Rachel V. Vitali

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POSITION

Assistant Professor
Department of Mechanical Engineering
University of Iowa, Iowa City, IA

EDUCATION

University of Michigan, Ann Arbor, MI

Bachelor of Science in Engineering, 2015

Concentration: Mechanical Engineering

Minor: Electrical Engineering

Master of Science in Engineering, 2017

Mechanical Engineering

Doctorate of Philosophy in Engineering, 2019

Mechanical Engineering

Engineering Education Research Certificate

Dissertation Title: Advancing Inertial Measurement Unit Technology for Human Biomechanics and Engineering Education

EXPERIENCE

Postdoctoral Researcher September 2019 – August 2020
University of Michigan, Industrial & Operations Engineering, Ann Arbor

- Development of IMU- and sEMG-based metrics of performance to characterize the biomechanical and motor control capabilities required to complete scientific fieldwork to better inform space suit design, field instrument design, astronaut training protocols, and concept of operations development.

Graduate Student Research Assistant June 2015 – August 2019
University of Michigan, Mechanical Engineering & Engineering Education, Ann Arbor

- Estimation and analysis of three-dimensional rotations across the human knee using IMUs attached to the thigh and shank.
- Quantification and assessment of warfighter performance with and without load using traditional and non-traditional IMU-based metrics.
- Integration of IMUs into an undergraduate dynamics course to better teach class concepts, increase student self-efficacy, and assist intention to persist in the field.

Undergraduate Student Research Assistant May 2013 – May 2015
University of Michigan, Mechanical Engineering & Kinesiology, Ann Arbor

- Analyzed mock rifle aiming dynamics by resolving IMU data and developed metrics of performance to assess aiming and turning skill level.
- Assisted with validation of IMU-derived kinematics with those measured using optical motion capture.
- Analyzed human motion data with optical motion capture.

Senior Capstone Project September 2014 – December 2014
University of Michigan, Mechanical Engineering, Ann Arbor

- Designed and built a neurosurgical training simulator prototype for medical residents to practice deep brain aneurysm corrective surgery.
- Matched prototype characteristics to a human brain including brain anatomy (including the cardiovascular system), material properties, and geometry.

ACHIEVEMENTS

NASA–TRISH Postdoctoral Fellow, 2019-2020
ProQuest Distinguished Dissertation Award, Honorable Mention
ASME Graduate Teaching Fellow, 2018-2019
University of Vermont Invited Talk (*Inertial Measurement Unit Technology: A Gateway to Engineering Dynamics Education*), March 2019
Exercise & Sport Science Initiative Symposium Invited Talk (*The use of wearable sensors to measure knee rotations on the field of play*), October 2018
Co-inventor on a University of Michigan invention disclosure that claims the use of an inertial sensor for assessing jumping performance

LEADERSHIP AND SERVICE

Michigan Postdoctoral Association of the College of Engineering, Advisory Member
American Society of Biomechanics, Education Committee
Mechanical Engineering Graduate Council, Outreach Co-Chair
Mechanical Engineering Graduate Council, Membership Co-Chair
American Society of Engineering Education Student Chapter, Co-Vice President
ME Planning Committee, Graduate Student Representative
ME 150^{th} Celebration Planning Committee, Graduate Student Representative

PROFESSIONAL MEMBERSHIPS

American Society of Mechanical Engineering, Member
American Society of Engineering Education, Member

PUBLICATIONS AND PRESENTATIONS

Published Journal Articles

13. Davidson SP, **Vitali RV**, Cain SM, Ojeda L, Zaferiou A, Leia LA, Perkins NC. *Quantifying Warfighter Performance during a Bounding Rush (Prone-Sprinting-Prone) Maneuver.* Journal of Applied Ergonomics. (in revision)

12. **Vitali RV**, McGinnis RS, Perkins NC. *Robust Error-State Kalman Filter for Estimating IMU Orientations.* IEEE Sensors Journal. (in revision)

11. **Vitali RV**, Perkins NC. *Determining Anatomical Frames via Inertial Motion Capture: A Survey of Methods.* Journal of Biomechanics, June 2020, 106, 109832.

