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Hailin Ren, Ph.D

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SUMMARY

- 9+ years experience in real-time control system design in **software**, **mechatronics,** and **mechanisms** (UAVs, Mobile Robots, Motion Capture Systems, Multi-Spectral Vision Systems)
- 8+ years experience in programming **microprocessors**, **embedded devices**, and **real time operating systems** (CPLD, Teensy, Odroid, Jetson, NuttX)
- 3+ years experience in **computer vision**, **machine learning**, and **reinforcement learning** (Autonomous Navigation, Human Pose Estimation, Human-Robot Interaction)
- Research interests include **Reinforcement Learning**, **Computer Vision**, and **Robotics/Mechatronics System Design**

PROFESSIONAL EXPERIENCE

Senior Software Engineer	**Mathworks,** Natick, MA, USA	Sep, 2020 – Present

Enhance the core infrastructure of Embedded Coder to allow users to customize production-quality C++ code.

Research & Teaching Assistant	**Virginia Tech,** Blacksburg, VA, USA	Aug 2016 - May 2020
Research Assistant	**Nanjing University of Sci & Tech,** China	Aug 2015 - May 2016
Research Assistant	**Columbia University,** New York, NY, USA	May 2014 - Aug 2020

EDUCATION

Ph.D., Mechanical Engineering	**Virginia Tech,** Blacksburg, VA, USA	May, 2020

GPA: 3.8/4.0 Advisor: Dr. Pinhas Ben-Tzvi
Dissertation Title: "Dual-Arm Manipulation with Human-Robot Interaction Using Artificial Intelligence"

M.S., Mechanical Engineering	**Columbia University,** New York, NY, USA	Dec, 2014

GPA: 4.07/4.33 Advisor: Dr. Sunil Agrawal
Thesis Title: "Modeling, Control, and Experimentation of a Quadcopter Using Differential Flatness Property"

B.S., Mechanical Engineering	**Nanjing University of Sci & Tech,** Nanjing, China	May, 2013

GPA: 3.7/4.0 Advisor: Dr. Zhian Zhang
Final Project Title: "Servo Control System Design of a Three-Cylinder Motion Platform"

TECHNICAL SKILLS

- Programming languages: Python (3+ years), C/C++ (8+ years), MATLAB (10+ years), VHDL (2 years)
- Software Packages: TensorFlow, Keras, OpenAI Gym, MuJoCo, Hyperopt, scikit-learn, OPenCV
   Robotic Operating System (ROS), Gazebo, Bullet, Point Cloud Library (PCL), Qt, LabVIEW,
   the Open Motion Planning Library, Autodesk Eagle, Altium Designer, Quartus II, Solidworks, MS Office
- Operating Systems: Linux, Mac OS, Windows, NuttX

TECHNICAL PROJECTS

Dual-Arm Manipulation with Human-Robot Interaction Using Artificial Intelligence, Virginia Tech
(May, 2018- May, 2020) *Software Skills*: *Python, Tensorflow, Keras, OpenAI Gym, Mujoco, MPI4PY*

- Designed a policy transfer framework towards scaling agents in Reinforcement Learning and achieved 90% faster convergence in dual-arm robotic manipulators (Kinova) using Deep Deterministic Policy Gradient and Hindsight Experience Replay
- Trained robotic manipulator to perform human pose manipulation for human extraction for rescue operations
- Designed Generative adversarial networks for global inverse kinematics and dynamics estimation of a robotic manipulator (Kinova) using real-world data

Human Pose Estimation and Extended Research, Virginia Tech
(May, 2017- May, 2020) *Software Skills*: *Python, Keras, MATLAB*

- Trained a parallel ensembles-based neural network for human pose estimation using Keras and COCO dataset, and decreased the processing time to 77%

- Designed a neural network and built a dataset for cricothyroid membrane detection in first-aid airway management
- Trained a robotic manipulator to perform cricothyrotomy using Portex® Cricothyrotomy kit with Reinforcement Learning techniques

Development of an Expandable 3D Motion Tracking System, Virginia Tech
(May, 2017- Dec, 2018) ***Software Skills***: ***C++, UDP, Autodesk Eagle, LabVIEW, Pozyx, Qualisys***
- Designed the PCB of the integrated system to host microprocessors and sensors
- Implemented an extended Kalman filter for sensor fusion and marker pose estimation on Teensy and communication protocol over ESP WiFi, and developed a GUI in LabVIEW to visualize the data and control the tracking system

