DES535
Ubiquitous Computing

Dr. Pragma Kar
Assistant Professor
Department of Human-Centered Design

INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY **DELHI**

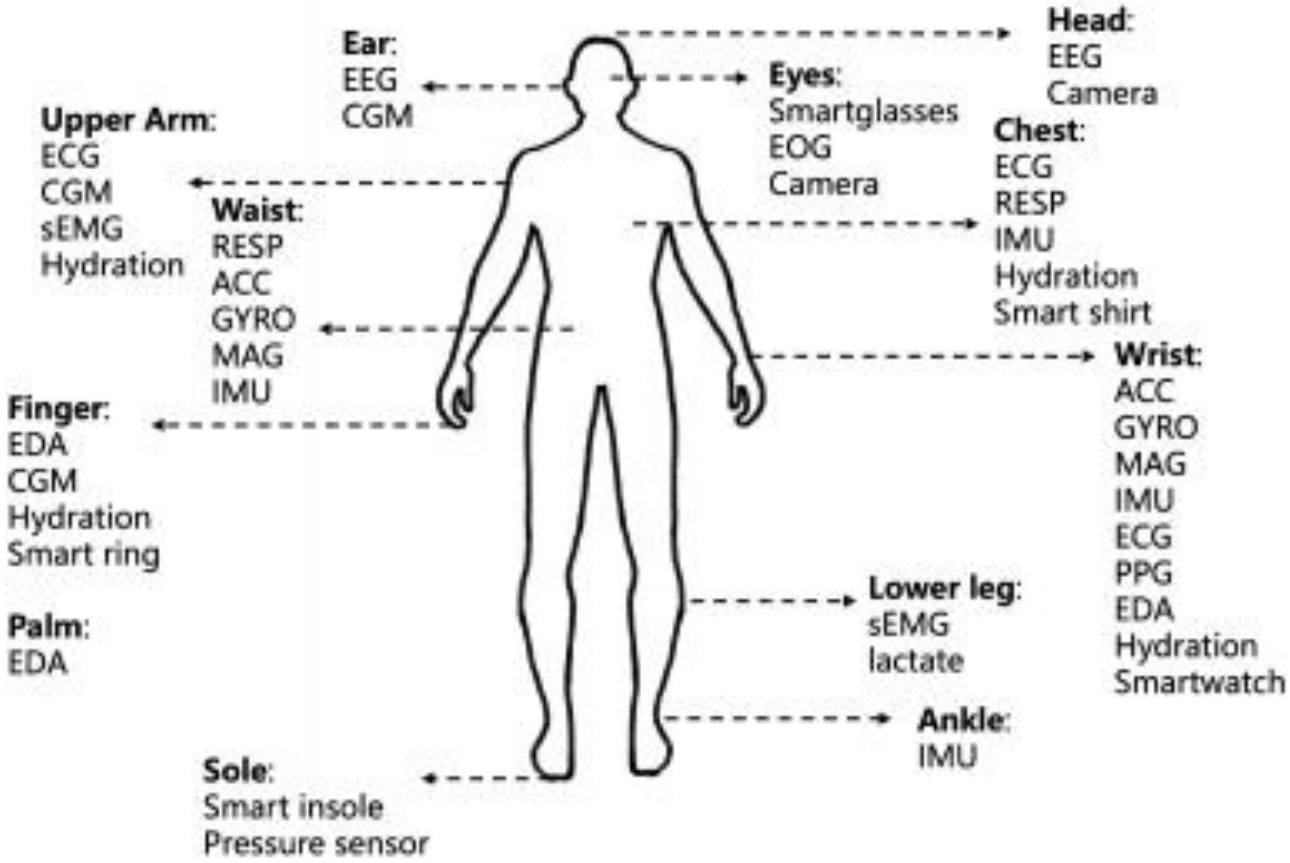
Google Classroom Code : pcwnf5t

Aspects of Ubiquitous Computing

Module II

Wearable Sensors

- Motion
- Bioelectric
- Biometric
- Environmental
- Optical and chemical
- Flexible



https://dl.acm.org/doi/full/10.1145/3648469

Wearable Sensors

- **Motion**
  - ACC : Accelerometers are capable of measuring the intensity and type of activities, such as detecting falls and monitoring walking patterns.
  - GYRO : Gyroscopes are used to measure orientation and angular rate, such as detecting ankle sprains and monitoring falls.
  - MAG : Magnetometers are capable of measuring to measure the surrounding magnetic field.
  - IMU : Inertial Measurement Unit that combines multiple ACCs and GYROs together.
  - MIMU : IMUs with MAGs. Magneto-Inertial Measurement Units are used in various applications of human activities, such as disease classification, gait detection, rehabilitation monitoring, athlete performance evaluation, and training optimization.

