Mecanum-Car Report 5.Semester

(BA-MECH-22)

Product Development

Bachelor - Mechatronik Design & Innovation

5. Semester

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Gruppe: BA-MECH-22

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9. Januar 2025

Inhaltsverzeichnis

1 Abstract

This report presents the development of a Mecanum-Car over two semesters as part of the Bachelor's program in Mechatronics Design and Innovation. The project combines mechanical design, electronic systems, and software integration to create a fully functional car with omnidirectional movement capabilities. The following sections detail the objectives, methods, and results, highlighting challenges and future potential for optimization.

2 Introduction

The Mecanum-Car project 2.1 was undertaken during the 4th and 5th semesters to integrate theoretical and practical aspects of mechatronic systems. The car uses Mecanum wheels to achieve omnidirectional movement, enabling precise control in confined spaces. The project included mechanical design, electronic system development, and software integration. This report documents the design process, implementation steps, and outcomes.

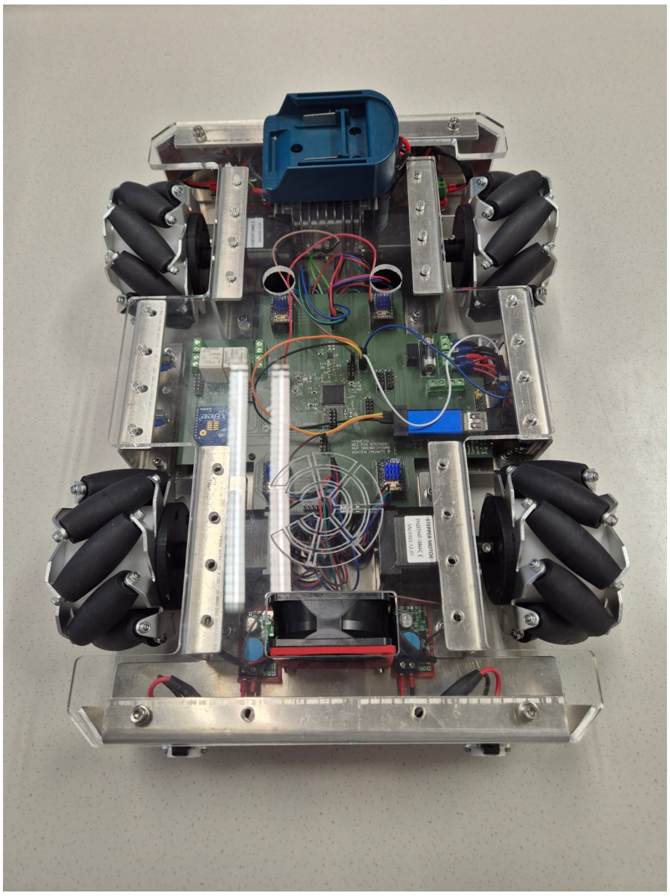

Abbildung 2.1: Robot with Mecanum wheels

3 Equipment and Tools

3.1 MECHANICAL COMPONENTS

- Lightweight aluminum chassis for durability and stability.
- Mecanum wheels for omnidirectional movement.
- Protective housing for electronic components.
- Air cooling system for the circuit board and motor drivers

3.2 ELECTRONIC COMPONENTS

- STM32F401VET6 microcontroller for control unit.
- Makita power drill battery with integrated voltage converter.
- Gyro sensor (MPU6050) for acceleration data acquisition.
- Communication modules: XBee.
- LEDs for front (white) and rear (red) lighting.

3.3 SOFTWARE TOOLS

- Altium Designer for PCB design.
- PlatformIO with Visual Studio Code for firmware development.
- Python and Pygame for external controller.

4 Project Objectives

The primary goal was to develop a fully functional Mecanum-Car with the following key features:

- Achieve omnidirectional movement through precise motor control.
- Implement a power supply system based on a Makita battery.
- Develop a custom PCB for motor control and integrate additional components like LEDs and fans.
- Enable control via an Xbox controller, a PC, and a custom-made controller, and provide debugging functionality through hardware buttons.

5 Methodology

5.1 MECHANICAL DESIGN

The chassis was designed to be lightweight yet robust. Aluminum was chosen for its strength-to-weight ratio. A protective housing was included to safeguard the electronics from external damage.

Additionally, an appealing Plexiglas cover featuring an MCI logo was installed to provide a clear view of the circuit board and the internal components of the robot, enhancing its aesthetic appeal.

A fan was mounted at the front of the vehicle to ensure adequate cooling of the electronic components??.

