Friedrich-Alexander-Universität
Department Artificial Intelligence
in Biomedical Engineering | AIBE

Machine Learning
Data Analytics

Chapter 10:

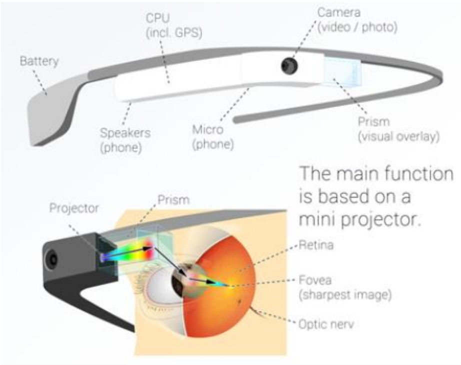
Wearable Technology: Human Body as a Design Space

Overview

Output method: Displays

There are several methods to output information from the device to the human. One possibility are displays, which are for example used in Google Glasses. In order to produce an image to the human eye that can be discriminated by human vision, a lot of optic is involved.

Google Glasses 2014



Google Glasses 2020

There is a limitation regarding the use cases as people have restricted interaction possibilities with the device. Nevertheless, there are still applications in education, healthcare and industry where the glasses are used.

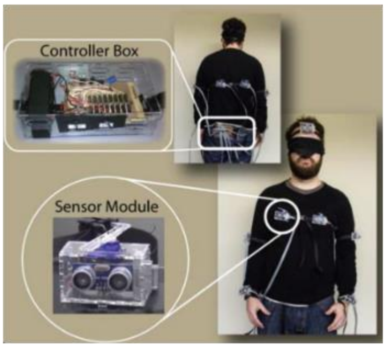
What application would be a reason for you to pay 1000$ for Google Glasses?

Many Google Glass users have faced some negative reactions from other people that have privacy concerns about the wearable device. An alternative to these glasses are lenses. They can be directly applied to the human eye. However, there are new challenges like the small size, where to put the battery and how to interact with it. Mojo vision works on such lenses. In 2019 they introduced the first prototype of the Mojo lens. In 2022, the Mojo-Vision-CEO tested a further developed version of that prototype for the first time ever.

Output method: Haptic

Victor Mateevitsi, Brad Haggadone, Jason Leigh, Brian Kunzer, and Robert V. Kenyon. 2013. Sensing the environment through SpiderSense. In Proceedings of the 4th Augmented Human International Conference (AH '13). ACM, New York, NY, USA, 51-57.

Body as Space



You can also use the upper body as the design space and collect different haptic information from this area. You could for example use a distance sensor that augments human perception. Via vibration feedback at specific parts of the body, the wearer's near environment can be projected on the skin and allows for directional awareness of objects [1].

Another application to use haptic information is electronic muscle stimulation. Here, you receive information from the environment and try to understand the movement target of the person. You can then apply stimulations directly to the muscle of the leg to change the position.

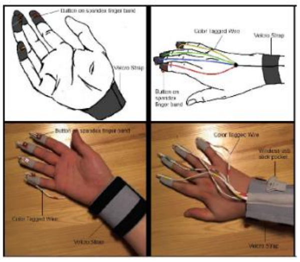
Actuate musculus sartorius that turns the leg

Input methods

Text input

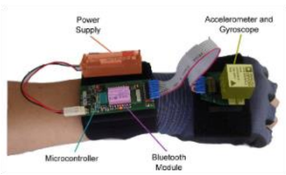
Base4-Textinput:

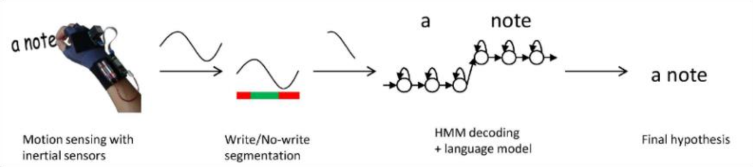
Every finger is encoding a single signal. If you do the right kind of movement, you can encode a certain letter. If you learn how the different movements for the different letters are, you can actually write.



