

UPINDER KAUR

(+1)765-775-3177 ◊ kauru@purdue.edu

EDUCATION

Purdue University

Ph.D. Candidate, School of Engineering Technology

Advisor: Dr. Richard M. Voyles

West Lafayette, USA

August 2019 - present

GPA: 3.97/4.00

Indira Gandhi Delhi Technical University

Masters of Technology, Robotics and Automation

Thesis Advisor: Dr. N. K. Chauhan, Dr. Sudipto Mukherjee

Delhi, India

August 2015 - June 2017

Score: 90.05%

Amity University

Bachelors of Technology, Mechanical and Automation Engineering

Thesis Advisor: Dr. Gaurav Gupta

Noida, India

August 2011 - June 2015

GPA: 8.82/10

RESEARCH EXPERIENCE

Graduate Research Assistant and Lab Manager

Purdue University

Aug 2019 - present

Cyber-Physical System (CPS) with Robots at the Edge

- Conceptualized the first-of-its-kind reference architecture for cyber-physical systems with robots as edge devices and in-body to out-of-body communication for precision animal agriculture.
- Designed and implemented a multi-hop ad-hoc network with self-powered wireless robot edge and fog nodes for real-time animal health tracking using ultra-low-power embedded circuitry. Developed a network testbed and digital twin with electro-quasistatic modeling for the CPS.
- Created a novel framework and dataset for edge security for robots. Developed a supervised and semi-supervised malware detection framework with LSTMs and CNNs. Deployed the framework by scaling down using pruning and quantization strategies for model compression.
- Conceptualized and implemented a novel zero-shot learning framework with parallel CNNs for zero-day attacks on robots. Deployed on embedded hardware with latency and space constraints.
- Created a first-of-its-kind 3D animal HFSS model to characterize the channel response for in-body to out-of-body wireless communication. Used asynchronous RGB-D and stereo image capture with point cloud processing and stitching to build a high-resolution solid model of the animal.

Autonomous Robots and Multimodal Perception with Machine Learning

- Formulated an autonomous self-adaptive framework for learning contact-intensive tasks using a multimodal perception and exploration framework. Developed a unique deep-learning-based sensor fusion for knowledge representation for the CMAB RL agent. Validated the framework for the task of closing a zip lock bag, achieving a 96% task success rate.
- Developed a reinforcement learning framework with multimodal inputs for learning contact-intensive tasks from demonstrations without reward engineering. Used deep learning and recurrent networks to identify key transition points from expert demonstrations to infer goals and rewards for the tasks.
- Designed a unique feature engineering framework for dexterous surgical skill transfer among robots. Achieved 95% accuracy for task transfer between a non-surgical and surgical robot.
- Implemented an adaptive human detector for online path planning of a mobile robot. Used Mask RCNN with YOLO for identifying and segmenting the goal points in the path of the robot.

Research Intern

Microsoft Research

May 2021 - August 2021 & May 2022 - August 2022

Traceability in Agriculture Supply Chains

- Conceptualised and implemented a novel sensor-sparse precision traceability system (patent pending) for tracking high-yield produce across key traceability points in agricultural supply chains.

- Designed an ultra-low power traceability node with onboard sensing and communication for tracking the movement of large-volume small-size crops through their lifetime.
- Built an online movement tracker with Kalman filters, motion modeling, and maximum likelihood estimation for real-time localization. The online simulator was validated by field experiments.

PROFESSIONAL EXPERIENCE

Senior Software Engineer

Bangalore, India

Electrification and Controls, General Motors Technical Center

August 2017-May 2019

- Developed and implemented verification and validation protocols for ECU software modules.
- Directed a team of four engineers in the design and execution of ECU memory software validation.
- Formulated algorithms for Ethernet protocol validation for vehicle ECUs.
- Trained a group of 65 colleagues in Mexico and USA in internal python-based tools.

ACADEMIC AND PROFESSIONAL HONORS

Dean's Travel Grant	2022
Purdue Graduate Student Travel Grant	2022
Chancellor's Gold Medal	2017
Vice Chancellor's Gold Medal	2017
Exemplary Performance Silver Plaque	2017
Ministry of Human Resource Development (MHRD) Scholarship	2015-2017
Academic Bronze Medal	2015

KEY SKILLS

- | | |
|--|--|
| • Languages: C/C++, Python, MATLAB, Shell | • Platforms: Linux, Windows |
| • ML/AI: Pytorch, Keras, Chainer, OpenAI Gym | • Robotics: KUKA, Baxter, ROS |
| • Computer Vision: OpenCV, ZED SDK | • Software: Gazebo, Solidworks, Fusion 360 |

MENTORING AND LEADERSHIP

Purdue Undergraduate Research Mentor

2019-present

- Mentored six undergraduates during Fall and Spring semesters on cyber-physical systems research.
- The research outcomes were published in international academic journals and conferences.