10. **Vitali RV**, Cain SM, Ojeda LV, Potter MV, Zaferiou A, Davidson SP, Coyne M, Hancock CL, Mendoza A, Stirling LA, Perkins NC. *Body-Worn IMU Array Reveals Effects of Load on Performance in an Outdoor Obstacle Course.* PLOS ONE, March 2019, 14(3), e0214008.

9. **Vitali RV**, Cain SM, Davidson SP, Perkins NC. *Human Crawling Performance and Technique Revealed by Inertial Measurement Units.* Journal of Biomechanics, February 2019, 84, 121-128.

8. Tammana A, McKay C, Cain SM, Davidson SP, **Vitali RV**, Ojeda L, Stirling L, Perkins NC. *Load-embedded inertial measurement unit reveals lifting performance.* Journal of Applied Ergonomics, January 2018, 70, 68-76.

7. Ojeda LV, Zaferiou AM, Cain SM, **Vitali RV**, Davidson SP, Stirling L, Perkins NC. *Estimating Stair Running Performance using Inertial Sensors.* Sensors, November 2017, 17(11), 2647.

6. Zaferiou AM, Ojeda LV, Cain SM, **Vitali RV**, Davidson SP, Stirling L, Perkins NC. *Quantifying Performance on an Outdoor Agility Drill using Foot-Mounted Inertial Measurement Units.* PLOS ONE, November 2017, 12(11).

5. **Vitali RV**, Cain SM, McGinnis RS, Zaferiou AM, Ojeda LV, Davidson SP, Perkins NC. *Method for Estimating Three-Dimensional Knee Rotations Using Two Inertial Measurement Units: Validation with a Coordinate Measurement Machine.* Sensors, August 2017, 17(9), 1970.

4. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Inertial Sensor and Cluster Analysis for Discriminating Agility Run Technique and Quantifying Changes across Load.* Biomedical Signal Processing and Control, October 2016, 32, 150-156.

3. Davidson SP, Cain SM, McGinnis RS, **Vitali RV**, Perkins NC, McLean SG. *Quantifying warfighter performance in a target acquisition and aiming task using wireless inertial sensors.* Journal of Applied Ergonomics, September 2016, 26, 27-33.

2. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Quantifying Effects of Load Carriage and Fatigue on Sacral Kinematics during Countermovement Vertical Jump with Novel IMU-Based Method.* Journal of Sports Engineering, March 2016, 19(1), 21-34.

1. Cain SM, McGinnis RS, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Quantifying performance and effects of load carriage during a challenging balancing task using an array of wireless inertial sensors.* Gait & Posture, January 2016, 43, 65-69.

Journal Articles In Preparation

3. **Vitali RV**, McGinnis RS, Perkins NC. *Method for Estimating Three-Dimensional Knee Rotations Using Two Inertial Measurement Units: Validation with Optical Motion Capture.* Sensors.

2. **Vitali RV**, Perkins NC, Finelli CJ. *Self-Efficacy and Intention to Persist Effects of Active Learning for Engineering Dynamics Classrooms.* Journal of Engineering Education.

1. **Vitali RV**, Perkins NC, Finelli CJ. *Incorporating IMU-Based Active Learning Exercises in an Undergraduate Engineering Dynamics Course.* European Journal of Engineering Education.

Conference Peer Reviewed Papers

8. **Vitali RV**, Miller MJ, Stirling LA. *Methodology for the Scientific Physical and Operations Characterization (SPOC) of Terrestrial Fieldwork.* International Conference on Environmental Systems, Lisbon, Portugal, July, 2020. (accepted)

7. **Vitali RV**, Perkins NC, Finelli CJ. *Continued Assessment of i-Newton for the Engaged Learning of Engineering Dynamics.* American Society of Engineering Education, Tampa, FL, June, 2019.

6. **Vitali RV**, Perkins NC, Finelli CJ. *Comparing Student Performance on Low-Stakes and High-Stakes Evaluations of Conceptual Understanding.* Frontiers in Education, San Jose, CA, October, 2018.

5. **Vitali RV**, Perkins NC, Finelli CJ. *Introduction and Assessment of i-Newton for the Engaged Learning of Engineering Dynamics.* American Society of Engineering Education, Salt Lake City, UT, June, 2018.

4. **Vitali RV**, Perkins NC, Finelli CJ. *Incorporating IMU Technology to Demonstrate Concepts in Undergraduate Dynamics Courses.* American Society of Engineering Education, Salt Lake City, UT, June, 2018.

3. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Inertial Sensor and Cluster Analysis for Discriminating Agility Run Technique.* 9th IFAC Symposium on Biological and Medical Systems. Berlin, September 2015.

2. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Wearable Inertial Sensor for Agility Run Performance Assessment.* SME IDETC/CIE 2015. Boston, MA, August 2015.

1. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Validation of Complementary Filter Based IMU Data Fusion for Tracking Torso Angle and Rifle Orientation.* 2014 ASME: International Mechanical Engineering

Congress and Exposition, November 14-20, Montreal, QC.

Conference Presentations and Posters

29. **Vitali RV**, Stirling LA. *Unlocking the Potential of Inertial Measurement Units (IMUs) for Human Movement Studies.* Human Factors and Ergonomics Society Annual Conference, Chicago, IL, October, 2020. (workshop)

28. Ritchie JN, Lapoine AP, **Vitali RV**, Oni IK, Soroush A, Burma JS, Dunn JF. *Internal consistency of sway measures from a head-mounted accelerometer in healthy controls.* HBI, ACHRI & Owerko Centre Summer Student Symposium (Virtual Meeting), August, 2020. (presentation)

27. Ritchie JN, Lapoine AP, **Vitali RV**, Oni IK, Soroush A, Burma JS, Dunn JF. *The potential for a head-mounted accelerometer to detect increased sway in concussed populations.* University of Calgary 14th Annual Biomedical Engineering Undergraduate Summer Research Symposium (Virtual Meeting), August, 2020. (presentation)

26. Benson E, Rhodes R, Kim H, **Vitali RV**. *Suit Sizing for Optimal Fit.* NASA EVA Exploration Workshop, Houston, TX, February, 2020. (panel)

25. **Vitali RV**, McGrath T, Miller MJ, Stirling LA. *Scientific Physical and Operations Characterization (SPOC) Capturing Physical Terrestrial Fieldwork in Context with Wearable Sensor Technology.* NASA EVA Exploration Workshop, Houston, TX, February, 2020. (presentation)

24. **Vitali RV**, Miller MJ, Stirling LA. *Scientific Physical and Operations Characterization (SPOC) Capturing Physical Terrestrial Fieldwork In Context.* Human Research Program Investigator's Workshop, Galveston, TX, January, 2020. (presentation and poster)

23. **Vitali RV**, Lapointe AP, Perkins NC. *Method for Estimating Three-Dimensional Knee Rotations with Inertial Measurement Units.* American Society of Biomechanics, Calgary, Canada, August, 2019. (poster)

22. **Vitali RV**, Cain SM, Potter MV, Ojeda LV, Davidson SP, Mendoza A, Stirling L, Perkins NC. *Load Effects on Performance for Example Obstacles in an Outdoor Course.* American Society of Biomechanics, Rochester, MN, August, 2018. (presentation and poster)

21. **Vitali RV**, Davidson SP, Cain SM, Perkins NC. *Evaluating Crawling Performance and Technique with Inertial Measurement Units.* Biomedical Engineering Society Annual Meeting, Atlanta, GA, October, 2018. (abstract)

20. **Vitali RV**, Lapointe AP, Perkins NC. *Method for Estimating Three-Dimensional Knee Rotations with Body-Worn Inertial Measurement Units.* 8th World Congress of Biomechanics, Dublin, Ireland, July, 2018. (poster)

19. **Vitali RV**, Cain SM, Stirling L, Perkins NC. *Assessing Performance Correlations Among Tasks in a Challenging Obstacle Course.* American Society of Biomechanics, Boulder, CO, August, 2017. (poster)

18. **Vitali RV**, Cain SM, Ojeda L, Davidson SP, Zaferiou AM, Perkins NC. *Method for Calculating Three-Dimensional Knee Rotations Using Inertial Measurement Units.* American Society of Biomechanics, Raleigh, NC, August, 2016. (poster)

17. Cain SM, Ojeda L, **Vitali RV**, Davidson SP, Zaferiou AM, Perkins NC. *A standard approach for using inertial measurement units (IMUs) to accurately measure human movement outside of the lab.* American Society of Biomechanics, Raleigh, NC, August, 2016. (poster)

