Hajar Abedi

PhD Candidate

Centre for Intelligent Antenna and Radio Systems

Wireless Sensor and Devices Lab

Vision and Image Processing Lab

Ubiquitous Health Technology Lab

University of Waterloo

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SUMMARY of QUALIFICATIONS

- Published more than 40 journal/ conference papers and patents
- 9+ years successful experience in antenna design and electromagnetic analysis
- 7+ years successful experience in microwave imaging
- 3+ years successful experience in the development of AI-powered radar-based sensors
- Extensive knowledge of the design, analysis, and validation of MIMO radars in multiple applications
- Extensive knowledge of the use of AI, machine learning and deep learning in Electromagnetics waves and radar sensors application
- Strong background in the field of signal processing from wireless system designs to optimizations
- Thorough knowledge of the use of machine learning and deep learning in wireless sensor applications
- Excellent leadership capabilities, communication skills, and a demonstrated willingness to work in a team environment with diverse faculty, researchers and students

RESEARCH INTEREST

Antennas, Signal Processing, Wireless Sensors, Artificial Intelligence, Machine Learning and Deep Learning.

EDUCATION

University of Waterloo, Waterloo, Canada **Jan 2019 – Present**
Ph.D. Candidate
Supervisors: Prof. George Shaker and Prof. Alexander Wong

Babol Noshirvani University of Technology, Babol, Iran **Sept 2014 - Feb 2017**
Master of Science in Telecommunication- Electromagnetic Fields & Waves

Babol Noshirvani University of Technology, Babol, Iran **Sept 2009 - Sep 2014**
Bachelor of Science in Telecommunication- Electromagnetic Fields & Waves

PROFESSIONAL EXPERIENCE

First-Ever Long-Term Bed Rest Study **Aug 2021 - Present**
Researcher at McGill University Health Center, Montreal, Canada, supported by the Canadian Institutes of Health Research, Canadian Space Agency and Canadian Frailty Network.

- Data collection, analysis, and validation of mm-wave FMCW MIMO radar sensors operation in the bed rest study
- Data collection, analysis, and validation of mm-wave FMCW MIMO radar sensors for biomedical non-contact vital sign detection
- Data collection, analysis, and validation of mm-wave FMCW MIMO radar sensors for gait analysis
- Data collection, analysis, and validation of mm-wave FMCW MIMO radar sensors for people tracking/ monitoring

AI-Powered Wireless Human Activity Recognition for Safety and Health Improvement **Sep 2021 - Present**
Intern at TandemLaunch Inc, Montreal, Canada.

- Analysis and validation of a mm-wave FMCW MIMO radar sensor for in-home gait monitoring and activity recognition
- Implement unsupervised learning based contactless hallway gait analysis
- Implement deep learning based multiple people monitoring/ tracking

Remote Activity Monitoring and Fall Detection System **Jun 2020 – March 2021**
Intern at Gold Sentintel Inc, Waterloo, Canada.

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in human tracking
- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in fall detection
- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in vital signs monitoring

Artificial Intelligence for Autonomous Human Monitoring and Activity Recognition for Safety and Health Improvement
May 2020 – March 2021
Research Assistant at Wireless Sensors and Devices Lab (WSDL), University of Waterloo, Waterloo, Canada, funded by Microsoft Corporation.

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in human tracking
- The use of deep learning in autonomous human tracking and activity recognition to support ageing and wellness

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor in obtaining gait characteristics

AI-Powered Automotive Radar Signal Processing for in-cabin Sensing **May 2020 – March 2021**
Research Assistant at WSDL, University of Waterloo, Waterloo, Canada in Collaboration with Vayyar Imaging Ltd.

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in a vehicle for detecting the presence/absence of occupants
- The use of machine learning and deep learning in people counting and positioning in the vehicles
- The use of deep learning in identifying the type of occupants (adults, kids and infants)

Lens Antenna Design **Oct 2019 – May 2021**
Research Assistant at WSDL, University of Waterloo, Waterloo, Canada

- Simulation and fabrication of a dielectric lens antenna integrated with a mm-wave MIMO radar
- Pattern measurement of the lens antenna paired with a mm-wave MIMO radar
- Test the mm-wave MIMO radar integrated with the dielectric lens in hallway gait monitoring

FMCW MIMO Imaging Radar **Aug 2019 - Present**
Research Assistant at WSDL, University of Waterloo, Waterloo, Canada

- Analysis, and validation of a mm-wave FMCW MIMO radar in imaging of targets
- MIMO radar technologies combined with deep learning/machine learning in driver status monitoring
- MIMO radar technologies combined with deep learning/machine learning to improve skier's safety.

In-vehicle Occupancy Detection **May 2019 – March 2020**
Research Assistant at WSDL, University of Waterloo, Waterloo, Canada in Collaboration with Nidec Automotive Corporation.

