

Thomas D. Lehmann

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Education

University of Alberta, Department of Electrical and Computer Engineering

Edmonton, Canada

PHD IN BIOMEDICAL ENGINEERING

Sept. 2013 - Jan. 2018

- *Areas of study:* Medical robotics, biomedical engineering, mechanics-based modeling, needle insertion, needle steering
- *Areas of research:* Needle insertion, needle steering, needle deflection modeling, sensing and estimation

Furtwangen University

Schwenningen, Germany

MSC IN BIOMEDICAL ENGINEERING

Oct. 2011 - Jun. 2013

- *Areas of study:* Physiological modeling, simulation, machine learning, decision support systems for medical ventilation of patients
- *Areas of research:* Decision support systems for medical ventilation of patients, needle insertion, needle deflection sensing and estimation

Furtwangen University

Schwenningen, Germany

BSC IN MEDICAL ENGINEERING

Mar. 2007 - Mar. 2011

- *Area of study:* Biomedical Technology

Work and Research Experience

Elementiam – Materials and Manufacturing

Edmonton, Canada

CONTRACTOR

Aug. 2021 - present

- Electrical design of a control cabinet for a 5-axis CNC-based Hybrid Manufacturing platform
 - Development of specifications, layout design, electrical schematics, design documentation, readiness for CSA approval

Additive Design and Manufacturing Systems Lab, MECE Department, University of Alberta

Edmonton, Canada

POSTDOCTORAL FELLOW

Oct. 2018 - present

- *Primary project:* Robotic large-scale metal wire and arc additive manufacturing (WAAM) in collaboration with InnoTech Alberta (Oct. 2018 - Apr. 2021)
 - Procurement, commissioning and installation of robotic large-scale WAAM platforms
 - Design and development of a ROS-based, hardware-agnostic software toolchain for robotic large-scale AM – from tool path to real-time computer-integrated execution
 - Software design and development (robot trajectory planning and execution, process planning)
 - Systems and sensor integration (hardware and software)
 - Research on process planning methods, deposition parameter identification and optimization, and sensor-fusion-based and machine-learning-based process optimization and control
 - Supervision of undergraduate and graduate students conducting research and development on process modeling, in-situ process monitoring and control, process planning, system setup and integration, and other related topics
- *Secondary projects:*
 - Automated repair of worn parts through 3D scanning and hybrid manufacturing
 - Robotic polymer AM

Telerobotic and Biorobotic Systems Lab, ECE Department, University of Alberta

Edmonton, Canada

RESEARCH ASSISTANT

Feb. 2018 - Sep. 2018

- Introduction of the robot middleware *Robot Operating System* (ROS) to the Telerobotic and Biorobotic Systems Lab
 - Development of point streaming interfaces for industrial robots using ROS-Industrial
 - Design and implementation of teleoperation for industrial robots using point streaming
 - Design and implementation of an admittance controller for industrial robots

Telerobotic and Biorobotic Systems Lab, ECE Department, University of Alberta

Edmonton, Canada

RESEARCH ASSISTANT

Sep. 2013 - Jan. 2018

- Research on PhD thesis topic: “Novel sensing and actuation methods for needle steering in soft tissue with application to prostate brachytherapy”
- Developing novel methods for deflection estimation and control of a bevel-tipped needle during insertion
- Design of a 2-DOF experimental needle insertion robot (hardware and software in Matlab and Simulink Real-Time) for validation of deflection estimation and control algorithms

ECE Department, University of Alberta

Edmonton, Canada

TEACHING ASSISTANT

Sep. 2014 - Dec. 2017

- Responsibilities: Instruction/supervision of laboratory and report/assignment grading
 - Fall Term 2014: ECE 210 – Introduction to Digital Logic Design
 - Winter Term 2015: ECE 212 – Introduction to Microprocessors
 - Fall Term 2015, 2016 & 2017: ECE 464 – Medical Robotics
 - Winter Term 2016 & 2017: ENCOMP 100 – Computer Programming for Engineers

