

# Stanford

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## Scott Uhrlrich

Research Engineer  
Bioengineering

### Bio

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#### BIO

Scott Uhrlrich is the Director of Research in the Stanford Human Performance Lab. He is interested in understanding pathological human movement as well as peak human performance. He uses experimental techniques and computational modeling to develop tools for preventing injury, improving the efficacy of rehabilitation, and maximizing mobility for individuals with diseases like osteoarthritis. Dr. Uhrlrich has designed and patented numerous rehabilitation tools and has investigated their efficacy in clinical trials. He also develops tools for measuring human movement with commodity sensors like a cell phone camera, facilitating clinically-actionable measurements to be made in the clinic, at home, or on the field.

#### ACADEMIC APPOINTMENTS

- Research Engineer, Bioengineering
- Member, Wu Tsai Human Performance Alliance

#### PROFESSIONAL EDUCATION

- PhD, Stanford University , Mechanical Engineering (2020)
- MS, Stanford University , Mechanical Engineering (2016)
- BS, Baylor University , Mechanical Engineering (2014)

#### LINKS

- Neuromuscular Biomechanics Lab: <https://nmbi.stanford.edu/>
- Stanford Human Performance Lab: <https://ortho.stanford.edu/humanperformance.html>
- Human Performance Alliance at Stanford: <https://humanperformance.stanford.edu/>
- Restore Center: <https://restore.stanford.edu/>
- OpenSim: <https://opensim.stanford.edu/>
- Mobilize Center: <https://mobilize.stanford.edu/>

### Research & Scholarship

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#### CURRENT RESEARCH AND SCHOLARLY INTERESTS

Experimental biomechanical analysis of healthy and pathological human movement. Real-time biofeedback to modify motor control and kinematics.

Musculoskeletal modeling and simulation for estimating unmeasurable quantities during movement, like joint forces in individuals with osteoarthritis. Predictive musculoskeletal simulations to design rehabilitation interventions.

Computer vision, wearable sensing, and machine learning to develop tools that democratize biomechanical analysis and translate biomechanical interventions into clinical practice.

Quantitative MRI for analyzing the effect of non-surgical treatments for osteoarthritis on cartilage health. PET-MRI for analyzing relationships between the mechanical loading of tissue metabolic activity.

## Publications

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### PUBLICATIONS

- **OpenCap: Human movement dynamics from smartphone videos.** *PLoS computational biology*  
Uhlrich, S. D., Falisse, A., Kidzinski, #., Muccini, J., Ko, M., Chaudhari, A. S., Hicks, J. L., Delp, S. L.  
2023; 19 (10): e1011462
- **Muscle coordination retraining inspired by musculoskeletal simulations reduces knee contact force.** *Scientific reports*  
Uhlrich, S. D., Jackson, R. W., Seth, A., Kolesar, J. A., Delp, S. L.  
2022; 12 (1): 9842
- **Osteoarthritis year in review 2023: biomechanics.** *Osteoarthritis and cartilage*  
Diamond, L. E., Grant, T., Uhlrich, S. D.  
2023
- **Simulating Muscle-Level Energetic Cost Savings When Humans Run with a Passive Assistive Device.** *IEEE robotics and automation letters*  
Stingel, J. P., Hicks, J. L., Uhlrich, S. D., Delp, S. L.  
2023; 8 (10): 6267-6274
- **Ten steps to becoming a musculoskeletal simulation expert: A half-century of progress and outlook for the future.** *Journal of biomechanics*  
Uhlrich, S. D., Uchida, T. K., Lee, M. R., Delp, S. L.  
2023; 154: 111623
- **Can static optimization detect changes in peak medial knee contact forces induced by gait modifications?** *Journal of biomechanics*  
Kaneda, J. M., Seagers, K. A., Uhlrich, S. D., Kolesar, J. A., Thomas, K. A., Delp, S. L.  
2023; 152: 111569
- **A scoping review of portable sensing for out-of-lab anterior cruciate ligament injury prevention and rehabilitation.** *NPJ digital medicine*  
Tan, T., Gatti, A. A., Fan, B., Shea, K. G., Sherman, S. L., Uhlrich, S. D., Hicks, J. L., Delp, S. L., Shull, P. B., Chaudhari, A. S.  
2023; 6 (1): 46
- **Smartphone videos of the sit-to-stand test predict osteoarthritis and health outcomes in a nationwide study.** *NPJ digital medicine*  
Boswell, M. A., Kidzinski, #., Hicks, J. L., Uhlrich, S. D., Falisse, A., Delp, S. L.  
2023; 6 (1): 32
- **Peak knee joint moments accurately predict medial and lateral knee contact forces in patients with valgus malalignment.** *Scientific reports*  
Holder, J., van Drongelen, S., Uhlrich, S. D., Herrmann, E., Meurer, A., Stief, F.  
2023; 13 (1): 2870
- **Personalization improves the biomechanical efficacy of foot progression angle modifications in individuals with medial knee osteoarthritis.** *Journal of biomechanics*  
Uhlrich, S. D., Kolesar, J. A., Kidzinski, L., Boswell, M. A., Silder, A., Gold, G. E., Delp, S. L., Beaupre, G. S.  
2022; 144: 111312
- **[18F]Sodium Fluoride PET-MRI Detects Increased Metabolic Bone Response to Whole-Joint Loading Stress in Osteoarthritic Knees.** *Osteoarthritis and cartilage*  
Watkins, L. E., Haddock, B., MacKay, J. W., Baker, J., Uhlrich, S. D., Mazzoli, V., Gold, G. E., Kogan, F.  
2022