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in a vehicle for detecting the presence/absence of occupants
- The use of machine learning in people counting and positioning in the vehicles
- The use of deep learning in identifying the type of targets.
- HFSS simulation of MIMO antennas.

Autonomous Human Tracking and Activity Recognition **Jan 2019 – April 2020**
Research Assistant at WSDL, University of Waterloo, Waterloo, Canada in Collaboration with Hill-Rom Company

- Analysis, and validation of a mm-wave FMCW MIMO radar sensor operation in human tracking
- The use of deep learning in autonomous human tracking and activity recognition to support ageing and wellness
- Analysis, and validation of a mm-wave FMCW MIMO radar sensor in obtaining gait characteristics
- HFSS simulation of MIMO radar antennas for gait monitoring
- Gait monitoring using MYO

Wireless Sensors and Devices Lab Coordinator **May 2019 - Present**
University of Waterloo, Waterloo,

- Manage the Wireless Sensors and Devices Lab
- Interface with other students and industry partners on multiple wireless technologies

Electrical Small Antennas (ESAs) for submarine applications **Feb 2017 - Dec 2018**
Research Assistant at Babol Noshirvani University of Technology, Babol, Iran

- Design electrical small antennas for MF/HF band in CST Microwave Studio
- Fabrication of electrically small antennas for submarine applications

Multiband Energy Harvesting Systems **Feb 2017 - Dec 2018**
Research Assistant at Babol Noshirvani University of Technology, Babol, Iran

- Design a meandered loop antenna at FM and GSM band in CST Microwave Studio
- Fabrication of a meandered loop antenna for energy harvesting system

Microwave Imaging **Feb 2015 - Dec 2018**
Research Assistant at Babol Noshirvani University of Technology, Babol, Iran

- Finite-Difference Time-Domain (FDTD) simulation in MATLAB (2D/3D)
- Through-the-wall imaging using synthetic aperture radar
- Microwave imaging using time-reversal methods
- Through-the-multilayered wall imaging using passive synthetic aperture radar
- Through-the-multilayered wall imaging based on the plane wave method

- Through-the-multilayered wall imaging using a Mont Carlo technique

Antenna Array Design **Jun 2013 - Sep 2014**

Undergraduate Research Assistant at Babol Noshirvani University of Technology, Babol, Iran

- Optimization algorithm to control nulls and to reduce the sidelobe level of planar array antenna
- Propose new algorithm, Competition over resources (COR) for planar arrays pattern synthesis
- Application of the COR algorithm for aperiodic linear antenna arrays

Sensors Design **Jun 2009 - Sep 2013**

Robotic Club, Babol University of Technology Babol, Iran

- Design line follower Robot using AVR microcontroller
- Human motion detector using weight sensors, motion sensors and AVR microcontroller
- DC motor remote controller using HMTR module and MATLAB

