Fraunhofer IMTE

Fraunhofer Research Institution for Individualized and Cell-Based Medical Engineering IMTE

19.03.2024 HospiBot – Joint Project Meeting

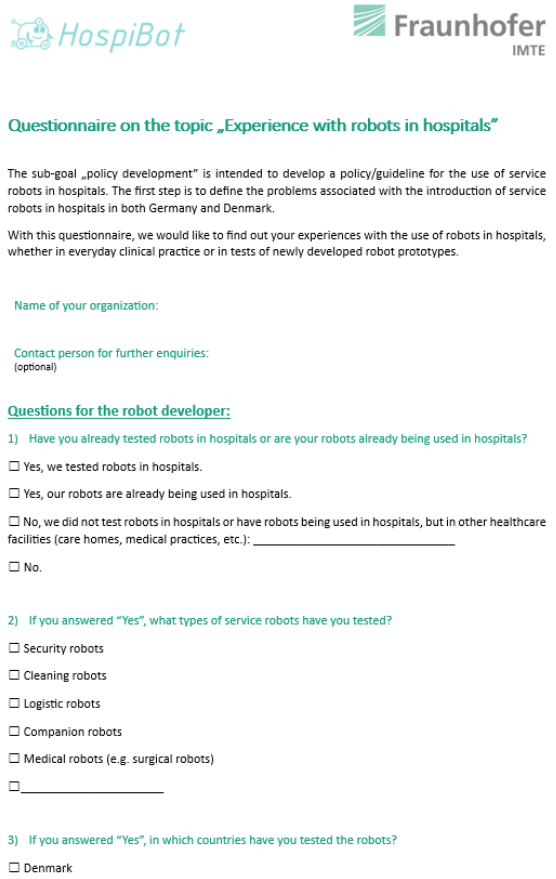
TZ6: Policy on mobile robots in hospitals

TZ6: Current status

Period 1	Period 2	Period 3
✓ M6.1 First meeting / problem is defined	M6.4 Symposium is held	M6.7 First version of the document is discussed in a meeting
M6.2 Second meeting is held	M6.5 Fourth meeting is held	M6.8 Final version of the document is produced
M6.3 Third meeting is held	M6.6 First version of the document is produced	M6.9 Five social media posts.

Questionnaire on the topic “Experience with robots in hospitals”

- The aim of the questionnaire was to find out your experience with the use of robots in hospitals.
- The questionnaire consisted of two parts: Questions for the robot developer and questions for the hospitals.
- Feedback:
  - 3 from robot developers (FH Kiel, SDU, UZL(UKSH)
  - 3 from hospitals (OUH, SHS, UZL(UKSH))



HospiBot

Fraunhofer IMTE

Questionnaire on the topic „Experience with robots in hospitals“

The sub-goal „policy development“ is intended to develop a policy/guideline for the use of service robots in hospitals. The first step is to define the problems associated with the introduction of service robots in hospitals in both Germany and Denmark.

With this questionnaire, we would like to find out your experiences with the use of robots in hospitals, whether in everyday clinical practice or in tests of newly developed robot prototypes.

Name of your organization:

Contact person for further enquiries:
(optional)

Questions for the robot developer:

1) Have you already tested robots in hospitals or are your robots already being used in hospitals?

☐ Yes, we tested robots in hospitals.

☐ Yes, our robots are already being used in hospitals.

☐ No, we did not test robots in hospitals or have robots being used in hospitals, but in other healthcare facilities (care homes, medical practices, etc.): _____

☐ No.

2) If you answered “Yes”, what types of service robots have you tested?

☐ Security robots

☐ Cleaning robots

☐ Logistic robots

☐ Companion robots

☐ Medical robots (e.g. surgical robots)

☐ _____

3) If you answered “Yes”, in which countries have you tested the robots?

☐ Denmark

TZ6: M6.1 First meeting / problem is defined

Results of the questionnaire:

General EU-Guidelines:

- CE marked according to their category ((MDR), Machine Directive etc.)
- General Data Protection Regulation (GDPR)

Local requirements from the hospitals:

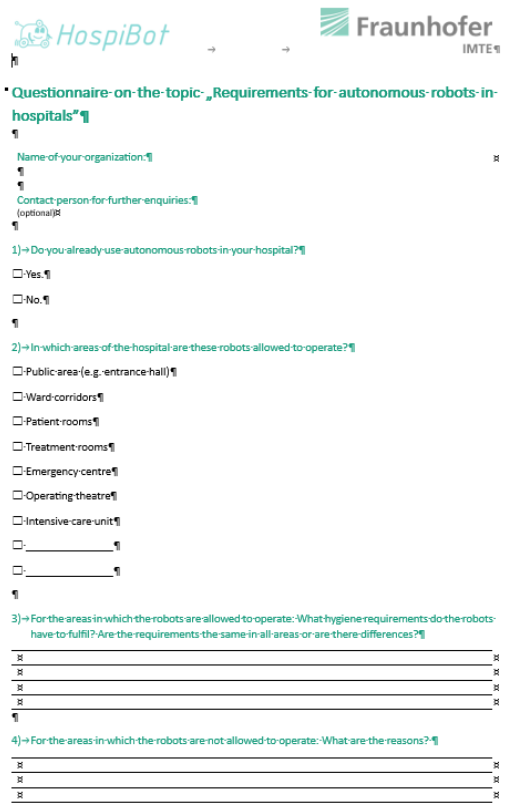
- Hygiene standards
- Risk assessment

Current restrictions:

- Not allowed to enter patient rooms or other special areas of the hospital
- No image data being recorded and restrictions on usage of auditory cues
- Ensuring escape routes

TZ6: Questionnaire for the hygiene and technical department in hospitals

- Preparation of a questionnaire for the hygiene and technical department



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Questionnaire on the topic „Requirements for autonomous robots in hospitals"

Name of your organization:

Contact person for further enquiries: (optional)

1) Do you already use autonomous robots in your hospital?

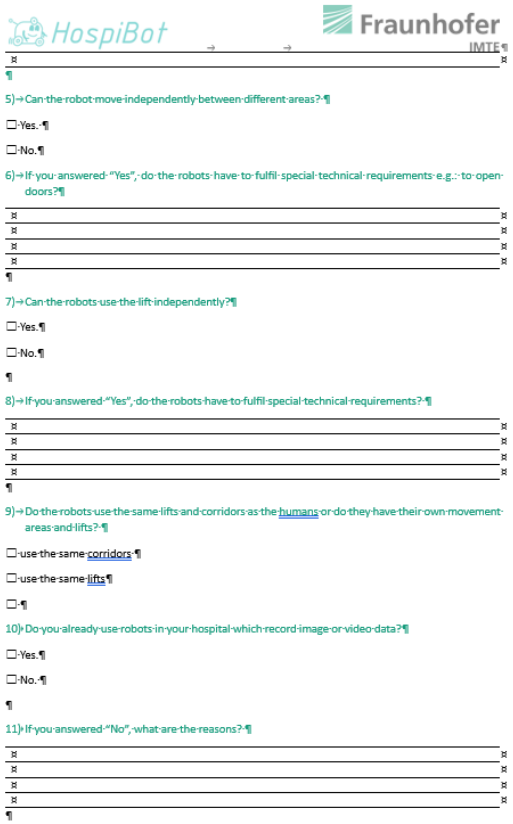
☐ Yes.
☐ No.

