

Mehdi Khantan

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PROFILE

Lead engineer with 15 years of experience in electrical engineering and data science, specializing in software, hardware, and firmware development for real-time applications in medical and neuroscience domains. Lead developer of the Virtual White Matter system, which enables real-time communication between cultured neural preparations to interconnect distinct biological neural networks. Skilled in neural signal processing, including spike detection, artifact rejection in noisy environments, and classification of neural responses. Collaborated closely with neuroscientists and clinicians to design, develop, and validate advanced neurostimulation and rehabilitation technologies.

EDUCATION

Ph.D., Electrical Engineering, Temple University, Philadelphia, PA	2025 (expected)
M.Sc., Electrical Engineering, University of Tabriz, East Azerbaijan, Iran	2013
B.Sc., Electrical Engineering, University of Tabriz, East Azerbaijan, Iran	2010

EMPLOYMENT HISTORY

Visiting Scientist and Engineering Lead Raphael Center for Neurorestoration, Thomas Jefferson University	2022-Present
Director of R&D, Odsun Co. LTD.	2013–2021
Research Assistant, Integrated Circuit Design Lab, University of Tabriz	2011–2013
Director of R&D, Tabriz University Robotic Group (TURG)	2010–2012

RESEARCH EXPERIENCE

Visiting Scientist and Engineering Lead Raphael Center for Neurorestoration, Thomas Jefferson University (2022–Present):

Developed Virtual White Matter: A novel system for cross-dish neural interaction and modulation that establishes functional connections between different neural preparations, facilitating interactions between in-vitro biological neural networks and enabling the rewiring of damaged in-vivo neural tissues using a novel real-time, low-latency spike detection system for neural signal analysis, optimized for electrically stimulated environments.

NuroSleeve—An Exoskeleton with Wireless Sensor Network: Developed and clinically tested a wireless sensor-integrated active orthosis (exoskeleton) for brain-computer interface (BCI)-

driven upper limb rehabilitation, enhancing functionality in individuals with motor impairments.

Wireless Functional Electrical Stimulation (FES): Designed and developed a wireless FES system for both percutaneous and implantable spinal cord stimulation, optimized for low-latency performance and safety-critical applications. The system includes built-in fault tolerance and complies with regulatory standards. Also developed a portable wireless device for delivering mechanical tactile stimulation for sensory substitution applications, successfully validated in clinical trials.

Brain-Computer Interface (BCI) Trial: Contributed to a clinical trial using the Layer 7 Cortical Interface by Precision Neuroscience for surface-level neural signal acquisition. Implemented real-time signal processing and control algorithms to enable volitional motor control of the NuroSleeve hand orthosis. Also contributed to a novel brain-to-cell interface by using decoded cortical activity from BCI signals to stimulate dissociated neural cultures.

3D Micro Electrode Arrays (MEAs): Designed 3D MEAs with 128 electrodes for culturing ex-vivo brain slices with automated medium exchange.

NeuroTuner System: Developed a Python-based software and stimulation system integrated with the Intan RHS platform to deliver and analyze diverse electrical stimulation paradigms. Enabled real-time delivery of pulses with variable parameters (type, frequency, shape, width, amplitude) and post-stimulus activity analysis in neural preparations.

Spinal Cord Stimulation Rehabilitation Platforms: Played a key role in the design, firmware and hardware safety evaluation, failure mode analysis, and regulatory compliance (FDA approval) of the RISES system, an advanced closed-loop spinal cord stimulation platform for spinal cord injury rehabilitation. Led the verification and validation of embedded firmware, ensuring real-time performance, fault resilience, and patient safety in a neurostimulation environment.

Fine Motor Assessment Devices: Designed and developed high-precision systems for evaluating fine motor function, including finger force measurement and foot strength assessment tools. These devices were utilized in clinical trials to quantify rehabilitation outcomes in spinal cord stimulation therapy.

Director of R&D, Odsun Co. LTD. (2013–2021):

Low-Power Data Acquisition System: Led the design of ultra-low-power data loggers for underground water management systems, enabling remote data collection with up to six months of battery life.

32-Channel Strain Gauge Data Logger: Developed a high-resolution 32-channel system for mechanical testing, supporting fatigue, strain, and stress analysis in structural materials.

IoT-Based Hydroclimatology Station: Built an IoT-enabled environmental monitoring station with custom-designed weather sensors to collect and transmit real-time hydroclimatology data.

Parking Guidance System: Designed and implemented an automated system for shopping centers to guide drivers to the nearest available parking space using sensor networks and real-time processing.

Director of R&D, Tabriz University Robotic Group (TURG) (2010–2012):

Soccer-Playing Robots: Led the development of a fully autonomous multi-agent robotic soccer team, integrating Xilinx FPGAs, microcontrollers, and ZigBee communication for coordination. Implemented a centralized AI and vision system for strategic decision-making and real-time image processing.

High-Voltage DC-DC Boost Converter: Engineered a 22.2V to 400V fast boost converter to charge capacitors within 4 seconds, powering a ball kicker mechanism capable of launching a 45g golf ball at 16 m/s.