Head of 9th National Robotic Competition **May 2012**

Babol Noshirvani University of Technology, Babol, Iran

PUBLICATIONS

Journals

- **Hajar Abedi**, Martin Ma, James He, Jennifer Yu, Ahmad Ansariyan and George Shaker, "AI-Powered Automotive Radar Signal Processing for in-cabin Sensing," Nature Machine Intelligence, *(under preparation).*
- **Hajar Abedi**, Xavier Chia and George Shaker, "In-Vehicle Detection of Distracted Driving Using mm-wave Radar Technology," *IEEE Transactions on Pattern Analysis and Machine Intelligence, (under preparation).*
- **Hajar Abedi,** Plinio P Morita, Jennifer Boger, Alexander Wong, and George Shaker, "In-Package Integrated Dielectric Lens Paired with a MIMO mm-Wave Radar for Corridor Gait Monitoring," IEEE J-ERM, *(under review).*
- Mohammad Omid Bagheri, **Hajar Abedi** and George Shaker, "The Use of Dielectric Rod Superstrate for X-Band Radar Antenna Gain Improvement," *IEEE Sensor, (under review).*
- **Hajar Abedi**, Ahmad Ansariyan, Plinio Morita, Jennifer Boger, Alex Wong and George Shaker," AI-Powered Non-Contact In-Home Gait Monitoring and Activity Recognition System Based on mm-Wave FMCW Radar and Cloud Computing," *IEEE Internet of Things Journal, (under review).*
- **Hajar Abedi**, Shenghang Luo and George Shaker, "AI-Powered In-Vehicle Passenger Monitoring using Low-Cost mm-Wave Radar", *IEEE Access, (under review).*
- **Hajar Abedi**, John Hanna, Steven Ding, Ahmad Ansariyan, Tom Paraschuk, Jennifer Boger, Plinio P Morita, Alexander Wong, and George Shaker, "Low-Cost 3D printed Dielectric Lens for a Millimeter-Wave MIMO Radar Antenna," *IEEE Transactions on Antennas and Propagation.*
- **Hajar Abedi**, Clara Magnier, Vishvam Mazumdar and George Shaker, "Improving Passenger Safety in Cars Using Novel Radar Signal Processing", *Engineering Reports*, 2021. https://doi.org/10.1002/eng2.12413
- **Hajar Abedi**, George Shaker, Jennifer Boger, Plinio Morita and Alex Wong, "Use of High-Frequency Radar for Gait Monitoring", *American Journal of Biomedical Science & Research.*
- Chia Xujie Xavier, **Hajar Abedi**, Jennifer Boger, Plinio Morita, Alexander Wong, George Shaker, "2D-Multiple Signal Processing Approach to Human Orientation Monitoring Using Millimeter-wave FMCW Radar", *Journal of Computational Vision and Imaging Systems, Volume: 5, Issue: 1, Page(s): 2–2, 2019.*
- **Hajar Abedi**, Clara Magnier, Jennifer Boger, Plinio Morita, Alexander Wong, George Shaker, "Integration of Random Forests and MM-Wave FMCW Radar Technology for Gait Recognition", *Journal of Computational Vision and Imaging Systems, Volume: 5, Issue: 1, Page(s): 2–2, 2019.*
- **Hajar Abedi**, Shenghang Luo, Steven Ding, Clara Magnier, Michael Bacani, George Shaker "On the Use of Low-Cost Radars and Machine Learning for In-Vehicle Passenger Detection", *Journal of Computational Vision and Imaging Systems, Volume: 5, Issue: 1, Page(s): 2–2, 2019.*
- Nastouh Nikkhah, Bijan Zakeri and **Hajar Abedi**, "Extremly Electrically Small MF/HF Antenna," *IET Microwaves, Antennas & Propagation, DOI: 10.1049/iet-map.2019.0200 , Print ISSN 1751-8725, Online ISSN 1751-8733, Sep 2019.*
- **Hajar Abedi** and Bijan Zakeri, "Through-the-Multilayered Wall Imaging Using Passive Synthetic Aperture Radar*," IEEE Transactions on Geoscience and Remote Sensing, Volume: 57, Issue: 7, Page(s): 4181 – 4191, July 2019, DOI: 10.1109/TGRS.2018.2890027.*
- **Hajar Abedi** and Bijan Zakeri, "Point Target Localization and Imaging Based on Plane Wave Method and SAR,"

Majlesi Journal of Telecommunication Devices, Volume 5, No 3, Sep. 2016.

- Reza Gholami, Bijan Zakeri, **Hajar Abedi** and Sina Mohseni, "Reduction of Dynamic Range Ratio through Competition Over Resources to synthesize planar array antennas," *AEU - International Journal of Electronics and Communications Volume 70, Issue 11, Pages 1522-1531, Nov. 2016.*