2) In which areas of the hospital are these robots allowed to operate?

☐ Public area (e.g. entrance hall)
☐ Ward corridors
☐ Patient rooms
☐ Treatment rooms
☐ Emergency centre
☐ Operating theatre
☐ Intensive care unit
☐ _____
☐ _____

3) For the areas in which the robots are allowed to operate: What hygiene requirements do the robots have to fulfil? Are the requirements the same in all areas or are there differences?

4) For the areas in which the robots are not allowed to operate: What are the reasons?



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5) Can the robot move independently between different areas?

☐ Yes.
☐ No.

6) If you answered "Yes", do the robots have to fulfil special technical requirements e.g.: to open doors?

7) Can the robots use the lift independently?

☐ Yes.
☐ No.

8) If you answered "Yes", do the robots have to fulfil special technical requirements?

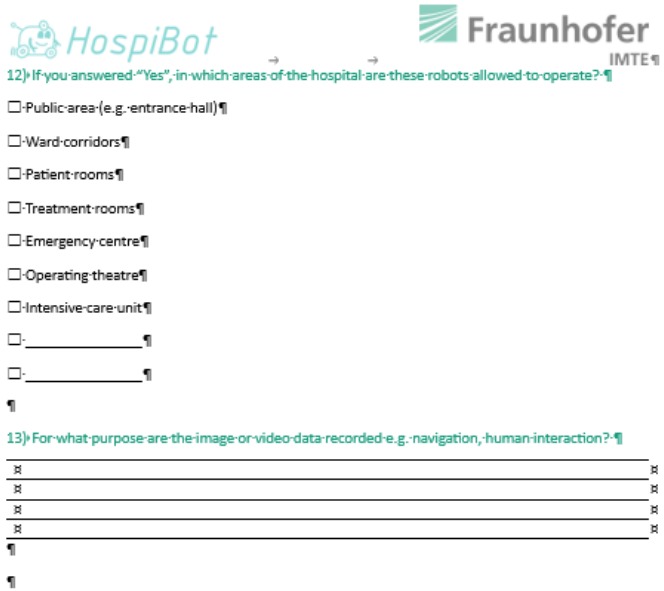
9) Do the robots use the same lifts and corridors as the humans or do they have their own movement areas and lifts?

☐ use the same corridors
☐ use the same lifts
☐

10) Do you already use robots in your hospital which record image or video data?

☐ Yes.
☐ No.

11) If you answered "No", what are the reasons?



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12) If you answered "Yes", in which areas of the hospital are these robots allowed to operate?

☐ Public area (e.g. entrance hall)
☐ Ward corridors
☐ Patient rooms
☐ Treatment rooms
☐ Emergency centre
☐ Operating theatre
☐ Intensive care unit
☐ _____
☐ _____

13) For what purpose are the image or video data recorded e.g. navigation, human interaction?

TZ6: Relevant legal documents

Product specific laws

EU-Regulation (applicable for Germany and Denmark)

- **2023/988 on general product safety**
- **2023/1230 on machinery** (valid from 14 January 2027; partially valid from 13 July 2023)

EU-Directive (must be transposed into national law)

- **2014/30/EU relating to electromagnetic compatibility**
  - Germany: Electromagnetic Compatibility Act – EMVG
  - Denmark: ?
- **2014/35/EU relating to the making available on the market of electrical equipment designed for use within certain voltage limits**
  - Germany: Product Safety Act – ProdSG; Regulation on electrical equipment – 1.ProdSV
  - Denmark: ?

Other specific laws

EU-Regulation (applicable for Germany and Denmark)

- **2016/679 – General Data Protection Regulation**

TZ6: Relevant legal documents

Work safety specific laws

EU-Directive

- **2009/104/EC – for the use of work equipment by workers**
  - German: Industrial Safety Act - BetrSichV
  - Denmark: ?
- **2003/10/EC - to the risks arising from physical agents (noise)**
  - German: Noise and Vibration Occupational Health and Safety Act - LärmVibrationsArbSchV
  - Denmark: ?
- **2013/35/EU - to the risks arising from physical agents (electromagnetic fields)**
  - German: Occupational Health and Safety Act on Electromagnetic Fields - EMFV
  - Denmark: ?
- **2002/44/EC - to the risks arising from physical agents (vibration)**
  - German: Noise and Vibration Occupational Health and Safety Act - LärmVibrationsArbSchV
  - Denmark: ?
- **2006/25/EC - to risks arising from physical agents (artificial optical radiation)**
  - German: Occupational Health and Safety Act on Artificial Optical Radiation - OStrV
  - Denmark: ?

TZ6: Next steps

- Finalize the questionnaire including your feedback and send it to the participating hospitals in Germany and Denmark

- Continue search for relevant legal documents (e.g. danish legal documents) and relevant standards
- Detailed work through the legal documents and standards

- Start planning the symposium in Phase 2 (Sep. 24 till Sep. 25)

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Thank you for your attention

Trust-Factors in Human-Robot-Interaction

Interreg
Kofinanziert von der Europäischen Union
Medfinansieret af Den Europæiske Union
Deutschland – Danmark

Fraunhofer IMTE
Fachhochschule Kiel
Hochschule für Angewandte Wissenschaften
Universität zu Lübeck
SDU University of Southern Denmark
Region Syddanmark OUH Odense Universitetshospital
Region of Southern Denmark Hospital Sønderjylland
Region Sjælland Sjællands Universitetshospital
UKSH

Agenda

1. Factors in Trust Building
2. Impact of Failure on Trust
3. Cultural Impact on Trust Building
4. Influence of Training on Trust Building

Factors in Trust Building

Robot Related Factors

- Performance
- Reliability
- Predictability
- Dependability

Human & Environmental Factors

- Operator personality
- Prior experiences
- Expertise in robot handling
- Culture
- Task type
- Task complexity

Interaction between Failure and Trust

- Failures and limitations are expected to reappear
- Failures will be compensated as long as the robots level of competency is identifiable
- Decreasing reliability causes a decrease of trust over time
- Magnitude of failures determines the amount of trust lost

Interaction between Failure and Trust

- Ambivalent magnitudes in failures decrease trust more than a number of severe failures
- Failures in one subsystem cause loss of trust in corresponding functions of the same subsystem
    - Trust loss does not spread to other subsystems
- Known issues and anticipated errors cause no loss of trust

Cultural Impact on Trust Building

Power Distance

- extent to which the less powerful members of institutions and organisations within a country expect and accept that power is distributed unequally

Uncertainty Avoidance

- extent to which the members of a culture feel threatened by ambiguous or unknown situations

Cultural Impact on Trust Building

Lower Power Distance

- Value of hands-on expertise
- Participative communication
- Employee autonomy

Higher Power Distance

- Less vigilance and monitoring for possible violations
- Robot may be perceived as authority
  - Result in quicker formation of trust
  - In case of a trust violation, trust will be regained slower

