Meet Our Members: Shusuke Okita

Dr. Shusuke Okita is a Post-Doctoral Fellow at Shirley Ryan AbilityLab. He obtained a Ph.D. in the Department of Mechanical and Aerospace Engineering at the University of California, Irvine this June. ASNR was pleased to welcome Shusuke as a new member in February of this year. He joined ASNR to be a part of community pursuing neurorehabilitation. Learn more about Dr. Okita's career and his research in this interview.

1) How did you get interested in science, and what steps did you take to get to your current role?

As a child, I didn't have a strong interest in engineering or science and was more interested in art and music. I eventually chose to major in engineering, but that path wasn't always clear to me. Understanding your own passion and finding a career that suits you can be difficult. But I did have an interest in understanding the intricate science or engineering behind complex mechanisms — how do we build a TV, a car, or a mobile phone? Growing up, my parents insisted that I pursue engineering. As I ventured into the world of engineering, my interest gradually shifted from basic science to the application of technology. This interest evolved over time, particularly during my Ph.D. at the University of California, Irvine, in the Department of Mechanical and Aerospace Engineering. My interactions with my advisor, Dr. David J. Reinkensmeyer, fostered my curiosity in delving into the field of neurorehabilitation.

2) What is the focus of your current research, and what are some of your findings?

My current research is focused on developing and enhancing the use of wearable sensors in neurorehabilitation. During my Ph.D. studies at UC Irvine, we explored the application of wearable sensors, specifically a wrist-worn inertial measurement unit (IMU), for upper extremity (UE) rehabilitation in stroke patients. The following key areas were investigated: better identification of hand movements, assessing the quality of movement in daily life, and the enhancement of wearable feedback.

The first study utilized a spectrogram-based convolutional neural network (CNN) algorithm for hand movement recognition using only a single wrist-worn sensor. With this sensor, we were able to successfully identify finger/wrist movements in stroke patients with about 75% accuracy. This suggests that wearable technology could significantly aid in home-based rehabilitation, particularly for hand-related healthcare.

Next, we examined how movement quality-based features could impact recovery for people after a stroke, as opposed to quantity-based features (i.e., the number of movements produced by the hand on the impaired side). The study identified that forearm speed, forearm postural diversity, and forearm postural complexity (measured by tilt angle sample entropy) increased as the UE Fugl-Meyer score (an index of UE impairment) improved. These measures were found

to best distinguish between varying degrees of impairment, leading to the hypothesis that promoting more diverse and complex movements can enhance the overall therapeutic benefit. In this study, the concept of “quality of the movement experience” (QOME) was introduced. It is a term introduced in the context of this research to describe the overall experience of movement in individuals, particularly those recovering from impairments like a stroke. QOME is not just about the number (quantity) or individual characteristics (such as speed, smoothness, or range of motion) of movements. It encompasses a broader perspective of movement experience, including diversity and complexity of movements, which can be essential for more effective rehabilitation. In the context of the research, QOME-related measures such as forearm speed, postural diversity (quantified by kurtosis of the tilt-angle), and postural complexity (quantified by sample entropy of tilt angle) were identified. These were found to increase as the UE Fugl-Meyer score (a measure of upper extremity impairment) improved, thus providing a way to quantify and track the quality of the movement experience. Further discussion and analysis will focus on application of QOME-based feedback.

Now, as a postdoctoral fellow at the Shirley Ryan AbilityLab under the supervision of Dr. Arun Jayaraman, I am extending my work with wearable sensor technologies to measure and predict lower limb recovery after stroke. Traditional methods for evaluating post-stroke recovery are often subjective and administered infrequently, making it challenging for clinicians to effectively track changes in function or impairment and to tailor treatment accordingly. Our project is designed to address these issues by developing machine-learning algorithms to automatically quantify impairments affecting gait and balance and predict future progression. Data is collected from sensors worn by patients undergoing inpatient or outpatient rehabilitation. We believe this approach will allow clinicians to objectively, precisely, and continuously evaluate both systemic and treatment-based recovery, enabling the design of more effective, personalized therapeutic strategies for their patients.

3) What are your longer-term career goals?

I would like to keep contributing to areas where I can leverage my skills, knowledge, and experience. For instance, I'm interested in confronting the challenges associated with aging populations, which are becoming more pronounced – especially in countries like my home country, Japan, with its rapidly increasing elderly population. Aging societies present a set of healthcare problems. As chronic diseases become more prevalent, physical mobility decreases and the need for long-term care rises. Cognitive issues such as dementia also increase, further complicating care and rehabilitation. These challenges require innovative solutions, combining medical knowledge with technological advancements, to improve quality of life for the elderly and to ease the strain on healthcare systems. Thus, I also hope to contribute to shaping policies and practices that address the social aspects of an aging society. This could include advocating for more inclusive community designs, promoting active aging, or enhancing training for healthcare providers in geriatric care.

To learn more, you can connect with Shusuke on Twitter and LinkedIn.