Institute of Technical Medicine (ITeM), Furtwangen University

Schwenningen, Germany

RESEARCH ASSISTANT

Mar. 2013 - Aug. 2013

- Design and implementation of a Java-based patient simulator
- Re-implementation of various mathematical models of the cardiovascular system, heart, and respiratory system

Telerobotic and Biorobotic Systems Lab, ECE Department, University of Alberta

Edmonton, Canada

RESEARCH ASSISTANT

Sep. 2012 - Feb. 2013

- Research on Master's thesis titled: “Development of an Intelligent Surgeon's Assistant for Needle Adjustment in Prostate Brachytherapy”
- Development of a virtual sensor for estimating needle deflection during insertion into soft tissue
- Design of an experimental setup for automated needle insertion

Institute of Technical Medicine (ITeM), Furtwangen University

Schwenningen, Germany

RESEARCH ASSISTANT

Nov. 2011 - Aug. 2012

- Implementation of a Java-based tool for real-time plotting of a ventilation support simulator for Android mobile devices

University of Canterbury

Christchurch, New Zealand

VISITING STUDENT

Oct. 2010 - Mar. 2011

- Research for Bachelor's thesis titled: “Software Development for an Autonomously Operating Robot Truck for the Location and Recovery of Objects”
- Research and development of image processing methods for object detection under noisy conditions
- Development of a state-machine-based algorithm for automatic manoeuvring and decision making

Aesculap AG

Tuttlingen, Germany

INTERN

Mar. 2009 - Aug. 2009

- Development of microcontroller software in C for automatic detection of various types of surgical drills
- Design and assembly of electronic circuits

Publications

Journals

- [1] T. Lehmann, D. Rose, E. Ranjbar, M. Ghasri-Khouzani, M. Tavakoli, H. Henein, T. Wolfe, A. J. Qureshi, “Large-scale metal additive manufacturing: a holistic review of the state of the art and challenges,” *International Materials Reviews*, 2021.
- [2] T. Lehmann, A. Jain, Y. Jain, H. Stainer, T. Wolfe, H. Henein, A. J. Qureshi, “Concurrent geometry- and material-based process identification and optimization for robotic CMT-based wire arc additive manufacturing,” *Materials & Design*, vol. 194, p. 108841, Sep. 2020.
- [3] T. Lehmann, R. Sloboda, N. Usmani and M. Tavakoli, “Model-Based Needle Steering in Soft Tissue via Lateral Needle Actuation,” in *IEEE Robotics and Automation Letters*, vol. 3, no. 4, pp. 3930-3936, Oct. 2018. Also, selected for presentation at the IEEE/RSJ International Conference on Intelligent Robots and Systems, Madrid, Spain, 2018.
- [4] T. Lehmann, R. Sloboda, N. Usmani, and M. Tavakoli, “Human-machine collaboration modalities for semi-automated needle insertion into soft tissue,” *IEEE Robotics and Automation Letters*, vol. 3, no. 1, pp. 477-483, 2018.
- [5] T. Lehmann, C. Rossa, N. Usmani, R. Sloboda, and M. Tavakoli, “Intraoperative Tissue Young's Modulus Identification During Needle Insertion Using a Laterally Actuated Needle,” *IEEE Transactions on Instrumentation and Measurement*, vol. 67, no. 2, pp. 371-381, 2018.

