Overview:

Technology trends and concepts such as the quantified self are expected to lead to a broad array of devices worn on or carried close to the human body. Examples of such emerging devices range from wristbands and watches, over jackets, shoes, and electronic tattoos, to the widely publicized glasses. These devices present novel security challenges in that they can acquire and provide access to personal and sensitive information but often lack convenient text input capabilities and therefore do not lend themselves well to conventional password-based user authentication techniques. These devices contain, however, a variety of other sensors to monitor body movements, medical parameters, or basic touch inputs, for example, which also presents new opportunities for user authorization and authentication.

This project develops holistic models and techniques for motion-based user authentication on wearable devices. It exploits two key characteristics of wearable devices that are due to their close proximity to the human body. First, it exploits that such closely worn sensors on wearable devices can measure fine-grained body movement information. It places particular emphasis on the use of MEMS inertial sensors because their size and power profile of these sensors makes it possible to include them in most wearable devices. Second, it exploits that such closely worn devices can provide stimuli to users through communication channels such as tactile actuators, in-ear headphones, or glass like displays that are likely unobservable even for adversaries in closest proximity (e.g., shoulder surfing). Rather than focusing on one specific wearable device and associated motion characteristics such as tracking arm movements with a wrist sensor, the project conducts a comprehensive analysis of motions observable from devices worn at different body positions. It studies to what extent such measurable motion patterns have biometric qualities and to what extent they can serve as a password-like secret and how robust they are under adversarial testing. This includes examining which motion patterns are unique to individuals, which motion patterns are more easily remembered, and which motion patterns are difficult to observe and replicate for others. It then explores how stimuli from devices can serve as challenges, a motion-based analogy of challenge-response protocols, to further harden the authentication schemes against observation and imitation by and adversary. It also studies how the proposed processing algorithms can be efficiently implemented on wearable devices with reasonable lantecies. With this approach, the project seeks to develop holistic design methodologies, tools, and algorithmic approaches that are applicable to broad classes of wearable devices.

Intellectual Merit:

The intellectual merit of the proposed activities derives from the following research activities: (i) exploring the design space of sensor-based user authentication mechanisms on wearable devices, (ii) designing protocols that incorporate unobservable stimuli as well as low-energy processing algorithms and communications techniques for authentication mechanisms to support substantial battery lifetimes, (iii) developing system support that facilitates efficient implementation of a variety of motion sensing and matching algorithms suitable for devices at different body positions, and (iv) integrating results into development tools as well as prototype and demonstration systems for a variety of wearable devices.

Broader Impacts:

Secure and convenient authentication techniques for wearable devices can be expected to bring significant societal benefits for protecting sensitive or personal information sensed by these devices as well as remote data accessed through these devices. The project will engage industry to increase the chance of technology transfer, drawing on existing working relationships with companies such as Qualcomm. Project results will also be disseminated through scholarly publications and at industry day events. The project also includes a set of integrated education activities that will offer research internships to NJ high school students and undergraduates, engage underrepresented groups, and enhance curricula.