Micro-module B: Mobile Sensing Application

B1- Mobile Sensing for Environmental Features and Well-being

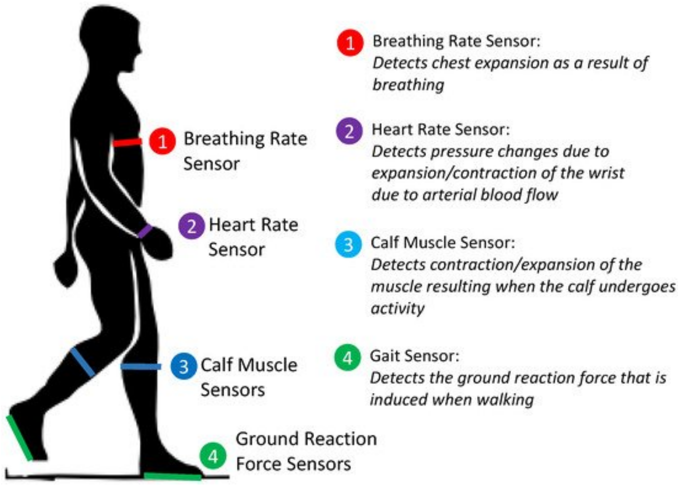
Measurement methods such as environment-installed sensors and questionnaire surveys have been widely employed in data gathering of human physiological and psychological states for mental healthcare. However, due to the high strain on individuals, these systems are impractical for continuous data collecting. Sensing via tiny sensors and wearable devices has recently become simple, due to better sensing technology with IoTs. This tutorial will give you a brief introduction to different types of wearable sensors and pratical research in the urban studies field.

1. Introduction of the wearable Sensors

1.1 Wearable Sensors

With the growth of big data, artificial intelligence, and robots, there is a growing interest in developing computer systems that can comprehend human emotional states. These emotional algorithms promise to elevate Human-Computer Interaction (HCI) to a new level, allowing humans and technology to coexist in a well-managed and natural symbiosis.

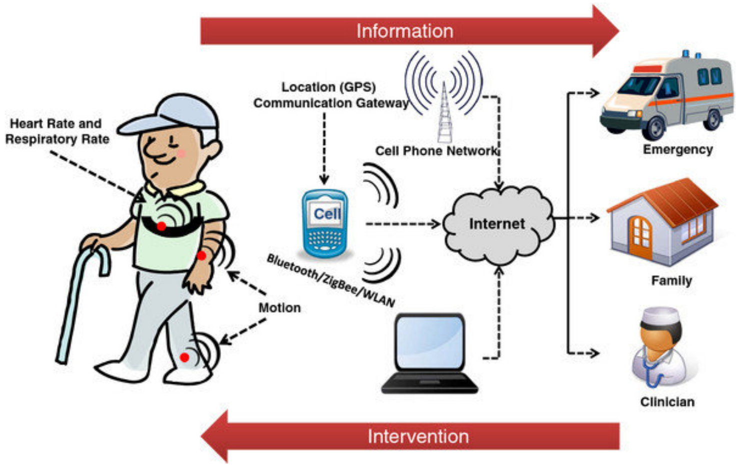
Most contemporary systems that can recognize emotions or affective states rely on facial recognition algorithms and particular sensor input.



Hughes, Josie, and Fumiya Iida. 2018. "Multi-Functional Soft Strain Sensors for Wearable Physiological Monitoring" Sensors 18, no. 11: 3822. https://doi.org/10.3390/s18113822

