Dr. Levi Manring

PHD | GUIDANCE, NAVIGATION, AND CONTROL ENGINEER

617.870.1225
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Euless, TX

SKILLS

- Matlab (Expert)
- Simulink
- LabVIEW Julia
- Python
- C++ / C#
- National Instruments
- Siemens Simcenter Testlab
- Maple
- Robot Operating System
- Linux
- Unity
- Visual Studio
- Solidworks
- Ansys
- Dynasty
- Autocad
- MS Office Products

PROFESSIONAL SUMMARY

I am a Senior Guidance, Navigation and Control engineer at Lockheed Martin Missiles, Fire, and Control in Grand Prairie, TX. I have have a combined 9 years of industry experience between Caterpillar, Inc., Los Alamos National Laboratory, and Lockheed Martin (>7 years post-undergraduate degree). I have a strong technical background, including a PhD from Duke University and authorship of 4 peer-reviewed journal articles and 5 conference papers. My primary experience is in various aspects of feedback control systems including design, implementation, and testing. This includes flight control development and optimization for autonomous drones, reinforcement learning, Bayesian Optimization, and adaptive or optimal control solutions.

EXPERIENCE

Guidance, Navigation, and Control Senior Engineer (MFC)
Lockheed Martin, (Grand Prairie, TX) ’22 – Present
I am currently working on a small rapid development program performing control algorithm and simulation development. I have made significant contributions in all areas of Guidance, Navigation, and Control. These include: modifying a Navigation Kalman Filter to perform sensor fusion, designing and testing an over-constrained closed-loop control with strong coupled behavior. I have also performed modeling and simulation improvements, and have performed data analysis and assisted with multiple flight tests. I have also implemented Continuous Integration (CI) pipeline practices for my team, increasing our efficiency. I recently was selected as a STEP (Subject Matter Expert Technical Excellence Program) Member for Lockheed MFC, and have received numerous performance-based commendations. For additional details on projects I have completed at Lockheed, see Notable Projects.

Graduate Research Assistant
Los Alamos National Laboratory, (Los Alamos, NM) ’19 – ‘22
I researched multi-axis vibrational control during an extended research assistantship that began in the summer of 2019 and continued via distance at Duke University in my doctoral work. I performed modal and shaker testing, closed-loop vibration control algorithm development, and developed test comparison methods. I published two journal articles and two conference articles as part of this work.

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TESTING SKILLS

- Closed-loop control development
- Environmental Testing
- Vibration Control
- Electrodynamic Shaker
- Testing Design
- Setup
- Operation

OTHER SKILLS

- Professional Report Writing
- Presenting
- Teamwork
- Leadership
- Soldering
- 3D Printing
- DOD TS Clearance, FE Exam – Pass
- STEP Member

EXPERIENCE

Los Alamos Dynamics Summer School Fellow
Los Alamos National Laboratory, (Los Alamos, NM) '18
I worked alongside two team-members to develop an application to control a robot arm using an Augmented Reality headset. As part of this 9 week educational program, my team submitted a conference paper to the 2019 IMAC Conference. I was one of 21 students selected for this program nationally.

Graduate Research Assistant
Duke University, (Durham, NC) '17 – '22
I modeled the dynamics of a vehicle on an unknown surface with stick/slip transitions as a test case for Reinforcement Learning. I also implemented Bayesian Optimization to generate environmental testing control solutions: i.e., shaker testing of structures in a laboratory to recreate an in-situ environment. I published 3 journal articles from my and 5 conference papers from my doctoral work.

Research Assistant
University of Missouri, (Columbia, MO) '17
I modeled the efficiency of a hyraulic pump-valve-actuator system. I demonstrated advanced dynamic systems mathematical modeling, nondimensional analysis, and numerical equation solving skills. I published my work in a first-author journal paper.

Corporate Intern, Hydraulics Research Department
Caterpillar, Inc., (Peoria, IL) '15 – '16
As a summer intern, I demonstrated advanced data analysis skills using Matlab, modeled dynamic control systems, led project presentations, and delivered key results in a timely manner to my team.

Undergraduate Research Assistant, Hydraulics Lab
University of Missouri, (Columbia, MO) '14 – '16
As an undergraduate, I built and tested numerous hydraulic circuits, assisted in training of new lab recruits, and contributed test results to a conference paper.

PUBLICATIONS

Manring, Levi H, John F Schultze, Sandra J Zimmerman, and Brian P Mann. Improving convergence of the matrix power control algorithm for random vibration testing. *Mechanical Systems and Signal Processing*, 182:109574, 2023.