Accelerometer and Gyroscope: Inertial Sensors.

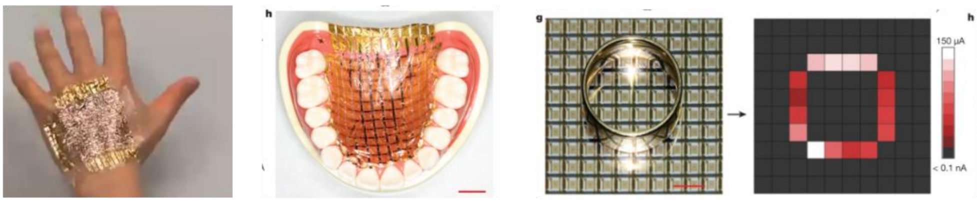
You can use inertial sensors around your wrist to do motion sensing. After you apply some segmentation and do HMM decoding you receive the text that you wrote. You just have to write as when you have a pencil in your hand.





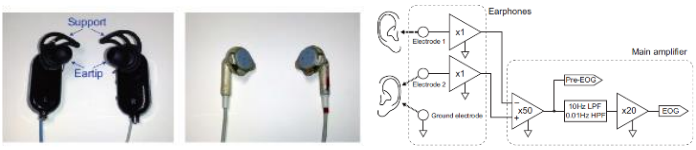
Touch foil

A touch foil can be used on the whole body as an input technology interface. Possible use cases are in your hand or maybe as a smart chewing device in your mouth. The touch foil is 2 Microns thick, weights 3g/m^2, has a bend radius of 5 Microns and is touch-sensitive [2].



Eye Gaze

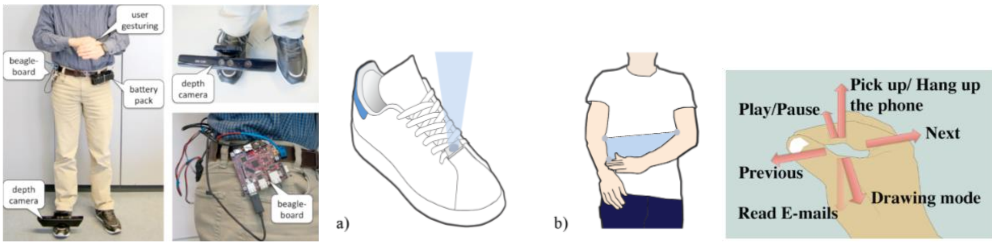
To track the movements of your eyes you can use special glasses (left image [3]). An alternative to glasses as an eye gesture input device are earphones (right image [4]). Using the EOG method, movements in the eye can be detected, as an electric signal is produced. You can use this for explicit input e.g selecting something out of a visual interface or for implicit input, e.g. importance (number of fixations), cognitive load (Pupil size), attention (Dwell time). When you use it to select something out of the visual interface, you have to consider the midas-touch problem.



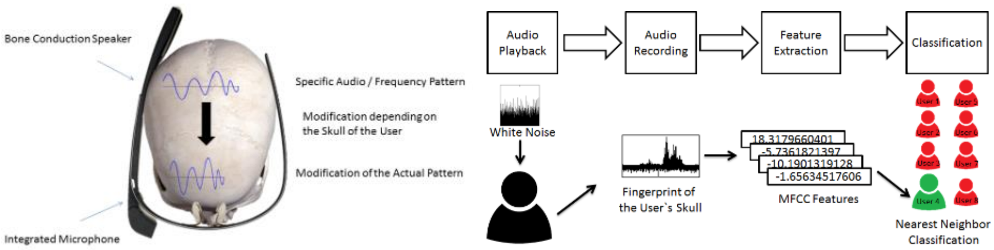
Gesture Input

Gesture input is typically done with the hand (e.g. controlling the smartwatch), but can also be done with the feet or even the head [5].

