Next Generation Orally-Activated Multi-Modal Assistive Technologies for People with Severe Disabilities

ABSTRACT

Fig.1 Intra-oral TTK

The oral cavity and tongue have been demonstrated to be effective physical sites for the activation of technologies, particularly for providing inputs to devices. For individuals with severe disabilities such as quadriplegia, devices that are activated by the tongue hold tremendous promise as a critical assistive technology for interacting with computing devices, cyber-physical systems such as robotic arms, consumer electronics and home appliances and utilities. The intra-oral device, TTK, first introduced in the late eighties, [Fig. 1], was a highly successful platform where a nine button key cell phone pad was inserted in a dental bridge, and allowed wireless communication for the wearer with their wheel chair or immediate environment. Even though the TTK is still in use today by more than 200 patients, the technology has become obsolete. Through a cross-campus collaborative effort between Stony Brook University Health Sciences, Medicine, Engineering and Computer Science, specifically, Human Computer Interaction (HCI), we propose to significantly update this platform and transform it into an integrated, multi-modality blue tooth driven integrated system, namely, the Bluetooth Remote Orally-Operated Keypad (BROOK). The system which will integrate oral, eye-gaze, and voice technologies with robotic control and manipulation, will provide an unprecedented degree of independence, and via integration with telemedicine platforms, would provide two-way communication with medical providers, as well as widely disseminated to potential users. The proposed research and development will involve three aims: 1) Prototype development of the BROOK intra-oral device and the establishment of its effective use in the oral cavity as a means of communication, independence, and health monitoring; 2) Interfacing BROOK with innovative HCI modalities to allow users to interact with additional technological devices, such as computers, smart phones, consumer electronics, home appliances and assorted utility controls with a high degree of ease and efficiency than was hitherto possible. This will include the development of intra-oral gestures for interfacing with a wheelchair mounted robotic arm and 360^{o} imaging; 3) Designing a clinical surveillance workflow for fever detection and response, based on the temperature, hydration, and vital signs readings emanating from BROOK. The implications of this research are strong, providing quadriplegics with an unprecedented level of functionality aimed at fostering greater independence and establishing a mechanism for health-related monitoring and communication previously nonexistent.

After establishing a proof-of-concept of the feasibility of this technology with the seed grant, we plan to apply for a large grant to the National Institute of Disability, Independent Living, and Rehabilitation Research (NIDILRR) and the NIH that will allow us to integrate a broad range of novel functionality and interfaces that can not only monitor health and wellness of BROOK users but also enable them to experience a greater degree of independence such as being able to seamlessly communicate with computing devices and independently operate robotic arms attached to wheel chairs, among others. This project represents a cross-campus collaboration between engineers, computer scientists, health care providers and the target population, focusing on the most innovative frontiers of healthcare designed for a population notoriously marginalized from many aspects of society.