Graduate Research Mentor

Summer 2021 & Summer 2022

- Mentored three students under the *Purdue-Berea Undergraduate Research Internship* program.

PUBLICATIONS

Book Chapter

- **Upinder Kaur**, Richard Voyles, and Shawn Donkin, 2020. "Future of Animal Welfare: Technological Innovations for Individualized Animal Care". In: Temple Grandin, ed., *Improving Animal Welfare: A Practical Approach*, 3rd ed. Wallingford: CABI.

Patent

- Vaishnavi Ranagnathan, **Upinder Kaur**, Peeyush Kumar, Tusher Chakraborty, and Ranveer Chandra, 2022. "Information traceability using sensor nodes for supply chains." Patent Filed.

Peer-Reviewed Conferences

- **Upinder Kaur**, Yubing Han, and Richard M. Voyles, "Hybrid Acoustic Localization with NLOS detection for in-vivo dynamic underwater environments". Submitted to International Conference on Acoustics, Speech, and Signal Processing (**ICASSP**), 2023.

- **Upinder Kaur**, and Richard M. Voyles, “CASPER: Criticality-Aware Self-Powered Wireless in-vivo Sensing Edge for Precision Animal Agriculture”. In 20th ACM Conference on Embedded Networked Sensor Systems (**SenSys**), 2022.
- **Upinder Kaur**, Z. Berkay Celik, and Richard M. Voyles, “Zero-Day Security for Robot Networks Using Zero-Shot Learning”. Submitted to International Conference on Conference on Robotics and Automation (**ICRA**), 2023.
- **Upinder Kaur**, Z. Berkay Celik, and Richard M. Voyles, “Robust and Energy Efficient Malware Detection for Robotic Cyber-Physical Systems”. In 2022 13th International Conference on Cyber-Physical Systems (**ICCPS**), 2022.
- Vaishnavi Ranganathan, Peeyush Kumar, **Upinder Kaur**, Sarah HQ Li, Tusher Chakraborty, and Ranveer Chandra. ”Re-Inventing the Food Supply Chain with IoT: A Data-Driven Solution to Reduce Food Loss.” IEEE Internet of Things Magazine 5, no. 1 (2022): 41-47.
- **Upinder Kaur**, Xin Ma, Richard M. Voyles, and Byung-Cheol Min, “Malware Detection Using Pseudo Semi-Supervised Learning”. In 3rd International Conference of Pattern Recognition and Artificial Intelligence (**ICPRAI**), 2022.
- Datta, Arunashish, **Upinder Kaur**, Victor Malacco, Mayukh Nath, Baibhab Chatterjee, Shawn S. Donkin, Richard M. Voyles, and Shreyas Sen. ”In-body to Out-of-body Communication Channel Modeling for Ruminant Animals for Smart Animal Agriculture.” In 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (**EMBC**), IEEE, 2021.
- **Upinder Kaur**, Haozhe Zhou, Xiaoxen Shen, Byung-Cheol Min, and Richard Voyles, “RoboMal: Malware Detection for Robot Network Systems”, in 5th IEEE Robotics Computing (**IRC**), 2021.
- **Upinder Kaur**, Praveen Abbaraju, Harrison McCarty, and Richard Voyles, “Clutter Slices Approach for Identification-on-the-Fly of Indoor Spaces”, in Proceedings of PRAConBE workshop of International Conference on Pattern Recognition (**ICPR**), 2020. (available on arxiv)
- Mythra V. Balakunthala, **Upinder Kaur**, Xin Ma, Juan Wachs and Richard Voyles, “Learning Multimodal Contact-Rich Skills from Demonstrations Without Reward Engineering”, in IEEE International Conference on Robotics and Automation (**ICRA**), 2021.
- Glebys Gonzalez, Mridul Agarwal, Mythra V. Balakunthala, Md Masudur Rahman, **Upinder Kaur**, Yexian Xue, Richard Voyles, Vaneet Aggarwal, and Juan Wachs, “DESERTS: Delay-Tolerant Semi-Autonomous Robot Teleoperation for Surgery” in IEEE International Conference on Robotics and Automation (**ICRA**), 2021.
- Yuanmeng Huang, Jonathan Miller, **Upinder Kaur**, Ram M.S. Ramdas, Shashank Priya, and Richard M. Voyles, “Hybridization Through Modularity: Exploring Complex Modes of Locomotion with a “Bag of Robotic Modules”, **ReMAR**, 2021.

