_follow\_up\_form\_\_SCRUM.xlsx](https://lucit.sharepoint.com/:x:/r/sites/AIroboticsproject2025-Team2/Jaetut%20asiakirjat/Team2/Docs/Work_amount_follow_up_form__SCRUM.xlsx?d=wb791b55cba6743dba7b4a5b6709ba1d2&csf=1&web=1&e=qKa44p))
  + DeskDash was successfully demonstrated during the project exhibition, receiving positive feedback from its functionality, the use of Lidar, line detection and object detection and fine design. Also, we received feedback on successful group work and communication. Link to video (<https://youtu.be/GkYHEzj9BDI>).

1. **General assessment of project pass-through**

The project was executed successfully, meeting most of the predefined goals within the given timeline. Key accomplishments include:

* Completion of all major milestones such as planning, prototyping, early development, component integration, core feature implementation, testing, and presentation.
* The robot was able to perform line detection and object detection; however, these systems are not yet integrated with the motor controller.
* Currently, the car is controlled manually via a mobile phone. Full autonomy has not been achieved yet, primarily due to the time-intensive nature of implementing SLAM.
* The team stayed on schedule and completed each sprint and project phase on time
* Finalizing the project to enable autonomous driving using SLAM, along with integration of the line and object detection features into the navigation system, is planned for future development.

**Challenges Faced:**

* Changing the core elements in the last couple of weeks (Lidar, Jetson camera) and assembling them.
* New 3D prints were needed after the modifications.
* Limited time prevented full implementation of mapping features needed to make the car self-driving.

1. **Workloads**

**A screenshot of a document

AI-generated content may be incorrect.**

Although the project was initially planned to require 193 hours, the team completed it in 444 hours. This can be attributed to several factors:

* Some components, such as setting up the LiDAR and integrating Micro-ROS, were significantly more complex and time-consuming than expected.
* Late changes to key hardware required additional development and integration time.
* Multiple iterations of 3D-printed parts were needed due to design changes.

1. **Staff**

The project team consisted of the following members:

**Svetlana Emden-Bazhenova** (Project manager): Mainly worked on line detection, object detection features, 3D printing models and development, ensured seamless collaboration and integration of all components and creating and dividing tasks between teams in Azure DevOps.

**Maiju Karhu** (Secretary): Managed meeting documentation, task summaries, Azure DevOps. Worked on assisting the team members, soldering, 3D print modelling and adjusting, labeling pictures, project exhibition video and script for video.

**Eemil Halkola**: Mainly worked on the hardware, software side and power distribution while assisting team members when needed. Ensured project had all the needed hardware and software needed, making development of the Deskdash as easy as possible.

**Kojo Denkyi** : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The team collaborated effectively, leveraging individual strengths to achieve a common goal. Weekly meetings, WhatsApp group and detailed memos helped maintain clear communication and accountability.

1. **Experience with the tools and methods used**

During this project, the team utilized a variety of tools and methods to accomplish the objectives efficiently and effectively. We worked with Lidar and programmed the system in MicroRos to handle data collection from the sensors. Lidar was particularly suitable for the development process.

To enable communication between the components, we implemented the MicroRos protocol within Lidar, which ensured reliable data exchange. The protocol was used to send and receive data between the sensors and the system.

This combination of Lidar, MicroRos and Jetson Orin proved to be highly suitable for the project.

We also implemented line detection and object detection using a camera. While both features functioned correctly, they are not yet integrated with the motor controller.

In addition, we carried out extensive 3D printing and became proficient in using 3D modeling tools to design and produce custom parts.

Overall, the tools and methods were effective in achieving the project’s goals and were well-suited for integrating hardware with software for real-time monitoring.

1. **Experience with stakeholders**

During the project we received guidance from teachers Tommi Kokko, Petri Hannula and Tuomas Valtanen.

After each sprint, a sprint review with the project teacher was held. The reviews were held to check up on the progress of the project and give advice for the future. Outside of the sprint reviews we received guidance and help from teachers and laboratory staff Ali and Sohan for any issues we faced during the project.

1. **Description of reusable solutions**

Lidar - The LiDar is a light and range detection sensor or a method where laser light is sent from the source and is reflected back from the surrounding objects. With LiDar you can easily map out spaces and create maps of them. This enhances the speed and decision-making of automotive vehicles and devices.