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SERVICE AND LEADERSHIP

Durham Schools – *Student Recruiter*

Reached out to numerous schools in the Durham area to give a presentation to middle school and high school students on what engineering is and how to make it a career. All schools had a student population that was over 50% minority students.

Duke Advanced Professional Degree Consulting Club – *Chair of Projects*

As the Chair of Projects, I recruited teams to handle consulting projects for clients. This involved interviewing, staffing, and then monitoring the teams over the course of their project. I guided the teams to help them present professional results to clients and learn the consulting skills they needed to succeed.

Love, Inc. – *Career Counselor*

Spent upwards of 100 hrs volunteering as a career counselor for the homeless. I helped many homeless and underprivileged people create resumes, apply for jobs, and obtain housing.

PUBLICATIONS

Manring, Levi H, Brian P Mann, and John F Schultze. A parameter study of the matrix power control algorithm. In *Sensors and Instrumentation, Aircraft/Aerospace and Dynamic Environments Testing, Volume* 7, pages 53–61. Springer, 2023.

Manring, Levi H, John F Schultze, Sandra J Zimmerman, and Brian P Mann. Improving magnitude and phase comparison metrics for frequency response functions using cross-correlation and log-frequency shifting. *Journal of Sound and Vibration*, 539:117255, 2022.

Manring, Levi H and Brian P Mann. Modeling and reinforcement learning control of an autonomous vehicle to get unstuck from a ditch. *Journal of Autonomous Vehicles and Systems*, 2(1):011003, 2022.

Manring, Levi H, Brian P Mann, and John F Schultze. Modal analysis of the box assembly with removable component in two configurations. In *Special Topics in Structural Dynamics & Experimental Techniques, Volume 5*, pages 271–281. Springer, 2021.

Manring, Levi H and Brian P Mann. Vehicle escape dynamics on an arbitrarily curved surface. In *Nonlinear Structures and Systems, Volume 1,* pages 141–149. Springer, 2020.

Manring, Levi, John Pederson, Dillon Potts, Beth Boardman, David Mascarenas, Troy Harden, and Alessandro Cattaneo. Augmented reality for interactive robot control. In *Special Topics in Structural Dynamics & Experimental Techniques, Volume 5*, pages 11–18. Springer, 2020.

James D Turner, **Manring, Levi H**, and Brian P Mann. Reinforcement learning for active damping of harmonically excited pendulum with highly nonlinear actuator. In *Nonlinear Structures and Systems, Volume 1*, pages 119–123. Springer, 2020.

Manring, Levi H and Noah D Manring. Mapping the efficiency of a double acting, single-rod hydraulic- actuator using a critically centered four-way spool valve and a load-sensing pump. *Journal of Dynamic Systems, Measurement, and Control*, 140(9), 2018.

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BUSINESS OWNERSHIP

The US College of Engineering Space Survey – *CEO/Owner*

Through this startup, sought to supply a data gap by contacting engineering colleges and collecting their space usage data. Collected data from 9 high-profile colleges and negotiated a total sale of $6300 for this information.

Manring Mowing – *CEO/Owner*

Owned and operated a lawn management and landscape company. Hired 4 part-time employees, accumulated over $20k in equipment, and served over 300 clients. Revenues grew from $17k in 2011 to $60k in 2013. Elected to sell 70% of clients and equipment to another landscape company in 2013. Managed the company for another year and a half before negotiating a final sale in January of 2015.

NOTABLE PROJECTS

Sensor Fusion, *Lockheed Martin, MFC*

Developed a new sensor fusion aiding capability using a navigation Kalman Filter. This capability improved autonomous drone performance.

Rotor Controller, *Lockheed Martin, MFC*

Developed a closed-loop rotor controller which overcame an unexpected hardware deficiency for flight tests. In this project, I performed system identification using test data, system modeling of rotor dynamic performance, and oversaw the implementation and testing of the closed-loop design. I performed stability analysis and developed a coupled closed-loop solution that was sufficient to exceed a pertinent customer requirement by an order of magnitude. There were numerous challenges in implementation, such as large latency and quantization errors on the feedback signal, which made modeling capability essential for tuning the controller performance. This rotor controller was not only key to the success of a flight test but I also assisted in developing a LabView version that was used at a crucial wind tunnel test.

Coupled Dynamics Modeling, *Lockheed Martin, MFC*

Developed a complex coupled-dynamics system of equations for a 12 DOF UAV system using first principles and Lagrangian mechanics. I implemented this mathematical model in simulation. This modeling capability continues to be essential for assessing performance as well as understanding how the true physics of the UAV.

