NTNU
Kunnskap for en bedre verden

Msc Mechatronics and Automation

MMA4002-Design For Automated Manufacturing

Individual Reflection Notes

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1 Learnings

During this course, I learned a great deal about designing products specifically for automated manufacturing. I gained a solid understanding of the principles of Industry 4.0 and 5.0, including the integration of advanced technologies like collaborative robots, additive manufacturing, and mobile robots for transportation into a streamlined production workflow. The practical use of these technologies in our project helped me understand how they can enhance efficiency, flexibility, and customization in manufacturing. I also gained knowledge of Design for Automated Assembly (DFAA) principles, which helped in simplifying our product to make it suitable for automated assembly, reducing complexity while maintaining functionality. Additionally, I learned how lean manufacturing principles, like waste minimization and continuous process optimization, play a vital role in automated production. The visit to Optimar provided valuable insight into how these concepts are applied in the industrial world, bridging the gap between theoretical knowledge and real-world application. Furthermore, working collaboratively with my team provided invaluable lessons about the importance of adaptability, effective communication, and problem-solving in an engineering context.

2 Technical Solutions

The project involved several crucial technical decisions, but three stood out as most impactful.

Material Selection

Choosing the right material was critical to ensure the underwater containers could withstand deep-sea pressure and resist corrosion. Initially, we considered multiple options like PLA, ABS, PETG, and Nylon. We eventually chose PLA for prototyping due to its ease of printing and cost-effectiveness. PETG was considered for the final product due to its superior chemical resistance and durability for long-term underwater use. This decision allowed us to balance material performance with practical manufacturability, ensuring that our prototypes could be quickly iterated while maintaining quality for the final product.

Designing the Lid Mechanism

Selecting a lid mechanism that allowed ease of use, especially for robotic assembly, was a critical decision. After multiple iterations, we opted for a twist-lock mechanism. The design went through different iterations to resolve issues related to fitting, sealing, and ease of manipulation by collaborative robots. The final twist-lock mechanism provided a reliable way to ensure the lid stayed securely in place without requiring complex robotic manipulation, contributing to the overall simplicity and robustness of the design.

Clip Variants and Bracket Design

We designed three different clip variants for attaching containers to the bracket, ultimately deciding between a magnet, twist, and slide clip. The magnet clip provided simplicity and reduced the complexity for robotic handling, while the twist and slide versions introduced added security. Our final decision focused on balancing robustness with simplicity, favoring the magnet clip for easier automated assembly and reducing the complexity of alignment during the manufacturing process. This choice demonstrated the application of DFAA principles, ensuring that the assembly process remained efficient and feasible for robotic integration.

3 Group collaboration

Our group worked effectively by dividing tasks based on each member's strengths and collaborating on shared responsibilities. Each team member contributed to different phases, such as material research, CAD modeling, and assembly. This division allowed us to leverage our individual expertise while working concurrently, significantly speeding up the project timeline. Moreover, we learned extensively from each other: while I contributed more to the modeling of the lid and container and worked on assembly with Thomas, I gained valuable insights into material properties and prototyping techniques from Torstein, which broadened my understanding of the manufacturing processes. Our collaborative approach also allowed us to solve problems more efficiently by combining different perspectives, particularly during the iterative design and testing phases.

4 Design for Automatic Manufacturing

This course has sparked my interest in design for automatic manufacturing, and I would like to explore this field further. The practical, hands-on approach we used to integrate robotics into the production process showed me the potential for innovations in automated systems. I am keen on applying what I have learned in a future career that involves designing products for automated manufacturing environments or working directly with collaborative robots, as I believe this is an essential area for advancing modern production capabilities. I am also interested in pursuing further research or specialization in this domain, particularly in optimizing design for collaborative robot integration and enhancing the efficiency of automated workflows.

5 Satisfaction with the Course

I found the course highly engaging, especially the practical focus on applying Industry 4.0 technologies and lean principles. The combination of lectures and hands-on project work helped solidify my understanding. However, one area of improvement would be to provide more resources on advanced robotic integration and vision system calibration, as our team faced challenges with precision during assembly. Additionally, incorporating more examples or case studies of successful automated manufacturing systems could further enhance our understanding of real-world applications. Including more in-depth coverage of Industry 5.0, particularly the human-centric aspects and how technology can adapt to human needs, would also be beneficial.

6 Other Topics

Reflecting on this course, I also realized the importance of resilience in both project execution and product design. Adopting Industry 5.0 concepts, like the use of collaborative robots working alongside humans, made me appreciate how automation should not only be about removing human labor but enhancing human-robot synergy for efficiency and innovation. The combination of human creativity with robotic precision allowed us to achieve a more refined product while reducing manual workload. Furthermore, I learned the value of flexibility in robotic programming, which played a crucial role in overcoming minor discrepancies during component handling—a lesson that will guide my approach to automation projects in the future. The use of modular product architecture in our project, which allowed for easy customization and scalability, further underscored the importance of designing adaptable systems in automated manufacturing.