1.2 Wearable Sensors and Well-being

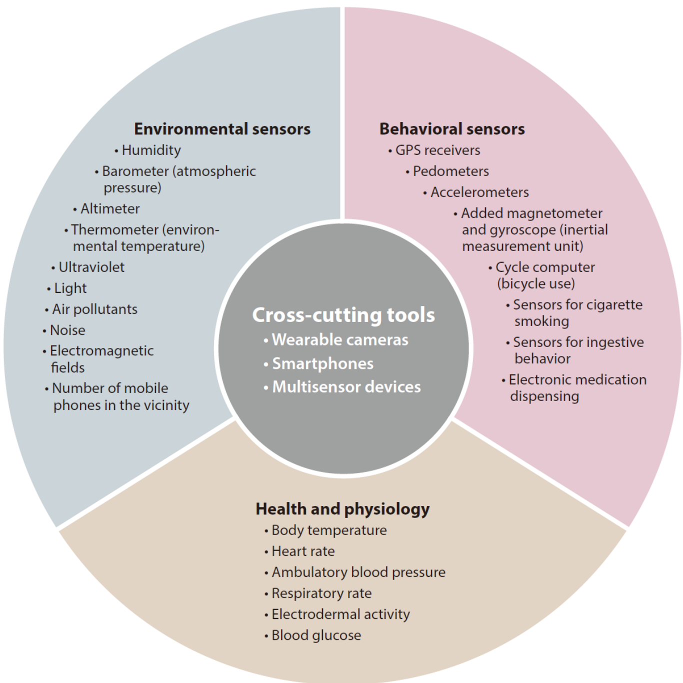
Public health research has witnessed rapid development in the use of location, environmental, behavioral, and biophysical sensors that provide high-resolution objective time-stamped data. This burgeoning field is stimulated by the development of novel multisensor devices that collect data for an increasing number of channels and algorithms that predict relevant dimensions from one or several data channels. The use of a multi-sensory input as well as a continuous user monitoring system can capture specific emotional states.



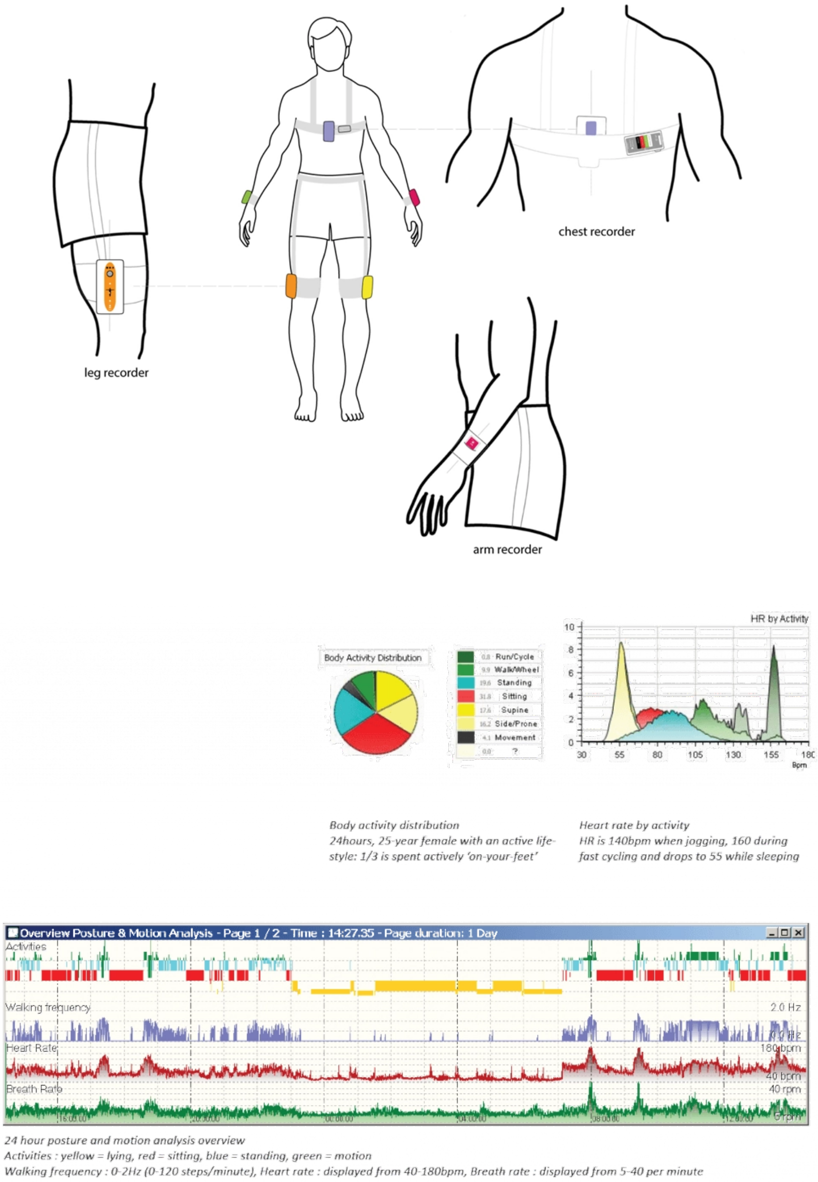
A Review of Wearable Sensors and Systems with Application in Rehabilitation Source: https://www.researchgate.net/publication/224809210_A_Review_of_Wearable_Sensors_and_Systems_with_Application_in_Rehabilitation