Conferences

- Mohammad Omid Bagheri, **Hajar Abedi**, and George Shaker, "Radar Antenna Gain Improvement Using an Integrated In-Package Dielectric Rod Superstrate", APS-URSI, 2021.
- **Hajar Abedi**, Plinio P Morita, Jennifer Boger, Alexander Wong, and George Shaker, "In-Package Integrated Dielectric Lens Paired with a MIMO mm-Wave Radar for Corridor Gait Monitoring", APS-URSI, 2021.
- **Hajar Abedi**, Ahmad Ansariyan, Plinio P Morita, Jennifer Boger, Alexander Wong, and George Shaker, "Sequential Deep Learning for In-Home Activity Monitoring Using mm-Wave FMCW Radar", APS-URSI, 2021.
- Mohammad Omid Bagheri, **Hajar Abedi**, and George Shaker, "Radar Antenna Gain Improvement Using 3D Printed Dielectric Lens and Metamaterial-Inspired Superstrates", ANTEM 2021.
- **Hajar Abedi,** Clara Magnier, and George Shaker "Passenger Counting and Safety Improvement Using an AI-Powered Radar Technology", ANTEM 2021.
- **Hajar Abedi**, George Shaker, Jennifer Boger, Alexander Wong, and Plinio P. Morita, "Autonomous Human Monitoring and Activity Recognition for Safety and Health Improvement", HFES International Symposium on Human Factors and Ergonomics in Health Care, 2021.
- **Hajar Abedi** and George Shaker, "Low-Cost 3D printed Dielectric Hyperbolic Lens Antenna for Beam Focusing and Steering of a 79GHz MIMO Radar", APS-URSI, 2020.
- **Hajar Abedi**, Shenghang Luo and George Shaker, "On the Use of Low-Cost Radars and Machine Learning for In-Vehicle Passenger Monitoring", *RWW2020.*
- Mostafa Alizadeh, **Hajar Abedi** and George Shaker, "Low-cost low-power in-vehicle occupant detection with mm-wave FMCW radar", *IEEE Sensor 2019.*
- **Hajar Abedi**, George Shaker, Plinio Morita, Alex Wong and Jennifer Boger, "Use of High-Frequency Radar to Capture Parameters of Gait", *AGE-WELL's 5th Annual Conference, 2019.*
- **Hajar Abedi**, George Shaker, Plinio Morita, Alex Wong and Jennifer Boger, "The use of radar in a smart bed for detecting gait-related physiological parameters", *Symposium on Aging Research (SoAR) 2019.*
- **Hajar Abedi** and B. Zakeri, "Through-the-Multilayered Wall Imaging Using Passive Synthetic Aperture Radar," *European Microwave Week (EUMW), 2018.*
- Ataolla Ebrahimzade, **Hajar Abedi** and Maryam Hesari "Gravitational Search Algorithm used to synthesis a planar array antenna for nulling control and side lobe level reduction," *IEEE 8th International Symposium on Telecommunications (IST) 27-28 September, 2016, Tehran, Iran.*
- **Hajar Abedi,** Reza Gholami and Bijan Zakeri "Competition over resources algorithm and its application for planar array pattern synthesis," *IEEE 8th International Symposium on Telecommunications (IST) 27-28 September, 2016, Tehran, Iran.*
- Reza Gholami, Bijan Zakeri, Sina Mohseni, and **H. Abedi,** "Driving Point Impedance Restriction in Synthesis of Linear Antenna Arrays Using Competition Over Resources Optimization Algorithm," *IEEE 4th International Conference on Computer and Knowledge Engineering 29 - 30 October, 2014, Mashhad, Iran.*
- Reza Gholami, Bijan Zakeri, Sina Mohseni, and **H. Abedi,** "Synthesis of Aperiodic Linear Antenna Arrays Based on Competition over Resources Optimization," *IEEE APACE Asia-Pacific Conference on Applied Electromagnetics 8 - 10 December, 2014, Johor, Malaysia.*
- **Hajar Abedi** and Masumeh Dansi, "Magnetic Behavior of Lentils in Water*," 15th Iranian Conference of Physics Students, 9-11 August 2007, Babol, Iran.*

Patent

- George Shaker, Mostafa Alizadeh, Safieddin Safavi-Naeini, **Hajar Abedi**, Xavier Chia, "System and Method for Sensing with Millimeter Waves for Sleep Position Detection, Vital Signs Monitoring and/or Driver Detection", US Patent App. 17/139,212.
- **Hajar Abedi**, Rohollah Bolbolnia and Reza Khanbabaei, "Human Body Motion Detector and Announcer", *Iran Patent #71792, issued October 5, 2011.*

MEDIA COVERAGE

- "A Life-Saving Jog to the Memory," Communications of the ACM, July 2020. https://cacm.acm.org/news/246237-a-life-saving-jog-to-the-memory/fulltext
- "Scientists develop sensor to save children and pets from hot car deaths," CNN, Nov, 2019. https://www.cnn.com/2019/11/11/americas/child-pet-car-sensor-scli-intl-scn/index.html
- "Scientists develop sensor to save children, pets left in vehicles," EurekAlert, Nov, 2019. https://www.eurekalert.org/news-releases/669665
- "Inexpensive Sensor to Save Lives of Children, Pets Left in Vehicles" SciTechDaily, Nov, 2019, https://scitechdaily.com/inexpensive-sensor-to-save-lives-of-children-pets-left-in-vehicles/

Service

Conference Organization

- Conference session co-chair, 19th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM 2021)
- Conference session host, 19th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM 2021)
- Head of National Robotic Competition, Babol Noshirvani University of Technology, Babol, Iran, 2012

Reviewing

- IEEE Transactions on Vehicular Technology
- IEEE Sensors Journal
- Electronics Letters
- IEEE Conferences

TEACHING EXPERIENCE

Teaching Assistants
Babol Noshirvani University of Technology, Babol, Iran **Feb 2014 - Dec 2017**

- Antenna I
- Fields & Waves
- Electricity & Magnetism

Teaching
Babol Noshirvani University of Technology, Babol, Iran **Feb 2010 - Dec 2015**

- Programming Language: MATLAB

HONORS AND AWARDS

Ranked first among master students
Babol Noshirvani University of Technology, Babol, Iran **Dec 2016**

First woman selected to be a head of National Robotic Competition
Babol Noshirvani University of Technology, Babol, Iran **May 2012**

MEMBERSHIP

- IEEE
- IEEE Antennas and Propagation Society
- Waterloo Artificial Intelligence Institute
- Centre for Intelligent Antenna and Radio Systems (CIARS), University of Waterloo

COMPUTER SKILLS

MATLAB

HFSS

Python

CST