Cultural Impact on Trust Building

Lower Uncertainty Avoidance

- Less need for structure and predictability
- Natural curiosity
- Comfortable in ambiguous situations

Higher Uncertainty Avoidance

- Importance of details and thorough planning
- Risk avoidance
- In combination with lower PD: strong reliance on expertise

Influence of Training on Trust Building

- Dissolvement of (prior) biases
- Trust in robots competencies
- Achieving system understandability
- Creating transparency about known issues and limitations
- Developing risk assessment

Sources

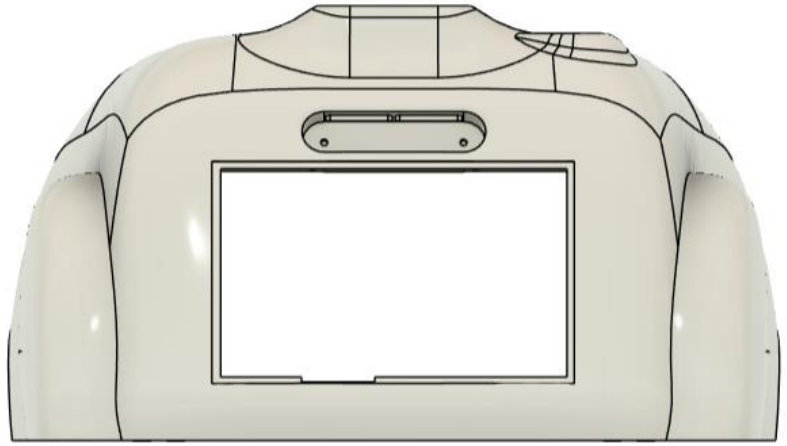
Freedy, Amos et al. (2007): Measurement of trust in human-robot collaboration, in: *International Symposium on Collaborative Technologies and Systems*, p. https://ieeexplore.ieee.org/abstract/document/4621745, [online] doi:10.1109/cts.2007.4621745.

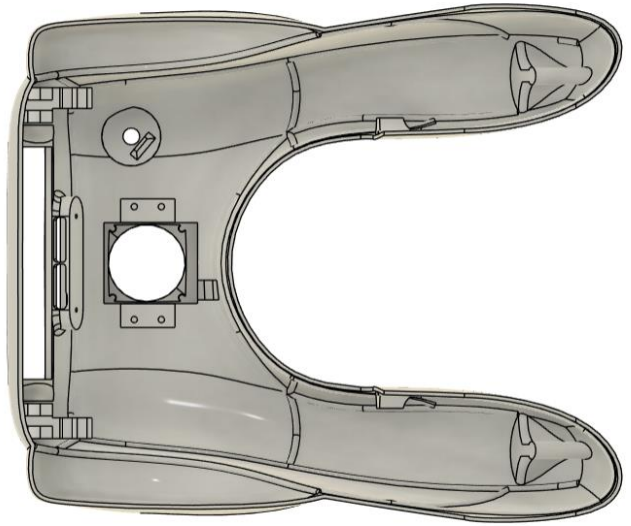
Hancock, Peter A. et al. (2011): A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction, in: *Human Factors*, vol. 53, no. 5, pp. 517–527, [online] doi:10.1177/0018720811417254.

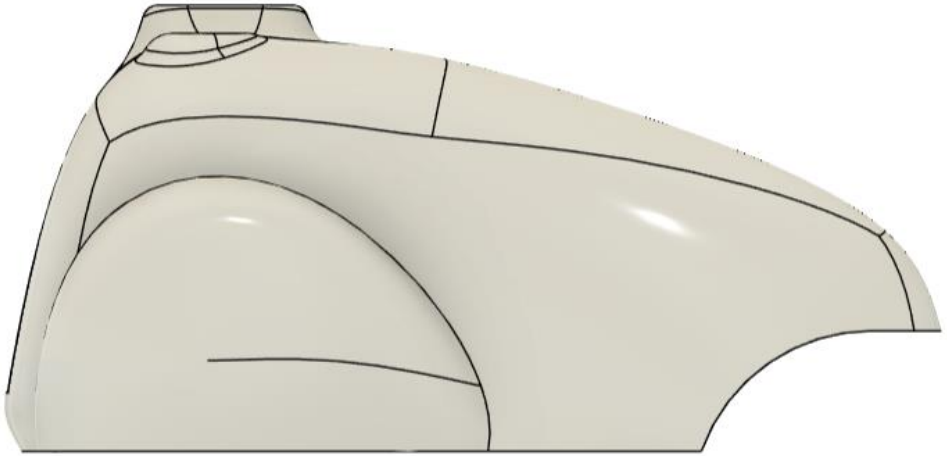
Lewis, Michael et al. (2018): The role of Trust in Human-Robot Interaction, in: *Studies in systems, decision and control*, pp. 135–159, [online] doi:10.1007/978-3-319-64816-3_8.

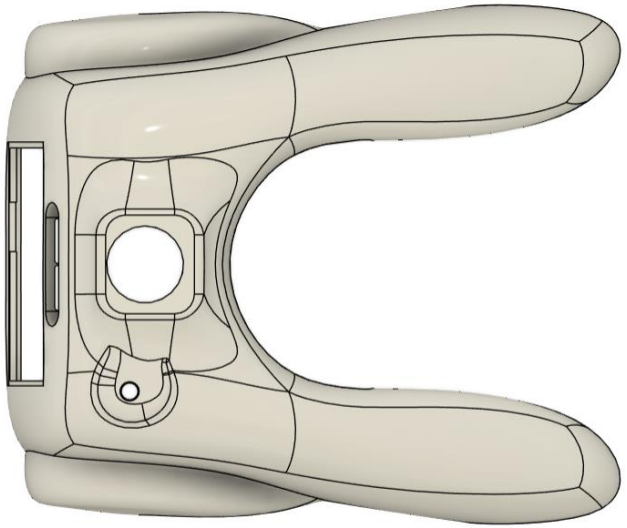
The Culture Factor Group (2023): Country Comparison Tool, Hofstede Insights, [online] https://www.hofstede-insights.com/country-comparison-tool?countries=denmark%2Cgermany [accessed 14.03.2024].

