

ExoskeleTUM @ LPL, LFE, AM and LCC

Design and Construction of a New Exoskeleton for Paraplegic Patients

Design und Konstruktion eines neuen Exoskeletts für Querschnittsgelähmte

Note on the course language: Our written course material will be in English to give international students the opportunity to join the project. Group work and daily communication however will be, depending on personal preferences, in both, German and English.

Hinweis zur Veranstaltungssprache: Alle schriftlichen Kursmaterialien sind auf Englisch, um auch internationalen Studierenden die Möglichkeit zu geben, am Projekt teilzunehmen. Gruppenarbeit und tägliche Kommunikation können auf Deutsch und Englisch erfolgen, je nach persönlicher Präferenz.

Our Vision

Develop and build a fully actuated lower limb exoskeleton with a students team to remobilize gait impaired patients – that's what *ExoskeleTUM* is about. Our long term project goal is the participation at *Cyathlon* organized by ETH Zurich (<https://cyathlon.ethz.ch/de/cyathlon>). Developing exoskeletons requires knowledge from various disciplines to achieve one common goal: return mobility and autonomy to gait impaired people in a world made for legs. TU Delft shows us, how to do it: *Project March* was established in 2016 and now the team already works on their 7th generation of exoskeleton (see figure 2).

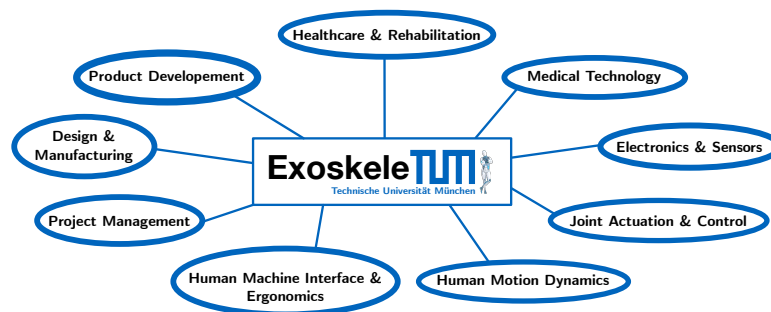


Figure 1: *ExoskeleTUM* as a collaborative students project incorporating numerous fields of research present at TUM.



Figure 2: Project March from TU Delft. The student organization supported by the Technical University Delft currently works on the 7th generation of their exoskeleton. The project started in 2016. Reprinted with permission from <https://www.projectmarch.nl/en/project-march>.

The Project Seminar

In this students seminar you will work on the development of the first exoskeleton prototype of in an interdisciplinary team. The mechanical team is supervised by Alexandra and Arian from the Chair of Applied Mechanics (**AM**), the ergonomics team by Manuel from the Chair of Ergonomics (**LFE**), the embedded systems team by Maximilian and Anand from the Laboratory for Product Development and Lightweight Design (**LPL**) and the frame design team by Chih-Yu from the Chair of Carbon Composites (**LCC**). All teams work closely together and meet on a regular basis to exchange their ideas and findings. Project kick-off, a midterm presentation and close up sessions are joint events for all teams.

Team 1 @ **LPL**: Energy Recycling Concepts during Walking

- Build an exploratory prototype to recycle energy in the swing phase of the leg
- Conceptualization using a toolbox on creative product development methods (e.g. morphological box, functional modeling etc.) with bottom-up and top-down approaches
- Conceptual prototyping of the selected solution

Team 2 @ **LFE**: User Centered Design of Human Machine Interaction

- Work on conceptual designs of human-machine interfaces for intention prediction considering different sensor systems like electromyography, electroencephalography or eye-tracking
- Build, record and analyze a device for neuronal signal processing and capturing
- Development of next generation input devices for an intuitive control of the exoskeleton

Team 3 @ **AM**: Joint Design and Control

- Evaluation of existing and exploration of new joint mechanism and actuator designs
- Conceptualization of a hierarchical control architecture: Smooth motion pattern transition control (sitting, standing, walking, stepping) and interface to user inputs
- Development of a joint unit test rig to represent the lower limb kinematic chain for testing gait control algorithms

Team 4 @ **LCC**: Patient-tailored Exoskeleton Frame Design

- Manufacturing of patient-tailored exoskeleton frame with carbon composites by hand lamination with Prepreg
- 3D scanning of human subject and CAD designing of the mold for the frame structure
- Evaluation of the manufacturing process for patient tailored frame structure

Application Procedure

Please send your application to exosketum@lpl.ed.tum.de including **(I) a short motivation letter** (max. 1 page A4) on why you want to participate in the projects and what previous experiences you may bring, **(II) your CV** and **(III) your transcript of records**. **Please submit all documents in PDF format with max. 1MB each.**

Looking forward to meet you in our seminar!

Arian, Alexandra, Maximilian, Anand, Manuel and Chih-Yu



You want to join the affiliated students team after or during the project seminar? Check out our webpage tumdash.com and the [application form](#) to become part of DASH!