Journals

- **Upinder Kaur**, Vaishnavi Ranganathan, Peeyush Kumar, Vikram Iyer, and Ranveer Chandra. ”Enabling Traceability in Agriculture Supply Chains using Smart Tracking” In preparation for **Science Robotics**.
- Arunashish Datta, **Upinder Kaur**, Victor Malacco, Mayukh Nath, Baibhab Chatterjee, Shawn S. Donkin, Richard M. Voyles, and Shreyas Sen. ”Sub-GHz In-Body to Out-of-Body Communication Channel Modeling for Ruminant Animals for Smart Animal Agriculture.” IEEE Transactions on Biomedical Engineering (2022).
- **Upinder Kaur**, Xin Ma, Yunameng Huang, and Richard Voyles, “Augmented Haptic Perception with Multi-Modal Sensing for Purposeful Manipulation Using Inspection-on-the-Fly.” Under review at IEEE Robotics and Automation Letters (**RA-L**).
- **Upinder Kaur**, Chan Su Han, Huiwen Bai, Barbara Roqueto dos Reis, Robin White, Robert A Nawrocki, Richard M. Voyles, Min Gyu Kang, and Shashank Priya, “Frontiers in Precision Dairy Technology I: Sensor technologies for real-time monitoring of the rumen environment”, to appear in the Journal of Dairy Science.
- **Upinder Kaur**, Rammohan Sriramdas, Xiaotian Li, Xin Ma, Arunashish Datta, Barbara Roqueto dos Reis, Shreyas Sen, Kristy Daniels, Robin White, Richard M. Voyles, Shashank Priya, “Frontiers

in Cyber-Animal Systems: Indwelling Robotics for Active Health Monitoring in Ruminants”, to appear in the Journal of Smart Agriculture Technology.

- Sangjun Eom, **Upinder Kaur**, Haozhe Zhou, David Kusuma, and Richard Voyles, “TupperwareEarth: Bringing Intelligent User Assistance to the “Internet of Kitchen Things”, in IEEE Internet of Things Journal (**IOTJ**), doi: 10.1109/JIOT.2022.3141112.
- **Upinder Kaur**, Victor M.R. Malacco, Arunashish Datta, Lei Xin, Kristy Daniels, Robin White, Shreyas Sundaram, George Chiu, Shreyas Sen, Shawn Donkin and Richard M. Voyles, “Frontiers in Cyber-Animal Systems 4: Implementation and Integration of Precision Dairy Systems” (tentative title), in preparation for Journal of Animal Science.
- **Upinder Kaur**, Victor M.R. Malacco, Arunashish Datta, Lei Xin, Kristy Daniels, Robin White, Shreyas Sundaram, George Chiu, Shreyas Sen, Shawn Donkin and Richard M. Voyles, “IoT Systems for Sustainable Animal Agriculture and Welfare: A Survey” (tentative title), in preparation for IEEE Internet of Things **IOTJ**.
- Haoguang Yang, Mythra V. Balakuntala, **Upinder Kaur**, Jhon J. Quione, Abigayle E. Moser, Ali Doosttalab, Antonio Esquivel-Puentes, Tanya Purwar, Luciano Castillo, Xin Ma, Richard M. Voyles (2022). “Occupant-centric robotic air filtration and planning for classrooms for Safer school reopening amid respiratory pandemics”. Robotics and Autonomous Systems (**RAS**), 147, 103919.
- **Upinder Kaur**, Glebys Gonzalez, Md Masudur Rahman, Vishnunandan Venkatesh, Natalia Sanchez, Gregory Hager, Yexiang Xue, Richard Voyles, and Juan Wachs, “From the DESK (Dexterous Surgical Skill) to the Battlefield - A Robotics Exploratory Study” in Military Health System Research Symposium (Military Medicine), 2020.
- Masadur Rahman, Mythra V. Balakuntala, Glebys Gonzalez, Mridul Agarwal, **Upinder Kaur**, Vishnunandan Venkatesh, Natalia Sanchez-Tamayo, Yexian Xue, Richard Voyles, Vaneet Aggarwal, and Juan Wachs, “SARTRES: a semi-autonomous robot teleoperation environment for surgery”. Computer Methods in Biomechanics and Biomedical Engineering: Imaging Visualization, pp.1-8. 2020.
- **Upinder Kaur**, Urfi Khan, Nathi Ram Chauhan, and Sudipto Mukherjee, “Collision Detection and Inverse Dynamics Control of KUKA LBR IIWA Robot”, in International Journal of Mechatronics and Automation (IJMA), Inderscience Publishers, 2020.