- **Changes in foot progression angle during gait reduce the knee adduction moment and do not increase hip moments in individuals with knee osteoarthritis.** *Journal of biomechanics*  
Seagers, K., Uhlrich, S. D., Kolesar, J. A., Berkson, M., Kaneda, J. M., Beaupre, G. S., Delp, S. L.  
2022; 141: 111204
- **OpenSense: An open-source toolbox for inertial-measurement-unit-based measurement of lower extremity kinematics over long durations.** *Journal of neuroengineering and rehabilitation*  
Al Borno, M., O'Day, J., Ibarra, V., Dunne, J., Seth, A., Habib, A., Ong, C., Hicks, J., Uhlrich, S., Delp, S.  
2022; 19 (1): 22
- **Assessment of Quantitative [18F]Sodium Fluoride PET Measures of Knee Subchondral Bone Perfusion and Mineralization in Osteoarthritic and Healthy Subjects.** *Osteoarthritis and cartilage*  
Watkins, L., MacKay, J., Haddock, B., Mazzoli, V., Uhlrich, S., Gold, G., Kogan, F.  
2021
- **A neural network to predict the knee adduction moment in patients with osteoarthritis using anatomical landmarks obtainable from 2D video analysis.** *Osteoarthritis and cartilage*  
Boswell, M. A., Uhlrich, S. D., Kidzinski, L., Thomas, K., Kolesar, J. A., Gold, G. E., Beaupre, G. S., Delp, S. L.  
2021
- **Evaluating the Relationship between Dynamic Na[F-18]F-Uptake Parameters and MRI Knee Osteoarthritic Findings**  
Watkins, L., MacKay, J., Haddock, B., Mazzoli, V., Uhlrich, S., Gold, G., Kogan, F.  
SOC NUCLEAR MEDICINE INC.2020
- **Rapid volumetric gagCEST imaging of knee articular cartilage at 3 T: evaluation of improved dynamic range and an osteoarthritic population.** *NMR in biomedicine*  
Watkins, L. E., Rubin, E. B., Mazzoli, V. n., Uhlrich, S. D., Desai, A. D., Black, M. n., Ho, G. K., Delp, S. L., Levenston, M. E., Beaupré, G. S., Gold, G. E., Kogan, F. n.  
2020: e4310
- **Connecting the legs with a spring improves human running economy.** *The Journal of experimental biology*  
Simpson, C. S., Welker, C. G., Uhlrich, S. D., Sketch, S. M., Jackson, R. W., Delp, S. L., Collins, S. H., Selinger, J. C., Hawkes, E. W.  
2019
- **Assessment of acute bone loading in humans using [18F]NaF PET/MRI.** *European journal of nuclear medicine and molecular imaging*  
Haddock, B., Fan, A. P., Uhlrich, S. D., Jorgensen, N. R., Suetta, C., Gold, G. E., Kogan, F.  
2019
- **Subject-specific toe-in or toe-out gait modifications reduce the larger knee adduction moment peak more than a non-personalized approach** *JOURNAL OF BIOMECHANICS*  
Uhlrich, S. D., Slider, A., Beaupre, G. S., Shull, P. B., Delp, S. L.  
2018; 66: 103–10