# Laith R. Sahawneh

Pittsburgh, PA 15632
(801)-691-6902, laithsahawneh@gmail.com

## Summary

- Research and development with thorough mathematical and probability background in the broad areas of autonomous systems with emphasis on **state estimation, localization**, **path planning**, collision detection and avoidance.
- Leadership role in agile development environments from technical concept development through implementation, testing and deployment using a wide range of software tools.
- Strong analytical, organizational and interpersonal skills.

## Education

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| 2011-2016 | **Brigham Young University** <br> **Ph.D. in Electrical and Computer Engineering** | **Provo, UT, USA** <br> **GPA: 3.90/4.00** |

- Dissertation: Airborne Collision Detection and Avoidance for Small UAS Sense and Avoid System

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| 2006-2009 | **American University of Sharjah** <br> **M.Sc. in Mechatronics Engineering** | **Sharjah, UAE** <br> **GPA: 3.92/4.00** |

- Thesis: Real-Time Implementation of GPS aided Low Cost Strapdown Inertial Navigation System

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| 1997-2002 | **Yarmouk University** <br> **B.Sc. in Electronics Engineering** | **Irbid, Jordan** <br> **GPA: 3.43/4.00** (#1 in class) |

## Work Experience

**04/2022 - present**  **TuSimple Inc**. (Autonomous Trucking Technologies)  **100% Remote**
**Staff Autonomy Systems Engineer**

- Defining detailed functional and performance requirements and driving cross-functional collaboration and analysis to ensure the developed and implemented autonomous solutions are scalable, extensible and inline with product requirements.
- Supporting Safety Engineers in conducting Failure Mode and Effect Analysis (FMEA) for **Planning**, **Control**, and **Localization** subsystems, identifying and addressing performance shortfalls to ensure components are appropriately designed to perform their intended function under all conditions (SOTIF).
- Collaborating with Algorithm and Software development, Verification and Validation teams to resolve failures identified in testing to optimize and mature architecture for commercialization readiness.
- Develop MBSE artifacts needed to support development including SysML models (using tools like Cameo) of requirements, functional, logical architecture models, and ICDs.
- Performing code reviews to ensure implementation aligns with architecture and requirements.

**08/2017 - 04/2022**  **Motional AD Inc**.  **Pittsburgh, PA**
**10/2020 - 04/2022 Senior Research Scientist**

- Responsible for the full development cycle of the trajectories scoring and selection module from the design all the way to writing production level C++ code, performance metrics formulation, testing & deployment on autonomous vehicles.
- Work cross-functionality across behavior definition, perception, **localization**, and **mapping** teams to drive new features to completion.
- Led initiatives to document and organize with clarity the Planner subsystem technical manual for the Gen1 program.
- Collaborate with data and testing engineers to define performance and success criteria, to automate metrics reports and outcome and to improve processes and increase efficiency.
- Partner with testing and simulation teams to formulate test cases that ensure requirements verification coverage.
- Collaborate with the behavior definition and assessment team to better understand and define autonomous driving behavior through translating traffic laws and stakeholder requirements into formal rules.

**09/2019 -10/2020  Research Scientist**

- Design and implementation of the **localization** and perception interface adapters complete with unit tests for **Planning** and **Control** integrated stacks.
- Co-developed and implemented a number of behavior and decision making algorithms namely traffic signal and stop-sign controlled multi-way intersections, crosswalks and unprotected turns.
- Design and implementation of geometric and simple motion based jaywalker handling logic.

- Explored and evaluated the multi-way intersection handling with multi-modal rule-based and simple kinematic motion models of traffic agents prediction algorithm.
- Design and implementation of C++ class that provides methods to compute the intersection between ray and other geometrical entities (lines, circles, arcs) for the geometry library within the autonomy map package.

**08/2017 -09/2019 Automated Driving Senior Engineer**
- Developed, and co-implemented, tested and deployed searching-based path planning algorithm.
- Implemented signed distance field based collision checking approach to improve obstacles avoidance capability.
- Design and implement a sliding-window algorithm to estimate curvature, rate change of curvature, heading of each point of a given reference path using singular value decomposition (SVD) to solve least squares of affine linear systems.
- Design, implement and deploy a sliding-window spline-based path smoothing algorithm.
- Led key activities to develop, improve, deploy and test a number of features namely automatic drifting, lane change abort, circumvention to support launching a self-driving program in Las Vegas and run autonomous driving during demonstrations at the annual CES2018 showcase.
- Involved in testing, triage, logs and data review, root-cause-analysis, test engineers training to support launching the self-driving Lyft-Aptiv fleet program in Vegas (30 BMW 5 series-based autonomous vehicles).

**02, 2016-08, 2017 University of Florida (UF Research & Engineering Education Facility/AFRL)                     Shalimar, FL**
  **Post-Doctoral Associate,** Department of Mechanical and Aerospace Engineering
- Research and development in **Graph-based cooperative localization** using relative observations between robots and range and bearing measurements to landmarks.
- Implementation of the **Extended Kalman Filter** with Cholesky factorization to enhance the numerical stability of the underlying **SLAM** problem.