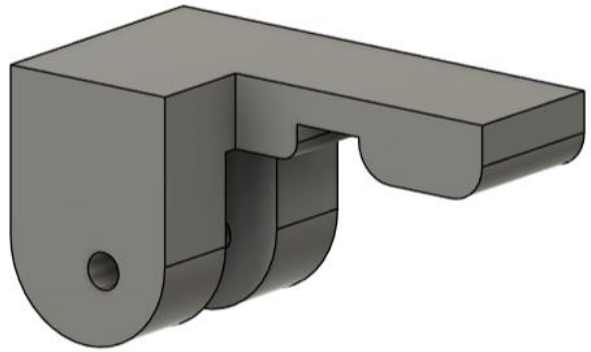
State of the shell

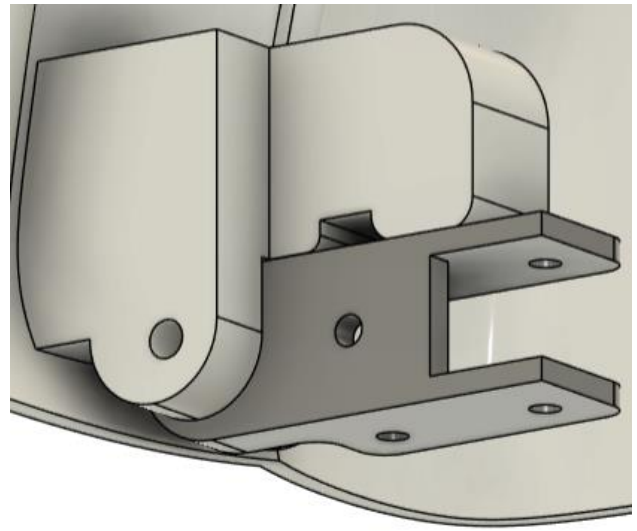


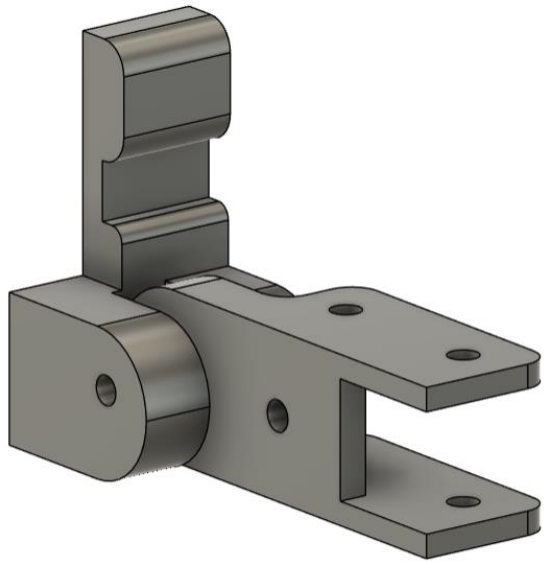


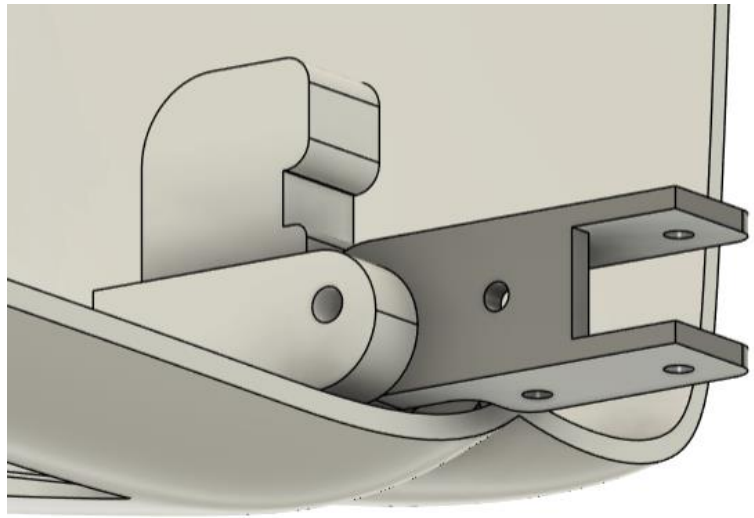


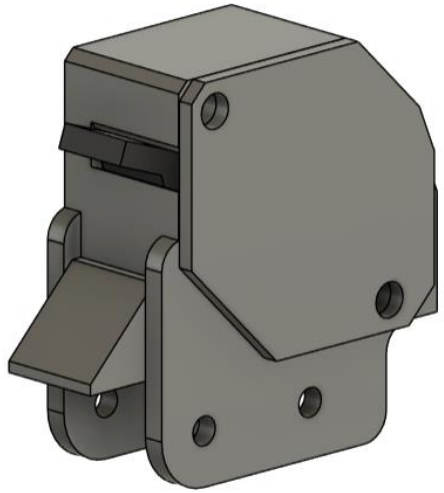


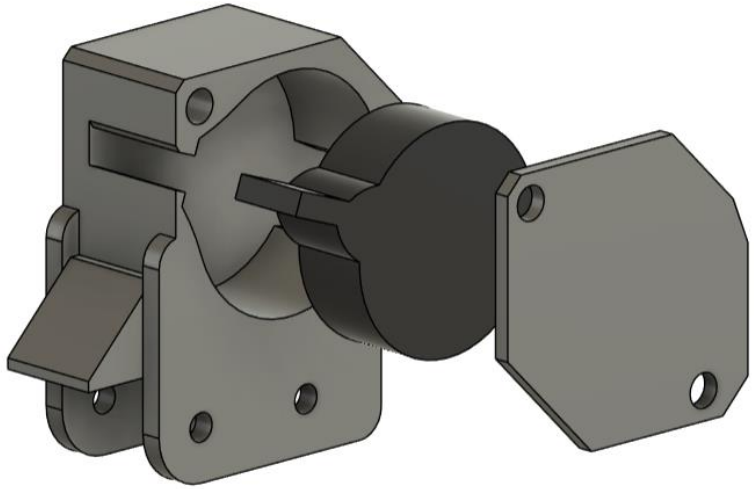


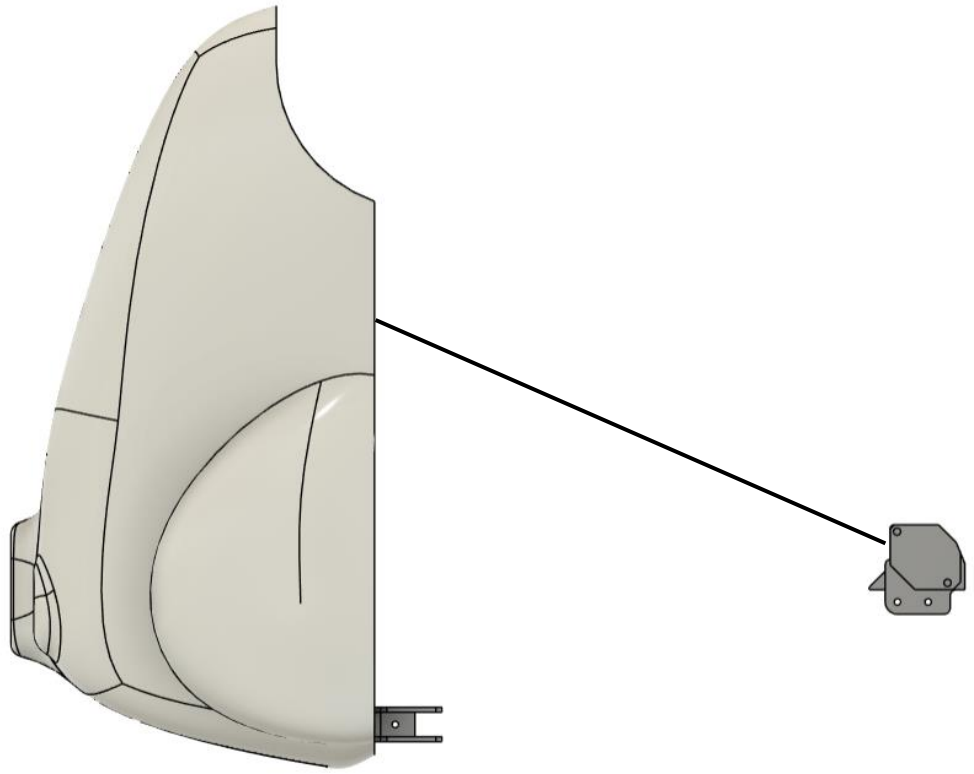


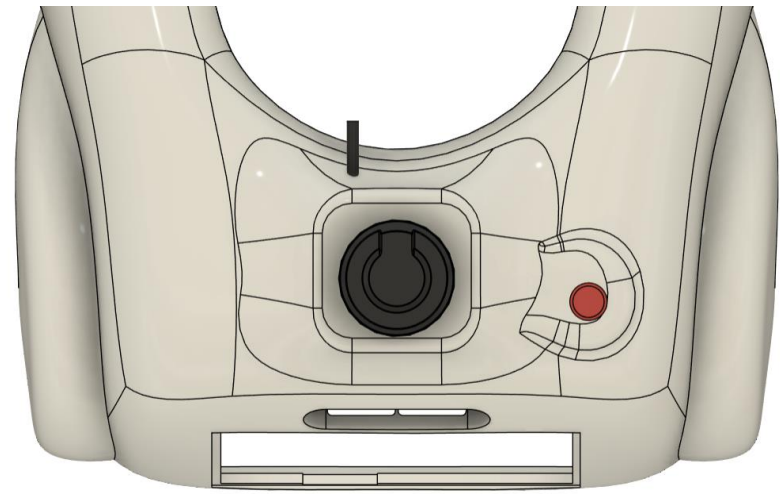












Welcome

HospiBot 2nd partner meeting

Sygehus Sønderjylland

Region of Southern Denmark

Interreg Deutschland – Danmark HospiBot

Hospital Sønderjylland

Agenda

10:00 - 10:15	Arrival and welcome from host - **Trine & Sabine**
10:15 - 11:00	TZ1 Management (contract, employment, any practical issues with the project, contact with Interreg) **Oskar**
	Coffee break
11:10 - 11:55	TZ2 Mobile base development, results and further plans - **Leon**
	12:00 - 13:00 Lunch
13:00 - 13:45	TZ3 Payload development and plans - **Robert**
	Coffee break
13:55 - 14:20	TZ4 Interface development - **Franziska**
14:20 - 15:10	TZ5 Testing plans – **Trine & Sabine**
	Coffee break
15:20 - 15:50	TZ6 Policy discussion - **Arndt-Peter, Lina**

Hospital Sønderjylland

Interreg Deutschland – Danmark HospiBot

Region of Southern Denmark

TZ5 - Testing plan

- Follow-up on the meeting in November:
  - Start talking to the staff to uncover needs to involve them from the start ► what did you learn?
- Discuss possible parametres and outcome for the testing period (based on the decided use cases):
  - Round table
  - Joint recap and summarizing
- Upcoming plan?

Hospital Sønderjylland

interreg Deutschland – Danmark HospiBot

Region of Southern Denmark

Needs discovered at SHS

- Two wards – orthopedic ward and FAM
  - Management support and engagement (allocate time and ressources)
  - The robot must have great value for the staff (useful and time-saving)
  - Training programme
  - Having a say about practical and logistik matters, e.g where does the robot have a parkingslot?

Hospital Sønderjylland

interreg Deutschland – Danmark HospiBot

Region of Southern Denmark