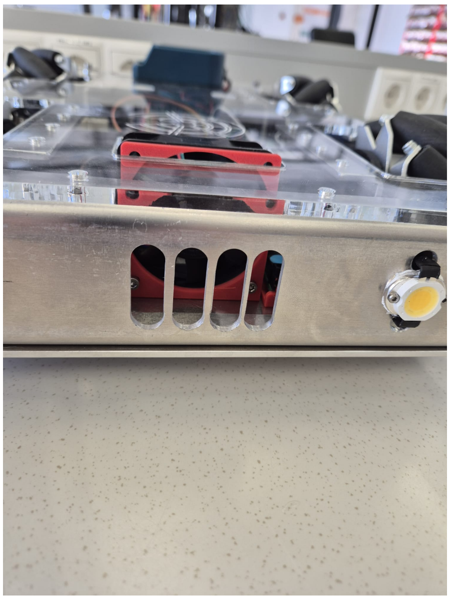

Abbildung 5.1: Air cooling

Mounts for controlling the front and rear LEDs were also designed and manufactured using a 3D printer. Environmentally friendly PLA material was used for this purpose ??.

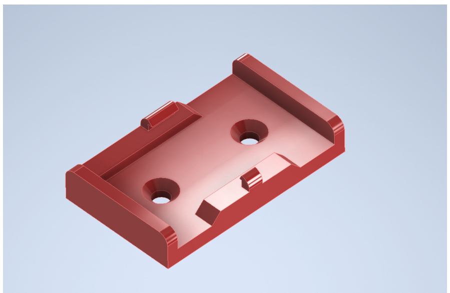

Abbildung 5.2: LED control fixture

5.2 ELECTRONIC SYSTEM

The control unit was based on the STM32F401VET6 microcontroller, offering sufficient capacity for future expansions. A Makita battery provided the primary power supply, ensuring reliable performance. Communication modules (XBee and infrared receiver) were integrated for wireless control. Cooling systems, including a fan, were added to maintain component performance.

The entire project was extended with a custom-designed controller that utilizes XBEE transmission. The controller is powered by three AAA batteries. The design was carefully crafted to ensure both ergonomic handling and a familiar look and feel, resembling a traditional console controller.

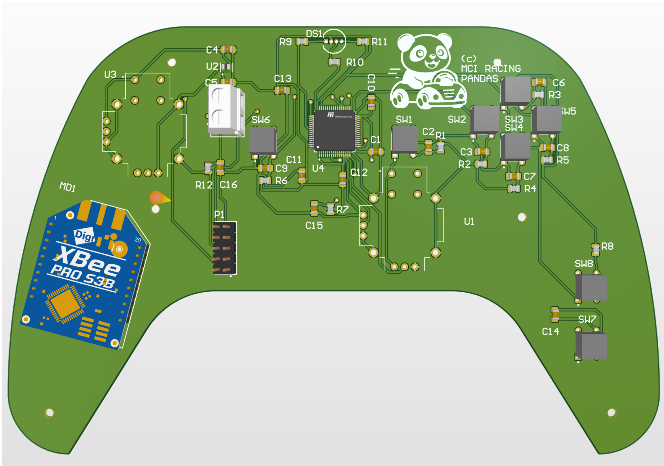

Abbildung 5.3: Mecanum car controller

The entire vehicle was rewired and enhanced with front and rear LEDs, including their corresponding control systems.

5.3 SOFTWARE DEVELOPMENT

Firmware was written in C++ and flashed onto the microcontroller using PlatformIO. Python scripts enabled external control via an Xbox controller. The communication protocol used UART2 to handle motor speed adjustments, lighting toggling, and emergency stops. Debugging functionalities were implemented via hardware buttons.

6 Discussion

The project highlighted the importance of iterative design and testing. While most objectives were achieved, certain challenges, such as optimizing motor driver performance, remain. The modular design allows for future enhancements, including sensor integration and advanced automation features.

Unfortunately, during the prototype development, a short circuit damaged the microcontroller. However, lessons were learned from this mistake. A new microcontroller was installed, and a complete circuit board diagnosis was performed, resulting in the vehicle's control board being fully operational again.

7 Conclusion and Future Work

The Mecanum-Car project successfully combined mechanical, electronic, and software systems to create a functional prototype. Future improvements could focus on:

- Optimizing motor driver performance for higher efficiency.
- Integrating additional sensors for autonomous operation.
- Developing a display for real-time sensor data visualization.

Our prototype was also showcased during an internal MCI presentation, which turned out to be a great success. This highlights that the project was not only successful but also brought us immense joy. Furthermore, it is intended to serve as learning material for future students.

All data can be accessed via the following link: `https://github.com/smariacher/mecanum_car`

Abbildungsverzeichnis

Literaturverzeichnis