Julian Nicolai

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Available: September 2022 — 8 Months

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Education

Carleton University — Ottawa, ON
Bachelor of Engineering in Electrical Engineering, Co-op Option — *Sept. 2019 – April. 2024*
Fourth year, GPA: 10.46/12.0 (A-)
Dean's Honor List 2019-2021; David A. Golden Award; Michael Oliver Scholarship

Conference Publications

Tilted FBG Sensor Data Extraction with Low-Resolution Spectral Interrogation Instrumentation — Rochester, NY
Frontiers in Optics + Laser Science 2022 — *October 17 – 20, 2022*
Technical Digest Series (Optica Publishing Group, 2022), paper JW4A.46

Experience

Carleton University — Ottawa, ON
Full-Time Advanced Photonic Components Laboratory (APClab) Research Associate — *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

Carleton University — Ottawa, ON
Part-Time Advanced Photonic Components Laboratory (APClab) Research Associate — *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

Carleton University — Ottawa, ON
Full-Time Advanced Photonic Components Laboratory (APClab) Research Associate — *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

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

Projects

Weather Satellite Image Reception & Decoding: Built and used a homemade quadrifilar helical antenna (using PVC pipes and coax cable) to capture data from both digital (METEOR M2-2) and analog (NOAA-15/18/19) satellites during flyover. The geostationary satellite GOES-16 was also received using a repurposed parabolic grid Wi-Fi antenna. Gained insight into orbital mechanics, RF communication technologies, and software defined radio.

Analog PWM Fan Controller Using 555 Timer: Using Multisim software, designed and simulated a 25 kHz PWM controller circuit to drive a computer fan; used a potentiometer to control duty cycle. Soldered onto compact perfboard, placed into a 3D printed case designed in Autodesk Inventor. A carbon filter was affixed to the fan to remove solder fumes.

Mechanical Keyboard Calculator: Reverse engineered the TI-36X Pro calculator input PCB traces and button contacts. Using Altium PCB Designer, recreated a custom PCB to interface with original calculator, but with Gateron Yellow mechanical key switches. Using Autodesk Inventor, the housing and keyboard keycaps were designed and 3D printed before being assembled into a final unit.

Biomechanical Eyes: Inspired by the human body, a pair of animatronic eyeballs were created using ping-pong balls, HDPE film canisters for eye sockets, and nylon floss (used for its low coefficient of friction) acting as the recti muscles, which were affixed to each of the four quandrants of the eyeball. Each dimension (X, Y) of each eye were tied together and controlled using an Arduino and two servo motors in a pull-pull configuration. Featured on the website Hackaday.

***Conway's Game of Life* Python-Based Simulation:** Developed an interactive simulator for cellular automata that generates GIF animations using John Conway's *"Game of Life"* algorithm; a user issues commands to set the initial state, board size, and time scale, before placing items and starting the simulation.

Skills

Languages: Python, C, MATLAB, Rust, LabVIEW, ARM Assembly, Java, Javascript/NodeJS, LaTeX

Software: Git, Linux, MS Word & Excel, Altium Designer, Multisim, Autodesk Inventor & Fusion 360

Equipment: Optical Spectrum Analysers, Digital/Analog Oscilloscopes, Function Generators

Hardware: Arduino, Raspberry Pi & Pico, 3D Printing, Nexys4 DDR FPGA