FPGA-Based PID Motor Control: Developed a robust PID controller on FPGA for precise position control of four BLDC motors, enabling smooth omnidirectional navigation.

Research Assistant, Integrated Circuit Design Lab, University of Tabriz (2011–2013):

Pipeline ADC Chip Design: Designed a high-speed sample-and-hold circuit for an 800 MSPS, 10-bit pipeline analog-to-digital converter (ADC) chip in 180nm CMOS technology.

CPU Design: Implemented a 32-bit MIPS processor on FPGA using Verilog HDL, covering instruction decoding, ALU operations, and memory interfacing.

TECHNICAL SKILLS

Machine Learning & Neural Signal Processing: Proficient in supervised and unsupervised machine learning, including classification (SVM, KNN, Random Forest), clustering, PCA, and feature selection using entropy-based methods. Specialized in neural signal analysis: spike detection, sorting, feature extraction, time-series and spectral analysis, artifact removal, and post-stimulus response evaluation. Experienced in analyzing evoked responses from intercortical neural stimulation.

Embedded Systems & Circuit Design: Experienced in analog and digital circuit design using Altium Designer and KiCad. Skilled in bare-metal embedded systems development and real-time firmware, and real time operating systems (RTOS) for ARM Cortex, ESP32, PIC, and AVR microcontrollers. Proficient in digital communication protocols (UART, SPI, I²C, I²S, CAN, 1-Wire, and custom GPIO) and wireless technologies including RF, BLE, Zigbee, and TCP/IP. Background in FPGA development (Verilog/VHDL) on Xilinx and Altera platforms, as well as CMOS analog/digital IC design and VLSI architecture, including MIPS processor implementation.

Software Development & Programming: Proficient in C, C++, C#, Python (including GUI development with PyQt), and MATLAB. Experienced with embedded and application development environments such as Visual Studio, Keil μ Vision, CodeVision AVR, Arduino IDE, and Platform IO. Skilled in IoT backend development using PHP, MySQL, REST APIs, HTTP,

HTTPS, and JSON. Comfortable with Unix/Linux systems, Bash scripting, automation (Cron jobs), technical documentation (LaTeX), and version control (Git).

Robotics & Industrial Automation: Designed autonomous robotic systems and assistive devices such as exoskeletons. Experienced in motor control using PID algorithms on microcontrollers and FPGAs for DC/BLDC motors and omnidirectional platforms. Background in mechanical systems involving hydraulics, pneumatics, CNC control, 3D scanning, and additive manufacturing.

PATENTS

Serruya, M. D., Napoli, A., **Khantan, M.**, Lim, J., & Obeid, I. Biological Artificial Intelligence System. U.S. Provisional Patent Application No. 63/799,087. Filed May 2025. Patent pending.

PUBLICATIONS

Journal Articles:

Khantan, M., Lim, J., Napoli, A., Obeid, I., & Serruya, M. D. (2025). Virtual White Matter: A novel system for cross-dish neural interaction and modulation. *Journal of Neural Engineering*.

Madarshahian, S., Guerrero, T., Aung, P. T., **Khantan, M.**, Bockbrader, M., Napoli, A., & Serruya, M. D. (2024). Initial feasibility evaluation of the RISES system: an innovative and activity-based closed-loop framework for spinal cord injury rehabilitation and recovery. *Journal of Rehabilitation and Assistive Technologies Engineering*.

Khantan, M., Avery, M., Aung, P. T., Guerrero, T., Napolitano, A., Dicianno, B. E., & Serruya, M. D. (2023). The NuroSleeve: A user-centered, 3D-printed hybrid orthosis for individuals with upper extremity impairment. *Journal of NeuroEngineering and Rehabilitation*, 20(1), 103.

Conference Presentations:

Madarshahian, S., Guerrero, T., Aung, P. T., Grampurohit, N., Gustafson, K., Harrop, J., **Khantan, M.**, Lee, Y., Matias, C., McCurdy, M., Mulcahey, M. J., Napoli, A., Vaccaro, A., & Serruya, M. D. (2023). The RISES System: An Innovative and Activity-Based Closed-Loop Platform for Spinal Cord Injury Rehabilitation and Recovery. *Progress in Clinical Motor Control II—Movement and Rehabilitation Sciences*, Chicago, IL, USA.

Khantan, M., Lim, J. T., Napoli, A., Obeid, I., & Serruya, M. D. (2023). Linking physically isolated in vitro neural specimens on separate three-dimensional microelectrode arrays via virtual white matter software. *Society for Neuroscience Annual Meeting (SfN)*, Washington, DC, USA.

Lim, J. T., **Khantan, M.**, Angelopoulos, E., Napoli, A., Obeid, I., & Serruya, M. D. (2023). Microstimulation-induced spatiotemporal dynamics of organotypic visual thalamocortical slices on a 3D multielectrode array. *Society for Neuroscience Annual Meeting (SfN)*, Washington, DC, USA.