16. Davidson SP, Cain SM, Ojeda L, **Vitali RV**, Zaferiou AM, Perkins NC. *Analysis of a drop landing task using inertial measurement units.* American Society of Biomechanics, Raleigh, NC, August, 2016. (poster)

15. Ojeda L, Cain SM, **Vitali RV**, Davidson SP, Zaferiou AM, Perkins NC. *Development of performance metrics using inertial sensors during running stair ascent.* American Society of Biomechanics, Raleigh, NC, August, 2016. (poster)

14. Zaferiou AM, Cain SM, Ojeda L, **Vitali RV**, Davidson SP, Perkins NC. *Using inertial measurement units mounted on the feet to detect performance metrics during an outdoor agility drill.* American Society of Biomechanics, Raleigh, NC, August, 2016. (poster)

13. **Vitali RV**, Cain SM, Ojeda L, Davidson SP, Zaferiou AM, Perkins NC. *Method for Calculating Three-Dimensional Knee Rotations Using Inertial Measurement Units.* Dynamic Walking, MI, June, 2016. (poster)

12. Cain SM, McGinnis RS, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Quantifying Performance and Effects of Load Carriage During Completion of a Window Obstacle Using an Array of Wireless Inertial Sensors.* American Society of Biomechanics, Columbus, OH, August, 2015. (poster)

11. McLean SG, Cain SM, Davidson SP, McGinnis RS, Vitali RV, Perkins NC. *Quantifying Field-Based Warfighter Performance Via a, Body-Worn Array of Wireless Inertial Sensors.* American Society of Biomechanics, Columbus, OH, August, 2015. (abstract)

10. Davidson SP, McGinnis RS, Cain SM, **Vitali RV**, Perkins NC, McLean SG. *Quantifying Warfighter Performance During a Prone-Running-Prone Movement Task using Wireless Inertial Sensors.* American Society of Biomechanics, Columbus, OH, August 2015. (poster)

9. Davidson SP, McGinnis RS, Cain SM, **Vitali RV**, Perkins NC, McLean SG. *Validating Inertial Measurement Units as a Method for Determining Rifle Aiming Performance.* International Society of Biomechanics, Glasgow, Scotland, July 2015. (poster)

8. Cain SM, Davidson SP, McGinnis RS, **Vitali RV**, Perkins NC, McLean SG. *Quantifying Performance and Effects of Load Carriage during a Challenging Balancing Task using an Array of Wireless Inertial Measurement Units.* International Society of Biomechanics. Glasgow, Scotland, July 2015. (poster)

7. Cain SM, McGinnis RS, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Using Inertial Measurement Units to Quantify Gait Performance.* Dynamic Walking 2014, June 10-13, Zurich, Switzerland. (poster)

6. **Vitali RV**, Cain SM, McGinnis RS, Davidson SP, Perkins NC, McLean SG. *Quantifying Rifle Aiming Dynamics with and Inertial Measurement Unit.* 7th World Congress of Biomechanics, July 6-11, Boston. MA. (poster)

5. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Validation of IMU-based Method for Tracking Warfighter Torso Angle during Up-Down Maneuver.* 7th World Congress of Biomechanics, July 6-11, Boston. MA. (poster)

4. McGinnis RS, Cain SM, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Validation of IMU-based Method for Tracking Warfighter Motion during Jumping Maneuver.* 7th World Congress of Biomechanics, July 6-11, Boston. MA. (poster)

3. Cain SM, McGinnis RS, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *An IMU-based method for quantifying gait: algorithm development and comparisons to motion capture and instrumented treadmill data.* 7th World Congress of Biomechanics, July 6-11, Boston. MA. (poster)

2. Davidson SP, McGinnis RS, Cain SM, **Vitali RV**, Perkins NC, McLean SG. *Validating Inertial Measurement Units as a Method for Determining Rifle Aiming Performance.* 7th World Congress of Biomechanics, July 6-11, Boston. MA. (poster)

1. Fox A, Cain SM, McGinnis RS, Davidson SP, **Vitali RV**, Perkins NC, McLean SG. *Ability of body worn inertial measurement units to detect changes in performance during a loaded step-up task.* American Society of Biomechanics 2014 Midwest Regional Meeting, March 4-5, Akron, OH. (poster)