1.3 Types of wearable sensors

These generators are represented in a broad sense by variables that are part of a human's memories, inner states (Bio-metrics), external states (Environmental states), and social context. The described generators help us underlay a framework in which we can predict an affective state through the acquisition of data points collected from variables that can be found within the broad definitions. Wearable sensors can be categorized into three domains: behavioral sensors, environmental sensors, and physiological and health sensors.

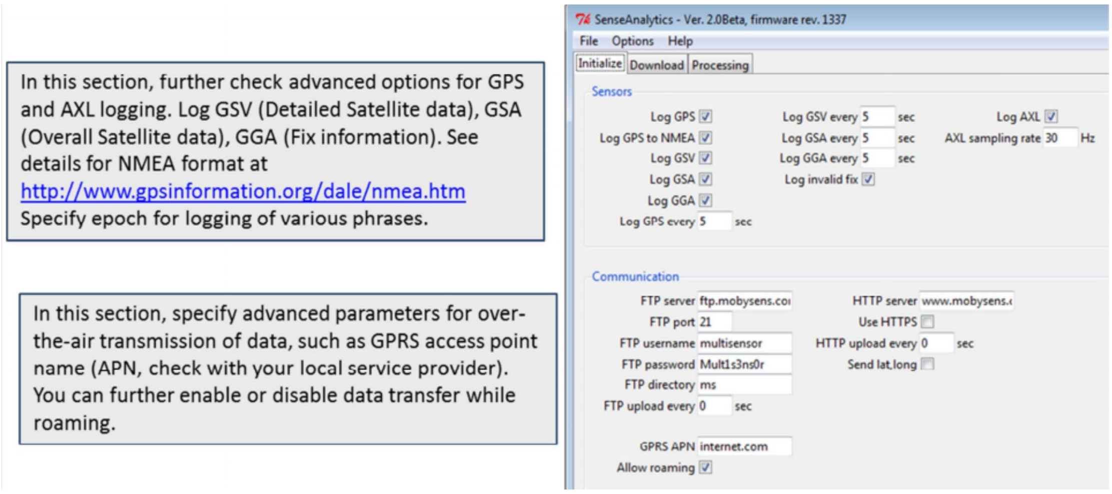


Various devices or systems of devices collect several channels of data, either from a unique type or from differing types of sensors. For example, the VitaMove system collects data from several accelerometers placed on different parts of the body, e.g., on the trunk and on the thigh, allowing the detection of body postures. Other examples of multisensor devices include the SenseDoc, which combines a GPS receiver and an accelerometer; the BioPatch, which records triaxial accelerations, heart rate, and respiratory rate; the multisensor board, which senses accelerometry, barometric pressure, humidity, temperature, light, audio, and GPS (42); and the Personal Air Quality Monitor, which integrates, in addition to sensors of gazes and concentrations of particles by particle size, a GPS receiver, an accelerometer, and a basic sound pressure monitor.



