Julian NICOLAI

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EDUCATION

Carleton University   Ottawa, ON
B.Eng. Electrical Engineering   *September 2019 – April 2024*
4th Year; GPA: 10.56/12.00 (A-)
Dean's Honor List 2019-2021

CONFERENCE ARTICLES

F. Buchfellner, Q. Bian, F. Moos, J. Nicolai, F. Zhang, W. Hu, M. Yang, A. Koch, J. Roths, "Intra-Spectral Temperature Compensated FBG Sensors for Hydrogen Detection and Beyond," in *Optical Sensors and Sensing Congress 2023 (AIS, FTS, HISE, SENSORS, ES)*, presented and to appear in Technical Digest Series (Optica Publishing Group, 2023), paper STh3D.2.

J. Nicolai and J. Albert, "Tilted FBG Sensor Data Extraction with Low-Resolution Spectral Interrogation Instrumentation," in *Frontiers in Optics + Laser Science 2022 (FIO, LS)*, Technical Digest Series (Optica Publishing Group, 2022), paper JW4A.46.

RESEARCH EXPERIENCE

Research Assistant (Full-Time)   Munich, Germany
Munich University of Applied Sciences (Hochschule München) – Photonics Laboratory   *June 2023 – August 2023*

- **Designed and verified** a computationally efficient algorithm to improve the temperature and hydrogen measurement decoupling standard deviation by 16.7 times, achieving sub 30 femtometre spectral precision
- **Constructed a LabVIEW program** using improved algorithm to make temperature and hydrogen concentration measurements in real-time (4 Hz)
- **Created π-shifted fibre Bragg grating sensors** in both standard and polarisation maintaining fibre using the phase mask method
- **Conducted experiments** to justify the use of polarisation maintaining fibre over standard fibre by the reduction of residual birefringence

Research Associate (Full-Time)   Ottawa, ON
Carleton University – Advanced Photonic Components Laboratory   *May 2022 – December 2022*

- **Developed and conducted experiments** in bending, vibration, and surrounding refractive index sensing using tilted fiber Bragg gratings
- **Automated experiments and data collection** by writing scripts to control and interface scientific equipment
- **Designed and 3D printed a high-frequency vibration generator** using 100 W speaker, amplifier, and script-controlled function generator; surmounted test sensor package to vibrating membrane
- **Wrote MATLAB scripts** to process and analyse large amounts of collected data
- **Created fiber grating simulations** using MATLAB and FIMMWAVE software to predict fiber spectral output
- **Constructed tilted fiber Bragg gratings** using a KrF excimer laser (248 nm) and phase mask

Research Associate (Part-Time)
Ottawa, ON

Carleton University – Advanced Photonic Components Laboratory
September 2021 – April 2022

- **Designed low-cost Raspberry Pi Pico-based optical interrogator** with 4 nm span using tunable VCSEL laser and photodiode
- **Created circuit simulations** for photodiode transimpedance amplifier and VCSEL laser driver circuits
- **Collaborated with PCB design engineers** to layout and manufacture a prototype board
- **Wrote muticore embedded Rust code for Raspberry Pi Pico** to implement serial communication and control on-board DAC and ADC; used for controlling VCSEL wavelength and reading photodiode optical power
- **Debugged and resoldered components** on prototype board, for tuning current limiting circuit and feedback resistor of transimpedance amplifier
- **Developed Python-based GUI client** to receive raw data packets from device over serial, process and analyze them, then display the spectrum and calculated temperature (extracted measurement) in real-time

Research Associate (Full-Time)
Ottawa, ON

Carleton University – Advanced Photonic Components Laboratory
May 2021 – August 2021

- **Developed a novel algorithm** to interpret bending experienced by a tilted fiber Bragg grating over time; used windowed Fourier analysis in order to detect frequencies in the time-domain
- **Wrote custom Python-based PyQt5 GUI** in order to communicate with, configure, and interpret up to 35 000 UDP network packets per second from a high-speed optical interrogator, speeding up testing and prototyping
- **Detected frequencies in real-time,** accurate to 1 Hz within the range of 18 Hz–8500 Hz using previously developed techniques combined with 1D Kalman filtering to reduce signal noise
- **Created sensor packaging** for fixed-fixed and cantilever sensor configurations using Autodesk Inventor; 3D printed for the quick prototyping and testing of different versions of sensor casings, reducing cost per unit from $148 to 10¢
- **Designed and 3D printed a low-frequency vibration generator** using an eccentric rotating mass on a variable speed DC motor in order to test and calibrate sensors
- **Calculated exact, real-time frequency of vibration** using the periodically-changing light levels on a photoresistor from the motor's eccentric rotation, thereby verifying accuracy of the developed vibration sensing software 12 times faster than manual measurement
- **Ran simulations using Simscape Multibody** in order to verify Euler-Bernoulli beam theory resonance calculations, investigate damping effects, and determine sensor viability
- **Produced weekly presentations** to communicate findings, update project progress, and reflect on approaches

PROFESSIONAL EXPERIENCE

Mevex Corporation
Ottawa, ON

Software Developer Internship
May 2020 – August 2020

- **Wrote Javascript and Python-based software** which improved monitoring and record-keeping of conveyor belt systems, leading to faster downed-machine response times
- **Designed and implemented an intuitive UI** which signifigantly reduced the time required to accomplish common tasks
- **Optimized written software** through regular code reviews and profiling, reducing the system resources required allowing it to run on less powerful hardware decreasing implementation costs by 26% per unit
- **Developed ways to manage and control high data throughput** from parallel network video feeds, allowing the ability to record, store, and play back higher resolution video
- **Created concise application documentation** to bolster usability and reduce training times

Academic Awards

2023   Mitacs RISE-Globalink Research Internship

2023   NSERC Undergraduate Student Research Award [Declined offer]

2022   Internship-Carleton University Research Experience (I-CUREUS)

2021   Mitacs RISE-Globalink Research Internship [Declined offer]

2021   Michael Oliver Scholarship

2020   David A. Golden Award

Competition Awards

2022   Most Innovative Award, Re-Engineering; Canadian Engineering Competition (CEC) 2022

2022 3rd Place Re-Engineering; Canadian Engineering Competition (CEC) 2022

2022 2nd Place Re-Engineering; Ontario Engineering Competition (OEC) 2022