Round table discussions

- The payload use cases:
  - Greeting & guiding
  - Patrolling
  - Small-scale logistics
- Will we test and evaluate them the same or differently?

Hospital Sønderjylland

interreg Deutschland – Danmark HospiBot

Region of Southern Denmark

Round table discussions

Hospital Sønderjylland

Test and evaluate HospiBot

- Define what kind of parameters we will use to measure the success rate?
- Comparable parametres: do we evaluate before/after? Estimated time? Resources? Economics?
- Do we compare hospitals? Germany/Denmark and/or inter-regional in Denmark?
- Other?

User evaluation

- Training programme for health care professionals? What personnel is needed for the specific use case? Resources and time?
- How can we evaluate the interaction with HospiBot?
- Comparable parametres: Value for staff/patients? Value for workflow? Pros and cons? Ideal number of HospiBot per ward?
- Other?

Interreg Deutschland – Danmark HospiBot

Region of Southern Denmark

SDU
Syddansk Universitet

Interreg
Deutschland – Danmark

Kofinanziert von
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Medfinansieret af
Den Europæiske Union

HospiBot

Second Project Meeting

Oskar Palinko

Aabenraa, 19.03.2024

TZ1 Management and Public Relations

- Milestones in Period1 according to project application
  - M1.1 Signing of the partnership agreement
  - M1.2 Organization of a kick-off meeting
  - M1.3 Establishment of website and social media presence
  - M1.4 First press release
  - M1.5 Second project meeting is held

TZ1 Management and Public Relations

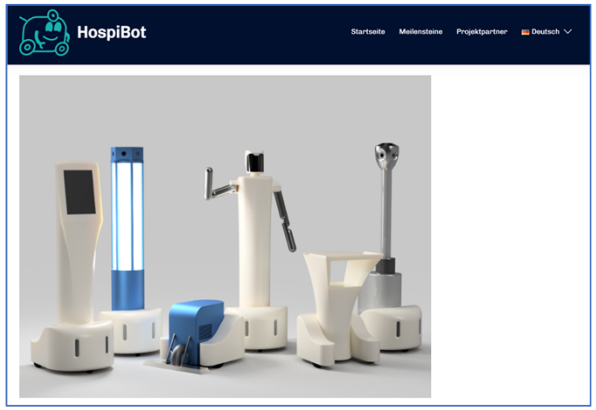
- Milestones in Period2 according to project application
  - M1.6 Third project meeting is held
  - M1.7 Fourth project meeting is held
  - M1.10 Midterm press release

Partnership contract signed

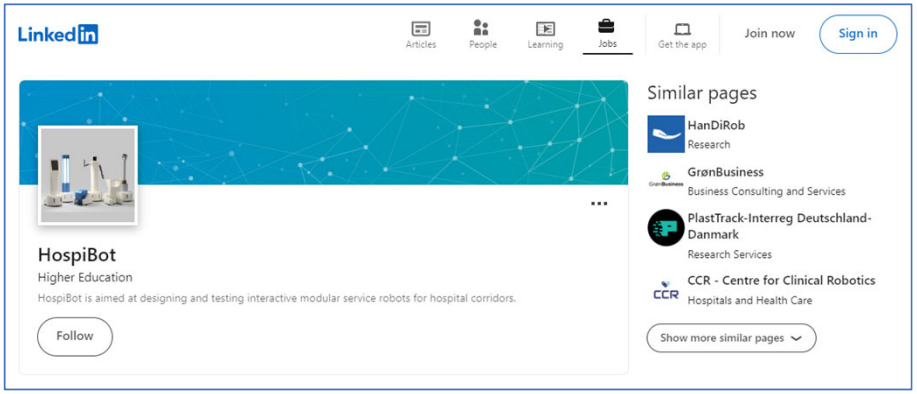
- Incorrect dates for yearly report deadline: **17.05.2024. and 17.05.2025**.
- The correct dates are: **17.10.2024. and 17.10.2025**.
- Partnership contracts here