**2011-2016          Brigham Young University                                                                              Provo, UT**
  **Graduate Research Assistant,** Department of Electrical and Computer Engineering
- Member of Multiple Agent Intelligent Coordination & Control Lab (Advisor: Prof. Randal W. Beard)
- Research and development of **path planning**, **collision detection and avoidance** algorithms for **autonomous vehicles** with focus on the following projects:

**Jan-Dec, 2012    Passive Collision Detection And Avoidance for UAV Sense and Avoid System**, grant support from UtopiaCompression Corporation / DARPA (DARPA SBIR Phase II).

**2013-2016        Sense and Avoid for Small UAS**, grant support from the NSF I/UCRC program through the NSF Center for Unmanned Aircraft Systems.

**2006-2011          Drake and Skull International PJSC                                                          Abu Dhabi, UAE**
  **Sr. Estimation Electrical Engineer**
- Lead a team of 3+ engineers, 10+ quantity surveyors, and draftsmen.
- Estimate cost of design, build and maintenance of electrical services for mega projects (+60 Million AED projects).
- Prepare technical documents, CAD drawings and bills of quantities.

**2004-2006          Ellipse A/S                                                                                       Abu Dhabi, UAE**
  **Electrical Engineer**
- Lead a team of 2+ engineers and technicians to install, test, commissioning, start up, and handover of medical and rehabilitation systems & equipment in UAE, Kuwait, Oman and K.S.A.
- Provide expert advice and after-sales support for equipment operation, and train client's qualified-staff.

**May-Dec. 2003    Jordan University of Science and Technology                                               Irbid, Jordan**
  **Maintenance Electrical Engineer**
- Repair, troubleshoot and service science and engineering labs' equipment and devices.
- Perform periodical, and preventive service on electrical equipment and systems.

**Software Skills**

- Experience in building production level C++ software in Linux (Ubuntu) environments.
- Experienced with MATLAB and Simulink.
- Fair knowledge of Python software development.
- Wide-range use of cross-platform IDEs (e.g. CLion).
- Experienced in using LaTeX, and version control software (e.g. git).
- Fair knowledge of Model-Based System Engineering software modeling tools (e.g. Cameo and MagicDraw).

**Teaching Experience**

Fall 2015    **Graduate Teaching Assistant,** Feedback Control of Dynamic Systems (ECEn 483/ ME 431)    **BYU, Provo**
- Provide assistance and guidance for students in lab projects both analytical solutions and Matlab/Simulink demonstration.

Fall 2008/09    **Graduate Teaching Assistant,** Mechatronics Design Lab (MTR 590)    **American University of Sharjah, UAE**
- Supervised mechatronics projects for 10 students, office hours, assignment grading and solutions.

Fall 1998/99    **Undergraduate Teaching Assistant,** Theory of Semiconductors (EE 246)    **Yarmouk University, Jordan**
- Teach class tutorials for 30-45 students.

**Internship**

2001-2002    **Egyptian Telephone Company (Quicktel)**    **Cairo, Egypt**
- Assembled, tested and installed telephone sets, boxes and cabinets.
- Jumbered main distribution frame and cabinets

July-Oct. 2001    **France Telecom Long Distance (FTLD)**    **Herndon, VA**
- Provided assistance to the network capacity managers in the areas of network sizing determination and data analysis.
- Designed and programmed the team website.

**Training**

October, 2021    **Tonex Training**    **Pittsburgh, USA**
- Certificate of Attendance-Agile Systems Engineering Training Bootcamp, 4 days.

July, 2021    **Dassault Systemes, Innovations**    **Pittsburgh, USA**
- Certificate of Completion – SysML Intensive with MBSE using Cameo Systems Modeler (CSM).

March, 2006    **IEEE, Innovations**    **Dubai, UAE**
- Certificate of Attendance-Smart environment–technology, Protocols and Applications Tutorials.

May, 2006    **Better Business**    **Abu Dhabi, UAE**
- Certificate of conclusion – Development of sales culture program.

August, 2005    **Balnea Erlebnisbader Gmbh & Co. KG**    **Chieming, Germany**
- Certificate of Completion -Operation and Maintenance of Balnea Gmbh Wellness and Spa's Equipment Control Panels.

February, 2004    **Danish Dermatologic Development A/S (DDD),**    **Abu Dhabi, UAE**
- Certificate of Completion – Installation and servicing of Ellipse Intense Pulsed Light Systems (I²PL) for Hair Removal, Photo Rejuvenation, Vascular Lesions, Acne and Pigmented Lesions.

**Professional Activities and Services**

- Member of IEEE.
- IEEE-Eta Kappa Nu (IEEE-HKN) / IEEE Young Professionals.
- IEEE Aerospace and Electronics Society (AESS).
- Member of AIAA.
- Professional Member of Institute of Navigation (ION).
- Four conference talks, 2 proposals, and 30+ paper reviews.
- Named an *Excellent Reviewer* for the Journal of Guidance, Control, and Dynamics twice for the years 2016 and 2017.