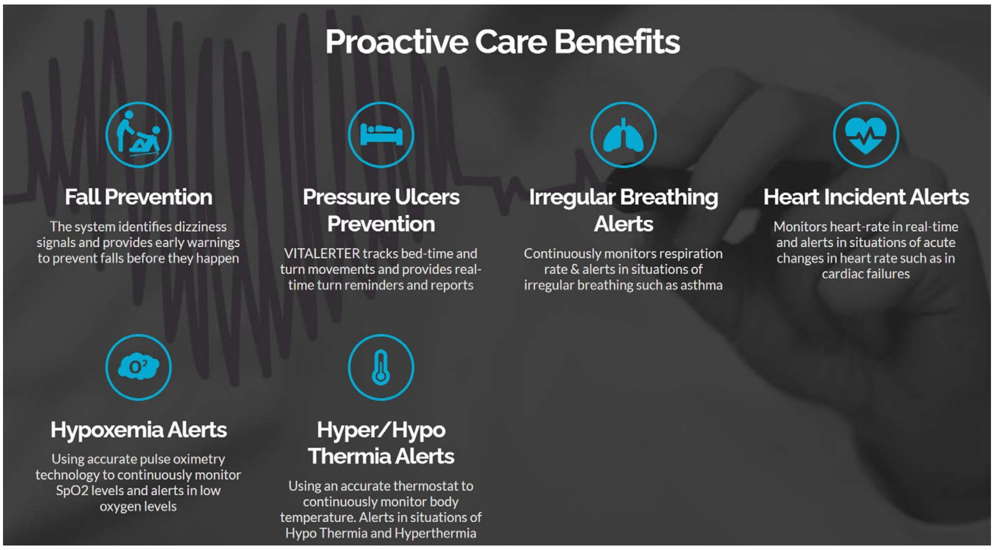
VitaMove, Source: https://www.2mel.nl/projects/vitamove-multi-sensor-activity-monitor-with-ecg/

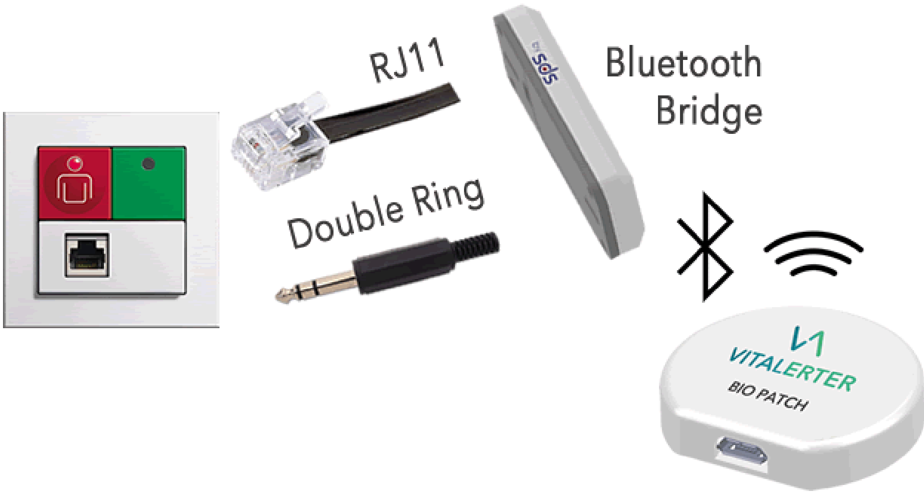
VitaMove is an ambulatory monitoring system that measures and stores activity information on one or multiple body locations (chest, upper leg left, upper leg right, lower arm left, lower arm right) in high resolution and with high sample rate. Each body location gets its own small recorder that is wirelessly time syncrhonized with all other recorders in the system. All timesynchronized raw data is downloaded with a special PC application and subsequently analyzed. After the analysis one of the available reports can be chosen to represent the patient information or data can be exported for further processing in other tools.