MicroRos – Micro-Ros is a open-source framework to enable Microcontrollers with Ros2 features by bridging the gap between resource strained microcontrollers and their larger counterpart processors within robotic applications which are based on the traditional ROS (Robot Operating System).

Jetson Orin Nano - Jetson Orin Nano is compact and powerful small attachable computer for IoT purposes that gives the power of generative AI for small edge devices. Jetson Orin Nano allows for on device and on time computing and data processing on devices without needing of a remote connection from other devices.

Camera – Device that connects into the system that enables system with video capabilities. Camera can be used or is considered as a sensor for certain IoT devices and projects.

1. **Assessments of the achievement of quality objectives**

Project was finished on time. Finished product is functioning as planned. The need of couple more extra weeks to work for autonomous driving in office space. Amount of work was higher than anticipated, which can be attributed to higher obstacles faced.

1. **Summary of experiences**

For all of the team members the project provided new lessons on project management, programming and electronic components. The project progress being tracked using sprints and Azure DevOps gave a new perspective and tools for project planning and management. Using programs such as MicroRos and OpenCV were also new. We also learned more about the different functions of motors and turning, working with motor controllers and ESP32 and connecting everything together to form a functioning self-driving car. Mapping the surrounding with Lidar was new and challenging.

**Eemil:** For the most part I learned how to build Ros and Docker environments from source. I learned a lot about hard ships of system configuration and power distribution. I understand how Ros and Micro-Ros work and how they can be implemented to create a robot. I also learned more about programming and systems for example how to create services on linux for automation within projects. I got the chance to work with 2d Lidar and learn to understand how it works and how it can be made to map environments for small automotive vehicles and devices. Even when we didn’t get the Lidar work on time for exhibition, I got the chance to see how it can be implemented with a little bit more time project would have been finished with success. I also learned more about time-management and the importance of planning for the project. The challenging the project provided forced us to plan and organize tasks carefully and enhanced our teamwork.

**Kojo:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Maiju:** Mainly, I learned how to use the 3D printing program TinkerCard. I also learned how to create a basic level program for self-teaching obstacle avoiding program for detection. Also, I understood how to work with Microsoft ClipChamp which is a very powerful tool. Additionally, I got to know even better how Azure DevOps works and how to use it. I think this knowledge will be very useful for me in working life. Also, I learned the importance of effective time management. This project required us to carefully plan and organize tasks to ensure everything was completed efficiently and on schedule. By prioritizing tasks and collaborating effectively as a team, we were able to deliver the project on time, which enhanced my ability to manage time and resources.

**Svetlana:** I learned how to implement and test line detection and object detection using a camera, and I understood how these vision systems contribute to autonomous navigation. I also learned about the complexity of integrating these features with motor control for full autonomy. In addition, I discovered that Docker environments limit the use of visualization tools. To overcome this, I encoded commands based on line detection and object detection outcomes to allow the car to navigate accordingly without real-time visual outputs. Since we made few redesigns of out car I mastered creating 3D modeling in ThinkerCad, slicing and printing the models. I also learned that it is very important to carefully estimate and choose the right hardware at the beginning of the project, taking into account the available time. We decided to use LiDAR, Docker, and implement the ROS 2 protocol—tasks that turned out to be significantly more complex and time-consuming than we had anticipated. I also learned to use Flask to build an API that streamed the camera output to a desktop interface. This was an important task that helped us see the robot’s camera view in real time and made it easier to check if line and object detection were working correctly. I also learned what Jetson Nano and LiDAR are, and I now understand the difference between ROS 2 and micro-ROS. I hope to deepen my knowledge of these technologies in the future

1. **Proposals for the development of the project course/studies**

We were mostly satisfied with how the project played out. We finished with adequate time. We also felt that we received a lot of guidance and help from the teachers when it was needed. For the beginning of the project, we would like more guidance for Ros 2 and Lidar. The information on programs and devices we learned before and during the project on our other courses was useful and enough for us to implement those elements in our project. We are planning to continue and complete the project at the beginning of the next semester, with the goal of making the car fully autonomous using mapping, line detection, and object detection.