Establishment of website and social media

- Website established
- Help from Franziska Uhing and Miriam Pfau
- More news needed



- LinkedIn site established
- More news needed



First press release in Denmark

- With help from SDU TEK Comm
- Generated lots of media attention in DK
- A press release in Germany would be great

VIA ritzau | Forside | Modtag pressemeddelelser | Kunder | Om Via Ritzau | Bliv kunde

SDU

SDU-forskere skal udvikle robotter, der kan aflaste sygeplejersker

21.9.2023 08:00:00 CEST | Syddansk Universitet

Del

Der er akut mangel på sygeplejersker i flere dele af Europa, og det skal et nyt projekt med Syddansk Universitet i spidsen gøre noget ved. De i alt otte partnere har fået en bevilling på godt 12 millioner til at bygge og afprøve en række nye hospitalsrobotter. Robotterne skal overtage nogle af de trivielle opgaver, som sundhedsfaglige i dag udfører, så de i stedet kan bruge mere tid på pleje og behandling af patienter.

SDU University of Southern Denmark · Universität zu Lübeck · Fachhochschule Kiel · Fraunhofer IMTE · Sygehus Sønderjylland · Region Sjælland · OUH Odense Universitetshospital Svendborg Sygehus · UKSH Universitätsklinikum Schleswig-Holstein

Half-year report

- On Teams – Management – Files – Reports
- No textual part needed unless set milestones were not reached
- Each work package leader should make an assessment for their TZ
- Deadline for partners April 16^{h}, 2024
- Deadline for lead partner, May 1st, 2024

Interreg
Deutschland – Danmark

WIR FÖRDERN ZUSAMMENHALT
VI STØTTER SAMHØRIGHED

Kurzbericht |Statusrapport

DE: Diese Word-Version des Berichtsformulars kann zur Vorbereitung des Berichts verwendet werden, der Bericht muss jedoch formell über das Datenaustauschsystem des Programms eingereicht werden. In den Fortschrittsberichten können Sie wahlweise auf Deutsch oder Dänisch oder Englisch berichten. Die angegebene Zeichenbegrenzung schließt Leerzeichen ein.

DK: Til forberedelse af rapporten kan denne word-version af statusrapportsformularen anvendes, men rapporten skal formelt indsendes via programmets dataudvekslingssystem. Statusrapporterne skrives på enten dansk, tysk eller engelsk. Den angivne tegnbegrænsning er inkl. mellemrum.

1. Projektdaten | Projektoplysninger	
Projektname | Projektnavn	HospiBot
Projektstart	01.09.2023
Projektende | Projektets afslutning	31.8.2026
Priorität | Prioritet	1 – Innovation
Spezifisches Ziel | Specifikt mål	
Leadpartner	SDU
Berichtszeitraum | Afrapporteringsperiode Projektperiode | Projektperiode	01.09.2023-29.02.2024 Periode 1
Website (sofern nicht die Interreg-Homepage als Projektwebsite genutzt wird | Website (hvis Interreg-hjemmesiden ikke benyttes som projektwebsite)	https://hospibot.eu/

Half year report - financial

- As budget model 1 was selected, it seems only employment documents and timesheets need to be submitted?
- Any other experience from partners?
- Waiting for clarification from Interreg
- Timesheet agreement between SDU and Interreg – no double work
- Signature - please make sure your Interreg employment documents are dated and signed by signature eligible management
- If report is accepted, payment for actual spent hours and initial funds

Half year report - financial - continued

- Make sure that one's reported timesheet hours are within requiements:
  - Someone in FG2 cannot claim FG1 salary
  - Also only active TZs and tasks are elibible (n-1), (n plus 1)
  - Only tasks form the budget document can be treated as eligible
- Expected to have details oversight over this

Signatures on timesheets

- Top management’s signature is requested
- Ask for Interreg to recognize one’s home institution’s timesheets
- Don’t forget to write comments for each daily chunk of hours

Other documentation

- Not yet clear if any other documentation is needed in financial reporting
- Still waiting for reply from Florian
- SHS?

Visit to Human-Robot Interaction conference

- Presented HospiBot HSR (Humanoid Service Robot)
- Positive feedback

A Humanoid Robot Platform for
Efficient Gaze Interaction and Physical Manipulation

Oskar Palinko
SDU Robotics, Maersk Mc-Kinney Moller Institute
University of Southern Denmark
Odense, Denmark
ospa@mmmi.sdu.dk

ABSTRACT

An upper-body humanoid robot design is introduced with focus on gaze interaction, physical manipulation, modularity, and affordability. Gaze interaction is facilitated by the two built-in cameras as well as a display showing two simulated eyes of the robot. Physical movement of the robot is achieved by using digital servo motors in each articulated joint. The system is modular, as parts can be removed, added, and replaced easily. The structural parts are 3D printed which makes the robot affordable and easily customizable. The robot has been field tested at the entrance of a children's hospital and the kids' reactions were very positive.

CCS CONCEPTS

• Human-centered computing → Interaction design.

KEYWORDS

Humanoid robot, gaze interaction, physical manipulation.

ACM Reference format:

Oskar Palinko. 2024. A Humanoid Robot Platform for Efficient Gaze Interaction and Physical Manipulation. In *Companion of the 2024 ACM/IEEE International Conference on Human-Robot Interaction (HRI'24 Companion), March 11–14, 2024, Boulder, CO, USA.* ACM, New York, NY, USA. https://doi.org/10.1145/3610978.3641091.

1 INTRODUCTION

The humanoid shape for robots is a rather popular design choice because the human environment is designed to accommodate our bodies' general proportions. E.g. the light switch on the wall is at the particular height where it can be easily operated by adults and children of appropriate age. If a robot is much shorter or much taller than people, then it could not turn on these switches, operate kitchen appliances or get into an elevator with ease. For the field of human-robot interaction, often, having a robot with a humanoid form is desirable, as people already know how to communicate with other people, so they could seamlessly transfer their human-human interaction skills onto robots. This of course also requires that the robot is good at interpreting interaction cues.

