Journal of Diabetes Science and Technology
2014, Vol. 8(1) 3–5

DOI: 10.1177/1932296813518858
dst.sagepub.com
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New Wearable Computers Move Ahead: Google Glass and Smart Wigs

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Keywords
computer, diabetes, Google glass, wearable, wig

Sony Corporation announced in November 2013 receipt of a US patent for a wig that is a wearable computing device.[1] This system, which is not being produced, consists of: (1) a wig made of hair that covers at least part of the head of the wearer, (2) 1 or more sensors for providing input data, (3) a processing control unit coupled to the sensors for processing input data, and (4) a communication interface that is coupled to the processing unit to communicate with a second computing device. The sensors, control unit and communication interface would be hidden and the second computing device would be remotely separated from the wearable computing device. The wig could also contain actuators to receive input from the processing unit and provide tactile feedback signals to the user. The wig could contain such sensors as a GPS, an ultrasound to detect objects near the wig, a camera to detect objects near the wig, an accelerometer to detect head motion, and a laser pointer. All these inputs could be transmitted to a second computing device that can control or be controlled by the wig system.

The Sony wearable computer wig can contain an actuator vibration motor device or a device that can generate a small electric shock in extreme situations to provide feedback signals or warnings. This could include warnings about hypoglycemia or hyperglycemia if the device was connected to real time glucose information. The vibration devices situated in 4 different directions on the head could be used to provide information to the wearer about which direction to walk. Motion, pressure, or strain gauges embedded in the wig could measure head motion and measure gestures such that the user could control a remote computer or smartphone by way of facial gestures.

Patients with diabetes were the first to use wearable medical devices for real-time health assessment, called continuous glucose monitors. We are now seeing introduction of many types of wearable computers which can monitor physiologic processes or disease treatments.[2] One of the closest to widespread distribution is Google Glass. The Google Glass system is a wearable Android-powered computer with an optical head-mounted display that displays information in a smartphone-like hands-free format in one's field of vision, takes pictures with a camera built into spectacle frames, and communicates with the Internet via voice commands, head tilts, and a touchpad on the side. It can make video calls, facilitate hands-free web searching, and run special apps. Eventually this wearable computer will likely be designed to accommodate wirelessly transmitted data from blood glucose (BG) monitors, continuous glucose monitors (CGMs), and insulin pumps. The computing portion of the device will be ready to take autonomous actions because of decision support software.

The term "glassomics" has been created to describe a branch of medical informatics concerned with the study and development of in vivo, ex vivo, and in silico applications for Google Glass, smart watches, and sensors. Qualcomm Life, Inc and Palomar Health in Escondido California have announced the launch of the Glassomics incubator to promote innovation in this area of medicine. The goal will be to develop Google Glass applications, or "glassware," for such areas as augmented reality guided clinical applications, physiological monitoring, genomic information mapping, and consumer health and wellness. Many applications for diabetes will be possible with the use of Google Glass.[3]

The most important metric for diabetes that benefits from real-time alerts to patients is hypoglycemia. A wig or another type of wearable computer, such as Google Glass, can receive information from a BG monitor that transmits wirelessly and automatically and notifies the wearer through sensory stimulation. The wig can contain a vibrating motor or an electroshock generating device pressing on the scalp. Google Glass contains a visual projection that can be programmed to present warning alert messages.

Another device that uses vibration to indicate a message is the SurroGait Rx system by Orpyx in Canada. This device under development contains a pressure-sensing insert for a shoe that can accurately detect pressure.[4] It also consists of a low-profile, ergonomic back pad. Pressure information

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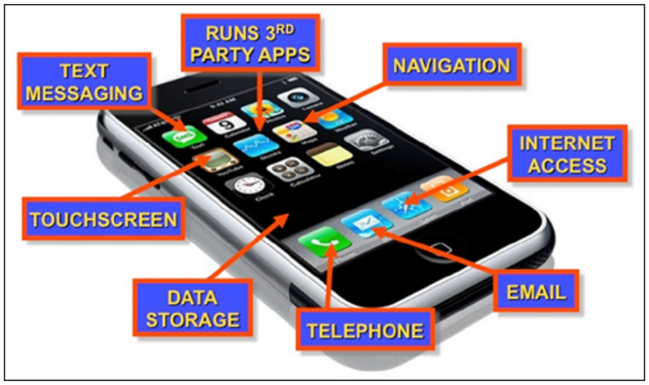

Figure 1. Features of a Smartphone.

collected in the shoe is sent wirelessly to the back display. The back display is an actuator that transposes sensation (that would otherwise be felt on a foot) onto the back, so that users can "feel" their feet through the back. The idea is to use the principle of neuroplasticity to rewire the brain to interpret the feeling on the back as corresponding to pressure against the feet.

BG monitors and CGMs will eventually routinely transmit data wirelessly to smartphones, the Internet, and receivers in wearable computers. At that point, quantitative measures of hypoglycemia will be able to trigger alerts in wearable computer systems. These systems will also receive and send alerts in response to signals from physiological qualitative hypoglycemia monitors.

Abnormal EKGs and abnormal EEGs are associated with hypoglycemia and the type of information that can be gleaned from sensors and software that can identify hypoglycemia form these measurements will become incorporated into wearable sensors. I expect that we will eventually see sophisticated actuator responses to hypoglycemic signals generating tactile alerts and if the response is managed by a smart computer worn as an actuator, the software controller for a closed loop system could end up having to justify its niche in the marketplace. Better sensors are coming. Better actuators that will provide tactile and auditory alerts are starting to appear.

Activity tracker wearable devices are becoming more sophisticated and useful for people with diabetes who want to keep track of exercise related data. These devices count the number of steps one takes, and some also keep track of distance traveled and calories burned. Activity trackers can contain hardware for tracking heart rate and in some cases can link with Wi-Fi-enabled scales, blood pressure monitors, and other devices to provide assist a patient with self-management. Paired with a companion web account or mobile app, they can provide insight into the habits that make up a patient's lifestyle.

These portable wearable sensors and actuators are mHealth devices, representing the use of mobile communications devices for health services and information. Mobile phones, patient monitoring devices, implanted or worn sensors, tablets, personal digital assistants, and other wireless devices can be part of mHealth systems. A smartphone is a cellular phone that can also perform many functions of a computer by running applications (apps) including Internet accessing, emailing, and text messaging. A smartphone provides instant access to information and instant capacity to communicate (Figure 1). Since the original smartphone, the iPhone, was launched in 2007, these devices have attained overwhelming popularity. Currently there are approximately 150 million smartphone users in the United States[5] and 1.5 billion users worldwide.[6]

Diabetes is a disease of numbers and smartphones are an excellent tool for storing, managing, and transmitting blood glucose, dietary, and exercise data. See Figure 1 for features of most smartphones. Mobile applications for smartphones have been developed for diabetes self-management and can track self-monitoring of blood glucose data, calculate insulin dosages, track doses of insulin or other diabetes medications, or track other data related to diabetes such as weight, diet, activity, or blood pressure.[7] One of the limitations of using smartphones for diabetes data tracking is the need for patients to manually enter BG data into their smartphone. New technologies are now being developed that can transform this data entry process into automatic transfer of data into a smartphone (via cable or wirelessly) or directly to the cloud for web storage.

As wearable continuous real-time CGM systems become more popular, we will see increasing numbers of patients wearing computers and using them to help manage their diabetes. Wearable computers are moving ahead for diabetes.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: DCK is a consultant to Google, Insuline, Sanofi, and Voluntis.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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