**Publications**

## Book Chapter

1. **Sahawneh, Laith R.,** and Beard, Randal W., "Path Planning in the Local Level Frame for Small Unmanned Aircraft Systems", *Kinematics,* IntTech, December, 2017, pp. 56-74. DOI: 10.5772/intechopen.71895.

## Journal Publication

2. **Sahawneh, Laith R.,** Wikle, Jared K., Spencer, Jonathan, Boren Michael, Roberts Kaleo, Beard, Randal W., McLain Timothy W., and Warnick, Karl F., "A Ground-Based Sense-and-Avoid System for Small Unmanned Aircraft System," American Institute of Aeronautics and Astronautics *Journal of Aerospace Information Systems*, April, 2018, 15(8):501-517, DOI: 10.2514/1.I010627.

3. Wikle Jared K., **Sahawneh, Laith R.,** Beard, Randal W., and McLain Timothy W., "Minimum Required Detection Range for UAS Detect and Avoid Systems**,**" American Institute of Aeronautics and Astronautics, *Journal of Aerospace Information Systems,* June, 2017**,** pp. 351-371.

4. **Sahawneh, Laith R.,** Duffield, Matthew O., Beard, Randal W., and McLain Timothy W., **"**Detect and Avoid for Small Unmanned Aircraft Systems using ADS-B**,"** *Journal of Air Traffic Control Quarterly*, Vol. 23, No. 2-3 (2015), pp. 203-240**.**

5. **Sahawneh, Laith R.,** Mackie, J., Spencer, J., Beard, Randal W. and Warnick, Karl F., "Airborne Radar-Based Collision Detection and Risk Estimation for small Unmanned Aircraft Systems", *AIAA Journal of Aerospace Information Systems*, Vol. 12, No. 12, 2015, pp. 756-766.

6. **Sahawneh, Laith R.,** M.A. Al-Jarrah, K. Assaleh and Mamoun F. Abdel-Hafez, 2011, "Real-Time Implementation of GPS Aided Low Cost Strapdown Inertial Navigation System", *Journal of Intelligent and Robotic Systems*, vol. 61, No. 1-4, 2011, pp. 527–544**.**

## Peer-Reviewed Conference Articles

7. Anusna Chakraborty, Kevin Brink, Rajnikant Sharma and **Laith Sahawneh,** "Relative Pose Estimation using Range-only Measurements with Large Initial Uncertainty", In proceedings of the 2018 American Control Conference (ACC), Wisconsin Center, Milwaukee, WI, June 27–29, 2018.

8. **Sahawneh, Laith R.,** and Brink, Kevin W., "Factor Graphs-Based Multi-Robot Cooperative **Localization**: A Study of Shared Information Influence on Optimization Accuracy and Consistency", *proceedings of the 2017 International Technical Meeting of the Institute of Navigation,* January 30-1, 2017, Monterey, CA, pp. 819-838.

9. **Sahawneh, Laith R.,** Argyle E., Matthew**,** Beard, Randal W., "*3*D Path Planning for Small UAS Operating in Low-Altitude Airspace", *2016 International Conference on Unmanned Aircraft Systems (ICUAS)*, IEEE, pp. 413-419, June, 2016.

10. Willis, A. R., **Sahawneh, L. R.**, and Brink, K. M., "Benchmarking Real-Time RGBD Odometry for Light-Duty UAVs," *Proceeding SPIE Vol. 9867, Three-Dimensional Imaging, Visualization, and Display*, June 1, 2016.

11. **Sahawneh, Laith R.,** Spencer, Jonathan, Beard, Randal W. and Warnick, Karl F., "Minimum Required Sensing Range for UAS Sense and Avoid Systems", *AIAA Infotech@Aerospace Conference*, 4-8 January, 2016.

12. **Sahawneh, Laith R.** and Beard, Randal W., "A Probabilistic Framework for Unmanned Aircraft Systems Collision Detection and Risk Estimation", *IEEE Control and Decision Conference*, Los Angeles, December 15-17, 2014.

13. **Sahawneh, Laith R.,** Beard, R., Avadhanam, S., and Bai, H., "Chain-based Collision Avoidance for UAS Sense-and-Avoid Systems," *AIAA Guidance, Navigation, and Control Conference*, Boston, MA, Paper no. AIAA-2013-4995, August, 2013.

14. **Sahawneh, Laith R.** and M.A. Al Jarrah, "Development and calibration of low cost MEMS IMU for UAV applications," *Proceedings of the 5th International Symposium on Mechatronics and its Applications (ISMA08)*, Amman, Jordan.

## Patents

- ▪ Autonomous Vehicle Post-Action Explanation System, US17463438.
- ▪ Precedence Determination at Multi-way Stops, US17583769.
- ▪ Generating Notifications Indicative of Unanticipated Actions, US63281033.
- ▪ Traffic Notification System for Autonomous Vehicle Collision Avoidance and Drifting, filed to US Patent Office.
- ▪ Automatic Lateral Drifting System for Self-Driving Vehicles, filed to US Patent Office.