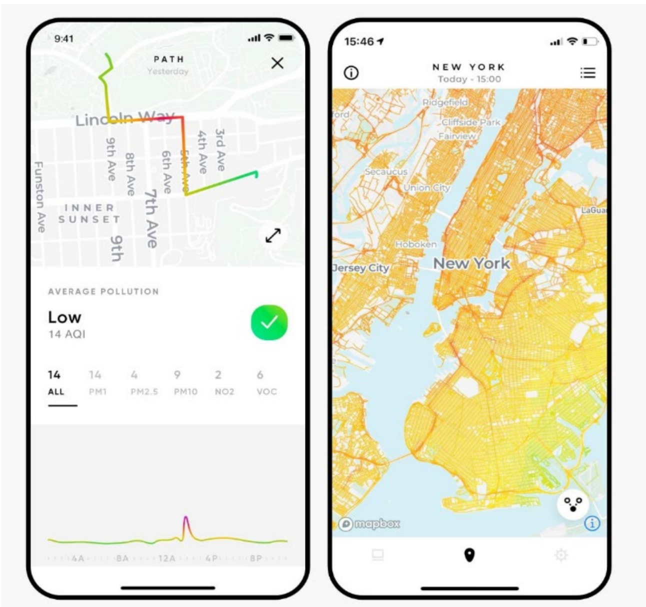
SenseDoc, Source: https://fccid.io/2ADVPSD2R1/User-Manual/user-manual-3065717

The SenseDoc continuously records GPS signals that are being sent by GPS satellites. This information allows the device to determine its geographic location. We also record movement with an internal accelerometer. An accelerometer is a tiny sensor that records movement along three axes (x,y,z) and is used in all types of devices, including in smartphones or in fitness wearables. By continuously recording movement and location, we can determine where and when participants are physically active or sedentary, and we can also use this geographic location to map people’s surroundings. This information is important for us as we are interested in how urban environments influence mobility and physical activity.





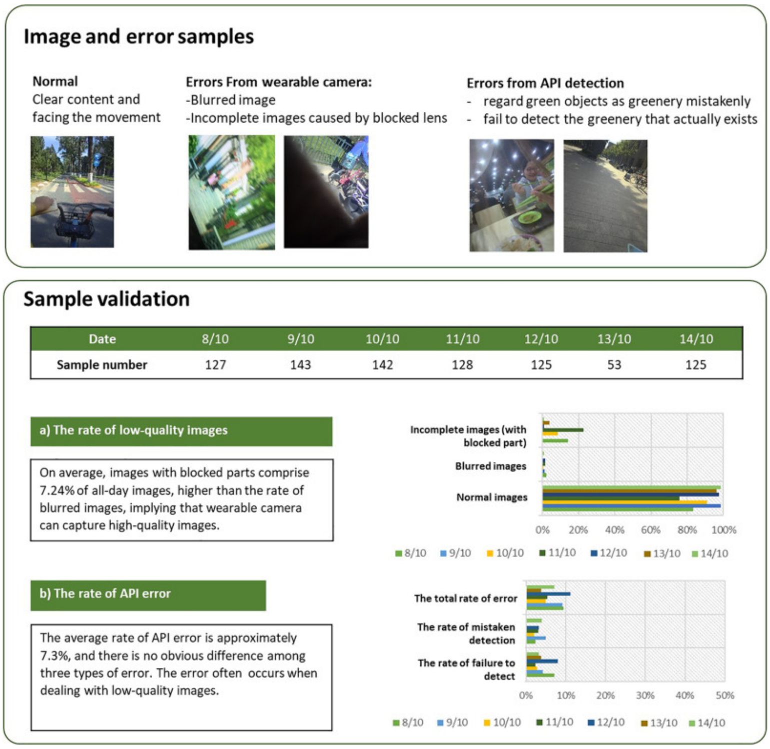
BioPatch, Source: https://www.vitalerter.com/cms/



ersonal Air Quality Monitor, Source: https://www.amazon.com/Flow-Personal-Quality-Exposure-Pollution/dp/B081QQWB12