CI Pipepline Integration, *Lockheed Martin, MFC*

I spearheaded an effort to integrate a Gitlab CI pipeline to increase my team's efficiency and capability to integrate with the software team. In this project, I set up a Docker container that runs Matlab and adapted the simulation to run on Linux. This gave our team the ability to automatically check code functionality and to automatically generate autocode which the software team uses in their pipeline as well. My team also uses the container to run Monte Carlo runs similar to using a cluster. The path to more regression testing and seamless integration is ongoing, but so far this effort has saved time and effort by reducing errors and speeding up code development and production.

Multi-axis vibrational control, *Los Alamos National Laboratory and Duke University*

I tested a structure called the Box Assembly with Removable Component (BARC) using both modal testing and shaker testing in two axes. The goals of this work were to find some correlation between free-free modal testing results and fixed-base. A conference paper on impedance matching between these two scenarios was published at the 2020 IMAC Conference.

Also used Bayesian Optimization to generate environmental testing control solutions: i.e., shaker testing of structures in a laboratory to recreate an in-situ environment. The goal of the this project was to learn the complex dynamics of a component under test (i.e., the BARC) and to generate a control solution that can be used to shake a component in such a way as to accurately mimic its real-use environment.

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NOTABLE PROJECTS

Augmented reality robot control application, *Los Alamos National Laboratory*

Worked with two other students to create an application to control an industrial robotic arm using an Augmented Reality headset called the Microsoft Hololens. We used Unity to develop an app that was deployed on the Hololens, which relayed gesture commands to the robot over a websocket connection. Created a customized control module in ROS to read the inputs from the user and control the robot. In addition, I also developed a Simulink node that connected with ROS over Wifi to simulate the torques on the joints of the robot and give the user torque feedback prior to executing a motion plan. The end result was a control application that was very intuitive to use and provided the user with helpful feedback. I published the results of this project with my team to the 2019 IMAC Conference.

Control of a vehicle escaping a well with an arbitrarily curved surface, *Duke University*

I modeled the dynamics of a vehicle moving on an arbitrarily curved surface. I applied a Reinforcement Learning algorithm called PILCO to this dynamic model to "train" the vehicle to escape a uniquely shaped ditch. In addition, I used this dynamic model to evaluate other control methods, such as oscillating the vehicle at its linear natural frequency and a control method similar to a human trying to push a vehicle out of a ditch by timing the application of force. I published the results from this dynamics study to the 2019 IMAC Conference. An expansion of this work including transition dynamics was developed into a published journal paper.

Mapping the efficiency of hydraulic actuator-valve-pump system, *U of Missouri*

After I graduated with my bachelor's degree, I spent a summer researching the efficiency of conventional hydraulic systems. My goal in this research was to establish a baseline to compare any improvements to the efficiency of hydraulic systems or components. I mathematically modeled an actuator-valve-pump system and performed nondimensional analysis to eliminate dependency on system/component size. I used a Newton-Raphson method to solve a system of non-linear nondimensional equations and create a four-quadrant efficiency map that describes the performance of this hydraulic system in all quasi-static modes of operation. These methods and results were published as a journal article.

Object-spotting controls development, *Caterpillar, Inc.*

I worked on a controls development project for an object-spotting/avoidance application. My role for this project was to gain an understanding of available sensor technologies that can be used to detect objects. This knowledge was gained by the testing of multiple sensors on CAT equipment at the Peoria Proving Grounds. I created analysis algorithms using MATLAB to understand the collected data and made recommendations on what sensor technologies to pursue. I also used this data to create component models that I integrated in a system model of my creation. I ran multiple simulations to demonstrate the functionality of the system model and helped create a control algorithm.

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COURSEWORK AREAS

Duke University, *Durham, NC*

Dynamic programming

Optimal control

Motion planning

Mechanical vibration

Nonlinear dynamics

Finite element method

Fourier transforms and applications

Nonlinear optimization

University of Missouri, *Columbia, MO*

Aircraft design and performance

Microfluidics

Modern Control

EDUCATION

PhD in Mechanical Engineering, Dynamical Systems Lab ('22)
Duke University
Durham, NC

M.S. in Mechanical Engineering, Dynamical Systems Lab ('20)
Duke University
Durham, NC

B.S. in Mechanical Engineering, Minors in Aerospace Engineering and Math ('17)
University of Missouri
Columbia, MO
Suma Cum Laude

REFERENCES

Available on request.