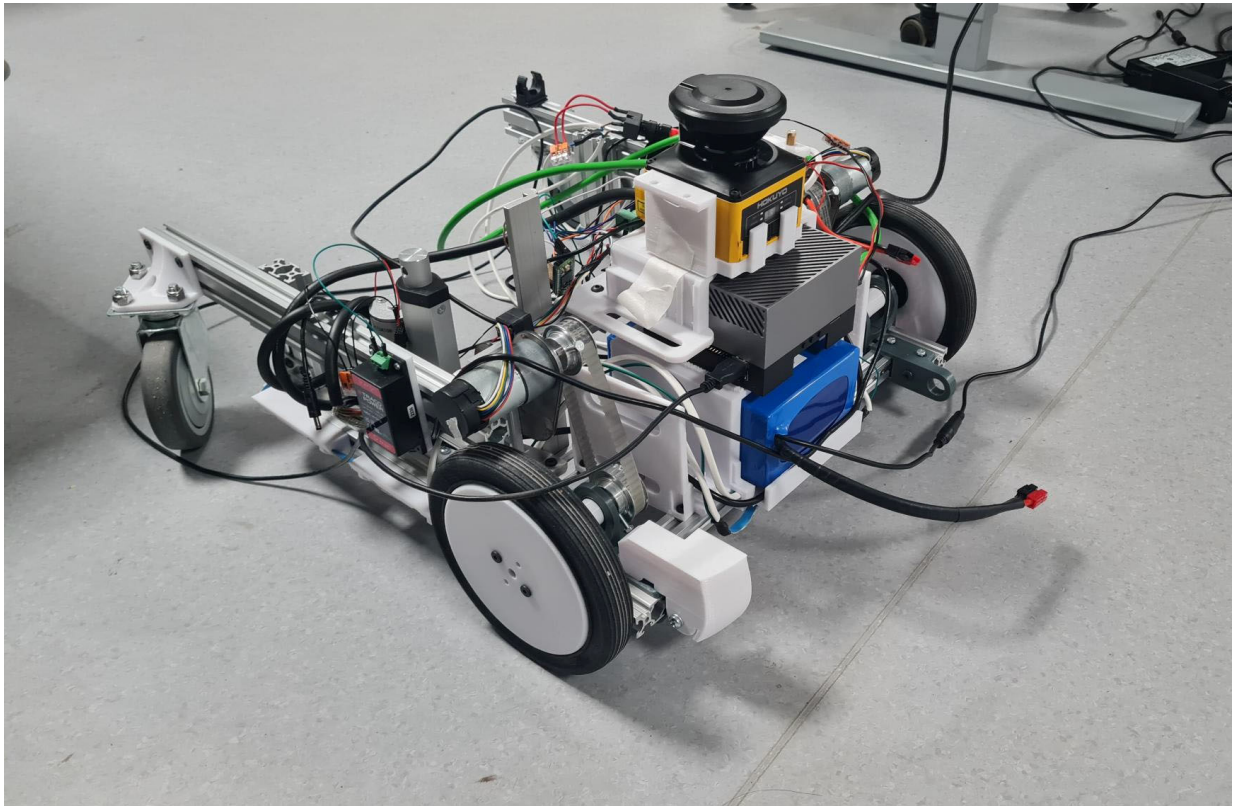
However, designing and building humanoid robots is quite a daunting task as high torque joint drives are necessary, which at the same time need to stay very light, as the robot needs to move its own body's weight. In previous decades the main solution for a high torque/weight ratio system was to have harmonic drives (or similar reductors) built into the joints of robots. Harmonic drives deliver high torque ratios with very low weight, as the

HRI '24 Companion, March 11–14, 2024, Boulder, CO, USA.

ACM ISBN 979-8-4007-0323-2/24/03.
https://doi.org/10.1145/3610978.3641091

Figure 1. HospiBot at the children's hospital in Odense during in-the-wild testing

TZ2 Mobile Robot Development



TZ2 Milestones

- Period1
  - M2.1 Specifications and initial CAD design of the robot is completed
  - M2.2 Implementation of the first prototype of the robot is completed
- Period2
  - M2.3 Implementation of the second, advanced prototype of the robot
  - M2.4 Robot behaviors implemented (localization, mapping, navigation, approach of people)
  - M2.5 Final version of the robot implemented with intelligent behaviors
  - M2.6 Five social media posts will be generated in TZ2

Development Team

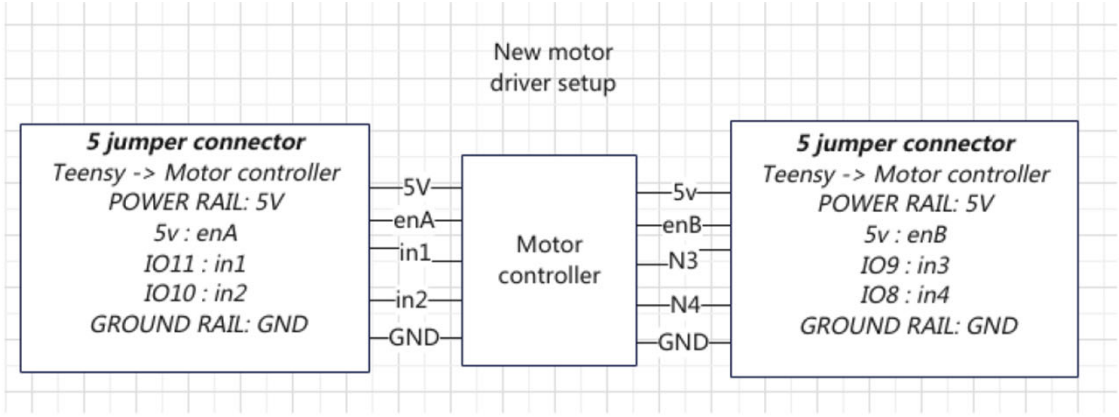
- Frederike Durow - navigation
- Anthon Skov Petersen – CAD design
- Peter Khiem Duc Tinh Nguyen – motor control, 3D printing
- Mikkel Kipp – other systems (audio, lights)

Peter’s Part

Motor driver

The aim is to plug two 5-set wires, into both sides of the motor driver pins.

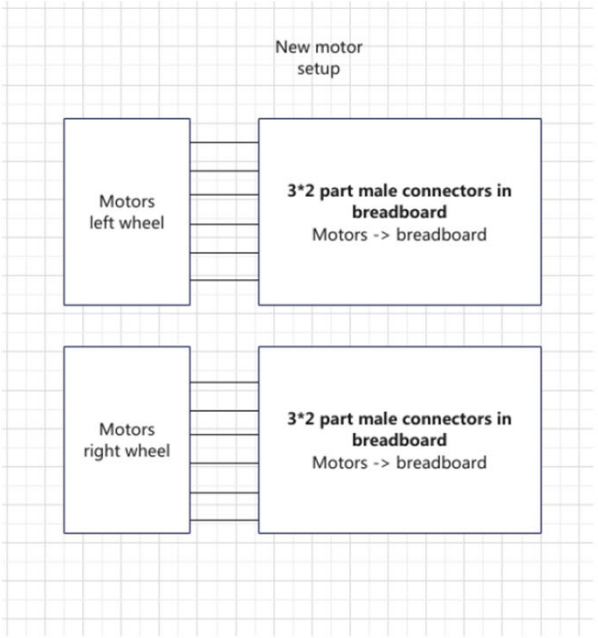
The pin configuration represents where it is
connected to its corresponding pin on the motor teensy.



