



## Université de technologie de Compiègne - Thesis proposal

Part 1: Scientific sheet		
Thesis proposal title	Flexible exoskeleton with sensor feedback for hand rehabilitation	
PhD grant	Co-funding : - Technology University of Compiègne (UTC) - Fixed term contract (18 months) - TU Braunschweig (TUBS) - Fixed term contract (18 months)	
Research laboratory	Research teams : - Roberval Laboratory (UTC) - Institute für Mikrotechnik (IMT - TUBS)	
Thesis supervisor(s)	Andreas Dietzel, Full-Professor at TUBS (Director of IMT) Frédéric Lamarque, Full-Professor at UTC	
Scientific domain(s)	Science and technology biomedical and health sciences Engineering	
Research work	Support for the elderly has been a field of innovation and research that has been booming over the last decade. Often, monitoring systems, mostly based on applications connected to a network, allow the resumption of physical activity or to know the state of awakening of dependent people. These systems are essential to improve people's living conditions, especially their autonomy. Despite this progress, there is still a lot to be done so that the systems can assist people in their daily activities when they are disabled, either by the reduction of their mobility (walking problems) or by the impossibility of doing essential actions (for instance to grasp an object with one's hand). Exoskeletons may be the solution, but they remain today too large and heavy. Within this context, the thesis aims to propose solutions for the rehabilitation of the hand of people with injuries or lack of hand mobility and give them the possibility of recovering normal grip strength after a training program. In details, the expected work concerns the idea of making a flexible instrumented glove that integrates smart material-based actuators (design at UTC and fabrication at TUBS), flexible sensors (done at TUBS) and a control strategy (done at UTC) to allow people who have difficulty in grasping objects with their hands to be helped during the task. The mainstream image is a glove that provides electrical assistance to people who would no longer be able to make this grip safely and in a normal time. Thanks to the information feedback coming from foil-type sensor systems based on flexible and stretchable substrates the glove will adjust the gripping force of the object, once the presence of the object is detected in the palm of the person.	
Key words	Mechanical design, smart material-based actuators, resistive microsensors, microfabrication, mechatronics integration	
Requirements	The applicant must have solid knowledge in mechanical design, mechatronics system integration and sensors/actuators technologies. Skills in microfabrication would be appreciate English minimum level : B2 / Willingness to live in both countries (France and Germany)	
Starting time	10-01-2023	
Location	Both sites (UTC and TUBS)	



Г



Part 2: Job description		
Duration	36 months	
Additional missions available	/	
Research laboratory	Roberval - UTC : The Roberval Laboratory aims at becoming a national center of excellence in the design and control of mechanical systems. The lab has developed a significant industrial partnership, especially in the fields of automotive, aeronautics and energy. These long-term actions result in funding via the ANR or competitive clusters (i-Trans and Industrie and Agro-Ressources).	
	IMT - TUBS : The research areas at the IMT (40 persons) range from numerical simulation methods and basic material science investigations to the development and production of complex microsystems. The research questions for microsystem technology typically come from interdisciplinary projects in the fields of mechatronics, process engineering and life sciences. Projects are typically funded by DFG, BMBF, BMWi and Volkswagenstiftung.	
Material resources	Roberval – UTC	
	Roberval Lab has 2 platforms (material sciences, micromechatronics) that will be available for the thesis work.	
	SEM (Zeiss), Profiler Dektak 150 and optical profiler ZYGO NewView 200, Tension compression and fatigue machines (INSTRON 1186, 450S), µmachine for tension compression Micromecha Proxima 100 (adaptable in SEM), Optical microscopes (Olympus BX41M, Keyence), Stereomicroscope LEICA M205C, Differential Scanning Calorimeter Q100 (TA intruments) for thermal characterisation, 3D printers : Femtosecond 2PP laser machining (Nanocribe), 3D Direct laser structuring (LPKF), Cameras (video, highspeed), 80 sqm Optical rooms (three optical tables + optical and photonics components), COMSOL / ANSYS simulation software, CAD design software (Creo, CATIA V5 and V6), electronics lab (oscilloscopes, impedance analyser, several DAQ devices, etc.)	
	IMT - TUBS	
	The IMT has a 300 sqm clean room with associated laboratories and modern processing equipment and analytical instruments for micro- and nanofabrication and characterization of materials and systems. The laboratory infrastructure includes typical equipment for lithography-based microfabrication as well as a facility for patterning using femtosecond laser beams.	
	Within the clean rooms: surface profiler (Dektak 8), film thickness by spectral reflectance, spray Cleaner, 2 spin coaters, mask-Aligner (EVG 620), mask writer (Heidelberg Instruments DWL 66), 4-level-oven (diffusion, LPCVD, oxidation), furnace for thermal bonding, sputter deposition machine, ECVD-tool, ICP-DRIE tool, barrel-Etcher (STS 308), femtosecond 2PP laser tool (nanoscribe)	





	In further labs: 2 confocal laser scanning microscopes (Zeiss KLSM and Keyence), several further microscopes including 2 Keyence 3D microscopes, high speed camera system, wafer saw (DAD 320), ink-jet-printer for functional materials, screen printer, contact angle analyser (home built), AFM (nanosurf), particle sizer by dynamic light scattering (DLS), scanning electron microscopes (DSM 960 and desktop Phantom), CO2-laser, femtosecond laser-microstructuring tool (Microstruct / 3Dmicromac), 3D $\mu$ -PIV (LaVision), microfluidics lab with pumps, valves etc. , COMSOL / ANSYS simulation software, CAD design software (Solidworks, Autodesk), electronics lab (oscilloscopes, impedance analyser etc.)
Human resources	Roberval : 150 persons including 63 permanent people IMT : 40 persons
Financial resources	Resources of the research teams will support the activities
Working conditions	Autonomy and frequent reporting is expected. Frequency of the meetings with the supervisors: 1 meeting every two weeks + short meetings in case of problems to be solved
Research project	A joint project will be proposed to ANR and/or DFG during the duration of the thesis
National collaborations	Both labs are connected to national academic partners through ongoing research projects (ANR, DFG)
International collaborations	Potential collaboration with industrial international companies working in the field of exoskeleton or end-user of this technology
International cosupervision (cotutelle)	Yes, UTC and TUBS
Contact	Frédéric Lamarque e-mail: frederic.lamarque@utc.fr Université de Technologie de Compiègne Centre Pierre Guillaumat Rue du docteur Schweitzer CS 60319 BP 60203 – Compiègne France Phone: + 33 (0) 3 44 23 45 19 Mobile phone : + 33 (0) 6 03 69 23 47 Website : https://roberval.utc.fr Andreas Dietzel e-mail: a.dietzel@tu-braunschweig.de Technische Universität Braunschweig.de Technische Universität Braunschweig   Institut für Mikrotechnik Alte Salzdahlumer Straße 203 D-38124 Braunschweig, Germany Phone: +49 (0) 531 391-9760 Mobile phone: +49 (0) 1737833552 Website : www.tu-braunschweig.de/imt