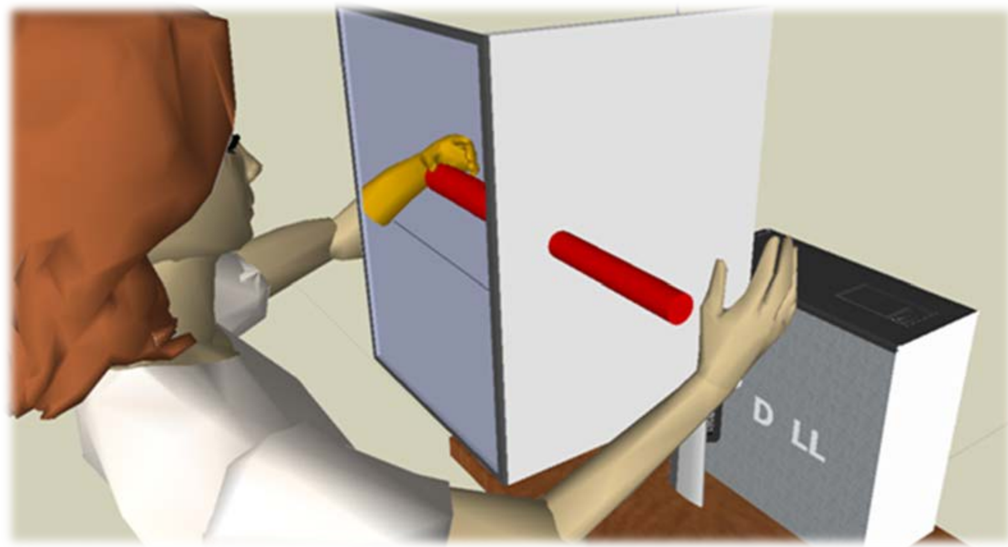

Human-Automation Interaction Research

Our research interests include haptics, computational neuroscience, human factors/ergonomics, and human-machine interaction. We apply solid mechanics, biological models, control, and statistical models to understand how the skin microstructure and mechanoreceptors create populations of neural responses that drive our tactile perception. Our unique, systems approach applies to medical and robotic domains and combines strengths from human factors and biomedical engineering. We are seeking to advance neural prosthetics/robotics, to aid people whose sense of touch is deteriorating, and to improve human-robot interfaces.

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"Exploring the neural and mechanical mechanisms underlying touch."

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Computational Neuroscience

We are using computational models and artificial sensor correlates to understand the neural basis of touch and capture the neural behavior of the skin-receptor interaction. We collaborate with neurophysiologists and surgeons to acquire electrophysiological and skin mechanics measurements. Specific modeling and analysis methodologies include solid mechanics (finite element models), statistics (response surface methodology for model fitting, ANCOVA, ANOVA, design of experiments, and logistic regression) and differential equations (models of neurons and receptor transduction), and psychophysical experimental techniques (signal detection theory, methods and laws of Fechner/Weber and Stevens). Our group has built some of the first models to combine the skin mechanics and neural dynamics for the SAI. Our models and artificial sensor correlates are critical for engineering the signaling of artificial sensors that interface directly with the human nervous system and restore touch sensitivity (e.g., in burn victims and amputees), as well as for applications in human-robotic manipulation in medicine.

Human-Machine Interaction

The work to understand the science of tactile perception is applied in the design of simulators. We are currently working with a group of clinicians and medical and nursing educators to create human-machine interfaces to train health care practitioners. Specifically, we are designing, building, and evaluating physical-computerized and virtual reality simulators. These simulators seek to train clinical palpation skills in breast and prostate screening exams and to train cognitive skills in other exams, such as chest tube insertion. The goal is to ensure that clinicians' skills are systematically trained, time-effective and highly accurate. The general methodologies used to task and work domain analysis, design of human-subjects experiments, systems modeling and statistical analysis, materials characterization, and simulator prototype construction with customized electronics, computer programming, silicone-elastomers, and metals.

RECENT RESEARCH DEVELOPMENTS

- Lesniak, D.R., Marshall, K.L., Wellnitz, S.A., Jenkins, B.A., Baba, Y., Rasband, M.N., Gerling, G.J., and Lumpkin, E.A., Computation Identifies Structural Features that Govern Neuronal Firing Properties in Slowly Adapting Touch Receptors, eLife, 3:e01448 2014
- Gerling, G.J., Rivest, I.I., Lesniak, D.R., Scanlon, J.R., and Wan, L., Validating a Population Model of Tactile Mechanotransduction of Slowly Adapting Type I Afferents at Levels of Skin Mechanics, Single-unit Response, and Psychophysics, IEEE Transactions on Haptics, 7(2):216-228; Apr-Jun 2014

RECENT GRANTS

- NIH - Peripheral Mechanisms Governing Tactile Encoding During Normal Target Remodeling
- DARPA-Reliability and Effectiveness of a Regenerative Peripheral Nerve Interface

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