https://dl.acm.org/doi/full/10.1145/3648469

Wearable Sensors

- **Bioelectric**
  - Acoustic Sensors : The acoustic sensor, also known as the microphone, is the sensor that detects sound waves and converts them into electrical signals. It is designed to capture and measure acoustic vibrations in the surrounding environment. Used in smartwatches, smart gloves, etc for call handling, commands, etc.
  - Electrocardiography (ECG) sensors typically consist of electrodes that can record the electrical heart signals and produce a visual representation of the heart's rhythm and activity.
  - Electroencephalography (EEG) : The human brain produces different brain signals all the time, and the response of EEG signals to emotional state fluctuations is sensitive and real time. EEG wearable sensors usually decode the brain's neural activity through head-mounted interface sensors.
  - Electrooculography (EOG) sensors measure the electrical potentials generated by the movement of the eyeball. Electrodes placed around the eyes detect the changes in electrical signals as the eye moves, allowing for the determination of gaze direction
  - Electromyography (EMG) sensor measures muscle electrical activity by detecting/amplifying myoelectric signals from contraction/relaxation.
    - Surface EMG (sEMG)
    - intramuscular EMG (iEMG)
  - Electrodermal Activity (EDA) sensors, also known as Galvanic Skin (GSR) response sensors, usually implemented in the palm or finger, measure the electrical potential difference resulting from changes in sweat gland activity. Used for anxiety monitoring and stress detection.

https://dl.acm.org/doi/full/10.1145/3648469

Wearable Sensors

- **Biometric**
  - Hydration Sensors : Common hydration sensors include impedance-based sensors, which estimate hydration by measuring the electrical resistance of body tissues; optical-based sensors, which estimate hydration by analyzing the interaction of light with the skin; and sweat-based sensors, which measure sweat electrolyte concentration.
  - Lactate Sensors. Lactate is a byproduct of anaerobic metabolism and is commonly used as an indicator of physical exertion and metabolic stress.

https://dl.acm.org/doi/full/10.1145/3648469

Wearable Sensors

- **Environmental**
  - TEMP: Temperature sensors are essential in our daily life, often embedded in wearable devices such as smartwatches and smart rings to help people continuously monitor their daily body temperature.
  - Pressure Sensor : pressure sensor embedded in the smart
  - insole provides valuable information by analyzing the pressure generated during gait activities. Some are embedded into wearable gloves that detect grip strength and muscle activity.

https://dl.acm.org/doi/full/10.1145/3648469

Wearable Sensors

- **Optical and chemical**
  - Photoplethysmography (PPG) sensors are a typical optical sensor that uses light to measure changes in blood volume in the microvascular tissue beneath the skin, mainly placed on the wrist and integrated into the wristband. Can be used for monitoring diseases, such as automatic detection of seizures, blood pressure monitoring, sleep apnea monitoring, etc.
  - Continuous Glucose Monitoring Sensors : Available examples include near-infrared C8 MediSensors, radio wave GlucoWISE, and Freestyle LibrePro, which analyzes electrochemical signals.

https://dl.acm.org/doi/full/10.1145/3648469

Applications of Wearables Sensors

- Medical : Qardio, Neurosky, Abbott Diabetes Care, iTBra, and ADAMM, eSight, OrCam, dbGLOVE, and Lechal Shoes.
- Wellness : LUMOBack, Netatmo JUNE, Violet.
- Sports : Runsense, StretchSense.
- Communications : Smartwatches, wristbands, smartrings, smart T-shirt.
- Glamor : Lightsensitive dresses, motion-sensitive dresses, stretch-sensitive dresses from Rainbow Winters.
- Business : Nymi band, NFC Ring, Digital Dreams wristbands, and MagicBands.

https://dl.acm.org/doi/pdf/10.1145/3133837

Privacy

- *Privacy is the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others.*

  - Alan Westin

- Types of Privacy:
  - Territorial : A smart wall transferring data about the resident to some remote insurer.
  - Bodily : A smart shirt transferring health data to the medical practitioner.
  - Communication : A smart watch analyzing your chats to understand your mood and alerting your therapist.

Privacy

- Borders of privacy breaches:
  - **Natural** : Physical limitations of observations, such as walls and doors, clothing, darkness, but also sealed letters and telephone calls. Even facial expressions can form a natural border against the true feelings of a person.
  - **Social** : Expectations about confidentiality for members of certain social roles, such as family members, doctors, or lawyers. It is also includes expectations that your colleagues will not read personal fax messages addressed to you, or material that you left lying around the photocopy machine.
  - **Spatial** : The usual expectations of people that parts of their life, both in time and social space, can remain separated from each other.
  - **Border due to transitory effect** : It describes what is best known as a fleeting moment, an unreflected utterance or action that one hopes gets forgotten soon, or old pictures and letters that one puts out in the trash.

Activity (Data Uploading)

Develop an app that records the instantaneous sensor data to a google form.

https://docs.google.com/forms/d/e/1FAIpQLSf9N0pIMl5hTn6fHDE5fsBuPSOsjqPSJ7EHnkjwUc0hfLZ2ew/~~viewform~~?usp=pp_url&entry.12540379=**1111**&entry.843881258=**datax**&entry.436787372=**datay**&entry.1128463996=**dataz**

https://docs.google.com/forms/d/e/1FAIpQLSf9N0pIMl5hTn6fHDE5fsBuPSOsjqPSJ7EHnkjwUc0hfLZ2ew/formResponse?submit=Submit?usp=pp_url&entry.12540379=**1111**&entry.843881258=**datax**&entry.436787372=**datay**&entry.1128463996=**dataz**