- [6] T. Lehmann, C. Rossa, N. Usmani, R. Sloboda, and M. Tavakoli, "Deflection modeling for a needle actuated by lateral force and axial rotation during insertion in soft phantom tissue," *Mechatronics*, vol. 48, pp. 42–53, 2017.
- [7] T. Lehmann, C. Rossa, N. Usmani, R. Sloboda and M. Tavakoli. "A real-time estimator for needle deflection during insertion into soft tissue based on adaptive modeling of needle-tissue interactions". *IEEE/ASME Transactions on Mechatronics*, vol. 21, issue 6, pp. 2601–2612, 2016.
- [8] C. Rossa, T. Lehmann, R. Sloboda, N. Usmani and M. Tavakoli. "A data-driven soft sensor for needle deflection in heterogeneous tissue using just-in-time modelling". *Medical & Biological Engineering & Computing*, pp. 1–14, 2016.
- [9] J. Kretschmer, B. Laufer, T. Lehmann, P. Stehle, D. Redmond, and K. Möller. "Ein softwarebasierter Patientensimulator zur Evaluierung medizinischer Entscheidungssysteme (A software-based patient simulator to evaluate medical decision support systems)". *at – Automatisierungstechnik*, vol. 64, issue 11, pp. 878–893, 2016.
- [10] P. Stehle, T. Lehmann, D. Redmond, K. Möller, and J. Kretschmer, "A java based simulator with user interface to simulate ventilated patients," *Current Directions in Biomedical Engineering*, vol. 1, no. 1, pp. 423–427, 2015.
- [11] T. Lehmann, M. Tavakoli, N. Usmani and R. Sloboda. "Force-Sensor-Based Estimation of Needle Tip Deflection in Brachytherapy". *Journal of Sensors*, vol. 2013, 2013.

Conferences (peer-reviewed)

- [12] T. Lehmann, C. Rossa, N. Usmani, R. Sloboda and M. Tavakoli. "Needle path control during insertion in soft tissue using a force-sensor-based deflection estimator". *Proceedings of the 2016 IEEE International Conference on Advanced Intelligent Mechatronics*, Banff, Canada, July 12–15, 2016, pp. 1174–1179.
- [13] J. Kretschmer, T. Lehmann, D. Redmond, P. Stehle and K. Möller, "A Modular Patient Simulator for Evaluation of Decision Support Algorithms in Mechanically Ventilated Patients", *XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (MEDICON 2016)*, 2016.
- [14] T. Lehmann, C. Rossa, N. Usmani, R. Sloboda and M. Tavakoli. "A virtual sensor for needle deflection estimation during soft-tissue needle insertion". *Proceedings of the 2015 IEEE International Conference on Robotics and Automation*, Seattle, USA, 2015, pp. 1217–1222.
- [15] T. Nguyen, T. Lehmann, J. Kretschmer and K. Möller, "Bringing model based ventilation therapy to the bedside", *2013 ICME International Conference on Complex Medical Engineering*, Beijing, China, 2013, pp. 666–669.

Presentations

The International Symposium on Medical Robotics (ISMR 2018)

Atlanta, USA

Presented poster titled "Intraoperative Identification of Tissue Young's Modulus During Prostate Brachytherapy"

Mar. 2018

The 2016 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)

Banff, Canada

Presented paper titled "Needle path control during insertion in soft tissue using a force-sensor-based deflection estimator"

Jul. 2016

The 2015 IEEE International Conference on Robotics and Automation (ICRA)

Seattle, USA

Presented paper titled "A virtual sensor for needle deflection estimation during soft-tissue needle insertion"

May 2015

Skills

Programming languages	C/C++, Java (Java SDK, Android SDK), Python, JavaScript, MATLAB/Simulink, Motoman INFORM
IDEs, build environments	eclipse, Qt Creator, Visual Studio, VS Code, cmake, catkin
Robotics software frameworks/ecosystems:	ROS, ROS-industrial, RViz, MoveIt!, Descartes, Robot Web Tools, roserial-arduino
Operating systems	Linux (Debian, Ubuntu), MS Windows
CAD, rapid prototyping, 3D printing (polymer)	SolidWorks, FlashForge Creator Pro, ReplicatorG, Cura, Slic3r
Documentation, word processing, productivity	LaTeX, MS Office, LibreOffice, Google Suite, Inkscape
Version control	Git, GitHub, Gitflow workflow, Apache Subversion
Certificates	Yaskawa Motoman - DX200 Welding Programming and Motosim Overview
Languages	German (native), English

Awards & Scholarships

- 2020 **Mitacs Accelerate Scholarship**, *Mitacs*
- 2018 **Travel Award**, *International Symposium on Medical Robotics*
- 2016 **Graduate Travel Award**, *University of Alberta*
- 2015 **Graduate Travel Award**, *University of Alberta*
- 2013 **Doctoral Recruitment Scholarship**, *University of Alberta*