Peter’s Part

Motor wires setup

- If a 6 set wire-set is found then that would be preferable, but until then, 2*3 wires-sets will be used



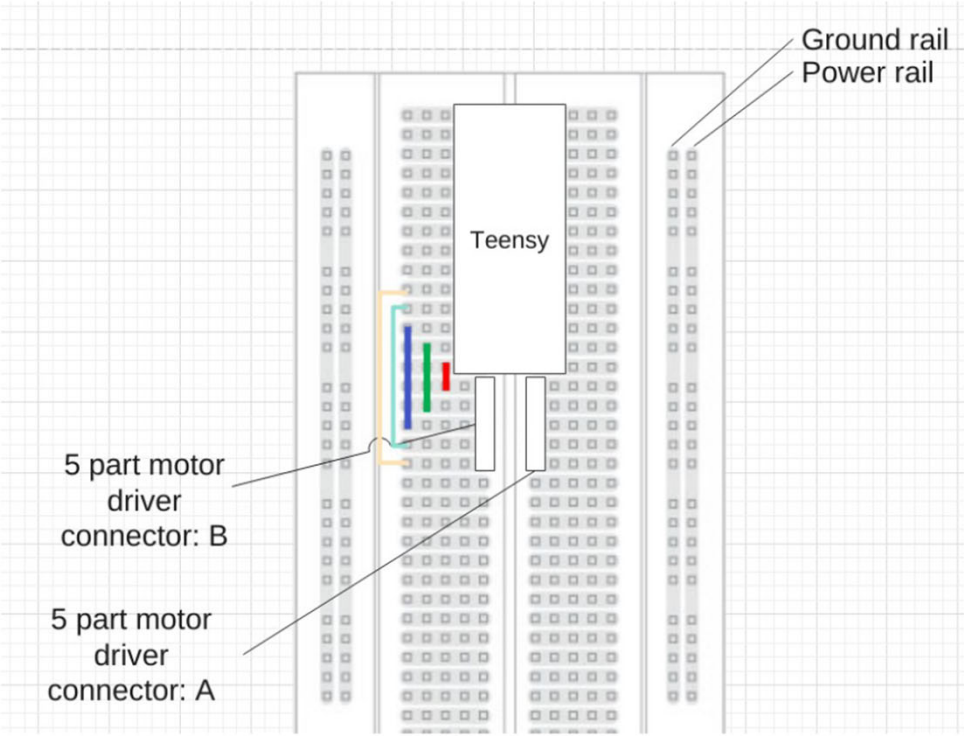
Peter's Part

Breadboard design for consideration

- Considered breadboard: https://dk.rs-online.com/web/p/laboratorieprint/2153175?gb=s

  Breadboard design is not finished, this is only an illustration of the idea of the breadboard layout.

  The idea is, that the wiring on the breadboard is harder to accidentally get dismounted, than airborne wires.

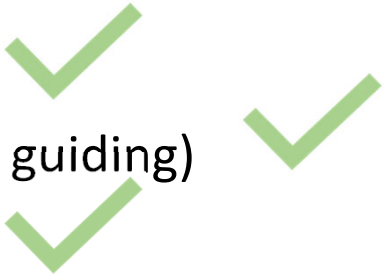


TZ2 Plans for the rest of Period1

- Finish up the shell for the robot
- Make it navigate reliably in different environments
- Improve the electronics design - wiring

TZ3 Payload Development Milestones

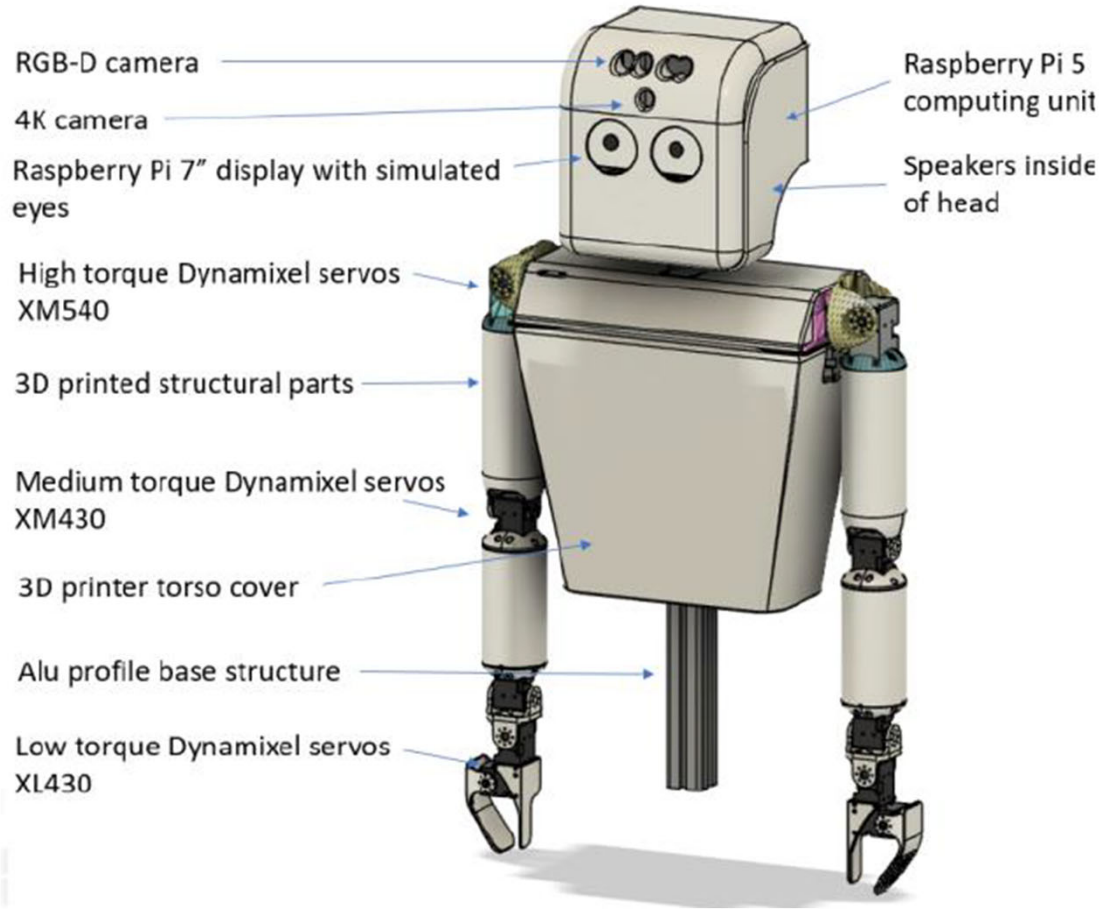
- Period1
  - M3.1 Three use cases are chosen for implementation
  - M3.2 Use case 1 implementation started (greeting and guiding)
  - M3.3 Use case 2 implementation started (patrolling)
- Period2
  - M3.4 Use case 1 implementation completed
  - M3.5 Use case 2 implementation completed
  - M3.6 Use case 3 implementation started



TZ3 Greeting and Guiding

- Will implement different solutions for a greeting robot:
  - Non-humanoid
    - Higher possible acceptance
  - Humanoid Service Robot
    - Higher versatility for different tasks

TZ3 Humanoid Service Robot



TZ3 Humanoid Service Robot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