System Design of a Hybrid Mechanism Mobile Robot for Vision Guided Autonomous Navigation, Virginia Tech
(Sep, 2016- May, 2017) ***Software Skills***: ***C++, Python, Keras, ROS, Gazebo, Qt, OpenCV, PCL, Autodesk Eagle***
- Designed the PCB of the integrated system to host the microprocessors, sensors, and peripheral devices
- Integrated ROS into the high-level controllers, Odroid XU4 and Jetson TX1 for motion control and visual feedback
- Developed a real-time obstacle avoidance algorithm using monocular vision and machine learning
- Trained DQN, DDQN, DQN with Prioritized Replay in ROS and Gazebo framework for obstacle avoidance using LIDAR

Modeling, Control, and Experimentation of a Quadcopter using Differential Flatness Property, Columbia University (May, 2014- Dec, 2014) ***Software Skills***: ***MATLAB/Simulink, C++, NuttX***
- Simulated a flatness property-based controller and trajectory planner of a quadcopter in Simulink, and implemented it on Pixhawk hardware with NuttX real-time operating system

Servo Control System Design of a Three-Cylinder Motion Platform, Nanjing University of Sci & Tech
(Sep, 2012- May, 2013) ***Software Skills***: ***Altium Designer, Quartus II, VHDL, C++***
- Designed the PCB of the integrated system to host the main processor and co-processor, sensors, and actuators
- Designed a kinematic model-based motion controller and implemented it on AVR microcontroller
- Implemented the low-level controller on Complex programmable logic device (CPLD) and designed a communication protocol between AVR and CPLD

SELECTED PUBLICATIONS

Peer-Reviewed Journals
[4] **Ren, H.**, Ben-Tzvi, P., "Learning Inverse Kinematics and Dynamics of a Robotic Manipulator using Generative Adversarial Networks", Robotics and Autonomous Systems, vol. 124, p. 103386, Feb 2020.
[3] **Ren, H.**, Ben-Tzvi, P., "Advising Reinforcement Learning Agents Towards Scaling in Continuous Control Environments with Sparse Rewards", Engineering Applications of Artificial Intelligence, vol. 90, p.103515, Apr 2020.
[2] **Ren, H.**, Kumar, A., Ben-Tzvi, P., "LOSA-X: Expandable 3D Motion Tracking System", IEEE Sensors Journal, Vol. 19, Issue 9, pp. 3288-3295, May 2019.
[1] Yanga, Y., **Ren, H.**, Yang, X., Ben-Tzvi, P., He, Z., "Optimal Interval of Periodic Polarity Reversal for Maximizing Hydrogen Production in Microbial Electrolysis Cells," International Journal of Hydrogen Energy, Vol. 42, Issue 31, pp. 20260-20268, Aug. 2017.
Peer-Reviewed Papers in Conference Proceedings
[6] Han, X., **Ren, H.**, Ben-Tzvi, P., "Autonomous Cricothyroid Membrane Detection Using Neural Networks for First-Aid Surgical Airway Management", Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference, Virtul, Online, August 17–19, 2020.
[5] Sebastian, B., **Ren, H.**, Ben-Tzvi, P., "Neural Network Based Heterogeneous Sensor Fusion for Robot Motion Planning", Proceedings of the 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2019), Macau, China, Nov. 4–8, 2019.
[4] **Ren, H.**, Qi, J., Ben-Tzvi, P., "Learning Flatness-based Controller using Neural Network", Proceedings of the ASME 2019 Dynamic Systems and Control Conf. (DSCC 2019), Park City, Utah, Oct. 8 - Oct. 11, 2019.
[3] **Ren, H.**, Feng, S., Wang, X., Ben-Tzvi, P., "Mobile Robot Obstacle Avoidance Base on Deep Reinforcement Learning", Proceedings of the 2019 ASME IDETC/CIE, 43rd Mechanisms & Robotics Conference, Anaheim, CA, August 18-21, 2019,
[2] **Ren, H.**, Kumar, A., Wang, X., Ben-Tzvi, P., "Parallel Deep Learning Ensembles for Human Pose Estimation", Proceedings of the ASME 2018 Dynamic Systems and Control Conf. (DSCC 2018), Atlanta, GA, Sep. 30 - Oct. 3, 2018.
[1] **Ren, H.**, Kumar, A., Ben-Tzvi, P., "Obstacle Identification for Vision Assisted Control Architecture of a Hybrid Mechanism Mobile Robot", Proceedings of the ASME 2017 Dynamic Systems and Control Conf. (DSCC 2017), Tysons Corner, VA, Oct 11-13, 2017.