feet or head as well

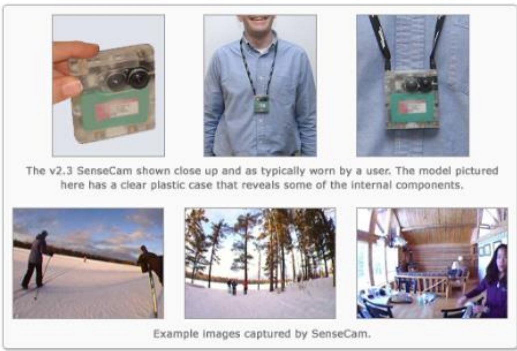


The head gesture can be used for implicit authentication [6].



Body camera

Body cameras monitor what is happening around you. An example of a body camera is the sense camera (left image) [7]. It takes pictures passively and is triggered every 30 seconds. Another example is the narrative clip 2 (right image). It has a built in GPS, takes 2 pictures every minute and has a storage capacity of 4000 pictures [8].



Think about use cases for the touch foil, the body camera, and gesture input.

Sensors

Depending on the use case and the application different sensors are used. Some commonly used sensors are: [9]

linear rotational.

Accelerometer, Gyroscopes, Magnetometers:

motion & orientation.

Accelerometers, gyroscopes and magnetometers are used for detecting motion and orientation. Accelerometers measure linear motion. Gyroscopes measure rotational motion and magnetometers measure the direction, strength or the relative change of a magnetic field at a particular location.

GPS:

GPS is used in many devices for scanning and informing users of their location. Information is sent to a satellite to quantify exact location and time. This serves as a transmitter and a receiver in which the information is returned to the sensor to notify the location.

Heart rate sensors:

Photoplethysmography.

There are various techniques and sensors that can be used in wearables to measure the heart rate. One method is using Photoplethysmography sensors. They use a light-based technology to measure the blood volume.

Temperature sensors:

Wearable temperature sensors are digital thermometers that measure the skin temperature and can be used in wrist watches, medical patches and smart clothing.

Pedometers:

step's. electric & mechancal,

Pedometers can count the user's steps while running or walking. There are electrical and mechanical pedometers. Today advanced Pedometers depend on MEMS technology. This permits more accurate detection of steps and fewer false positives.

Pressure sensors:

When pressure is applied to the sensor, the circuit causes a change in the resistance. They can be for example used for pulse wave monitoring,

Patel, S., Park, H., Bonato, P. et al. A review of wearable sensors and systems with application in rehabilitation. J NeuroEngineering Rehabil 9, 21 (2012).

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[2] Ultrathin and lightweight organic solar cells with high flexibility Martin Kaltenbrunner, Matthew S White, Eric D Głowacki, Tsuyoshi Sekitani, Takao Someya, Niyazi Serdar Sariciftci, Siegfried Bauer. Nature Communications 3, 770, 2012

[3] https://www.tobiipro.com/de/produkte/tobii-pro-glasses-2/

[4] Hiroyuki Manabe, Masaaki Fukumoto, and Tohru Yagi. 2013. Conductive rubber electrodes for earphone-based eye gesture input interface. In *Proceedings of the 17th annual international symposium on International symposium on wearable computers* (ISWC '13). ACM, New York, NY, USA, 33-40

[5] Bailly, G., Müller, J., Rohs, M., Wigdor, D., & Kratz, S. (2012, May). ShoeSense: a new perspective on gestural interaction and wearable applications.

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[7] Steve Hodges, Lyndsay Williams, Emma Berry, Shahram Izadi, James Srinivasan, Alex Butler, Gavin Smyth, Narinder Kapur and Ken Wood, SenseCam: a Retrospective Memory Aid In Dourish and A. Friday (Eds.): Ubicomp 2006, LNCS 4206, pp. 177 – 193, 2006. © Springer-Verlag Berlin Heidelberg 2006.

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[9] https://jneuroengrehab.biomedcentral.com/articles/10.1186/1743-0003-9-21