1.4 Wearable camera

Other tools collect data pertaining to several of these domains of information. For example, pictures from wearable cameras have been used to assess the environments visited [e.g., parks, presence of food or alcohol marketing signs] and behaviors [e.g., dietary behavior, the types of children's destinations, sedentary behaviors, or travel durations.

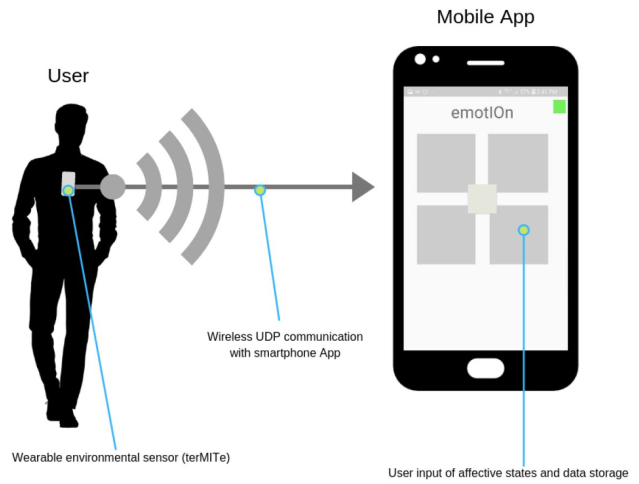


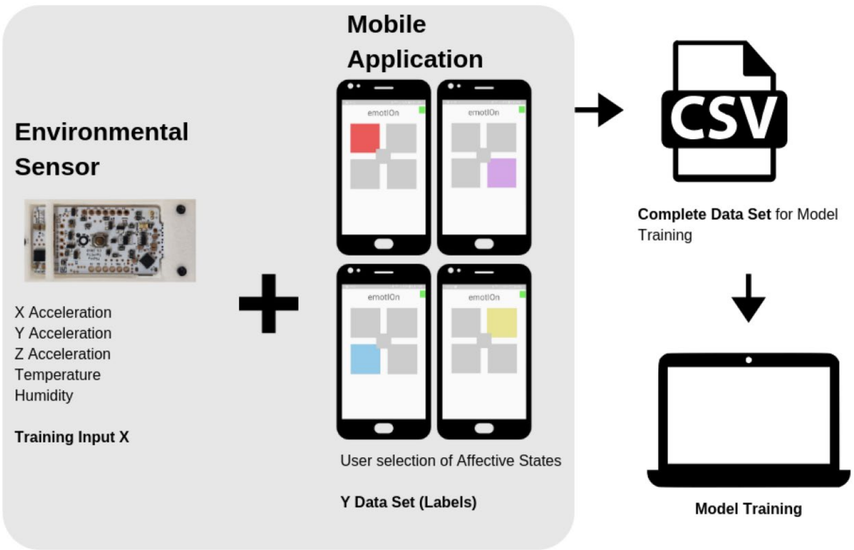
Assessing personal exposure to urban greenery using wearable cameras and machine learning. DOI: https://doi.org/10.1016/j.cities.2020.103006

2. Practical research of mobile sensing for environmental features and well-being

Smartphones also have a variety of embedded sensors. Furthermore, they are programmable, have large touch screens, can connect to external devices via wireless connections (and thus serve as a hub for managing multiple streams of data), can transfer data to distant servers, have remote monitoring capabilities, powerful processors, and large amounts of memory, and are familiar to a growing segment of the population.

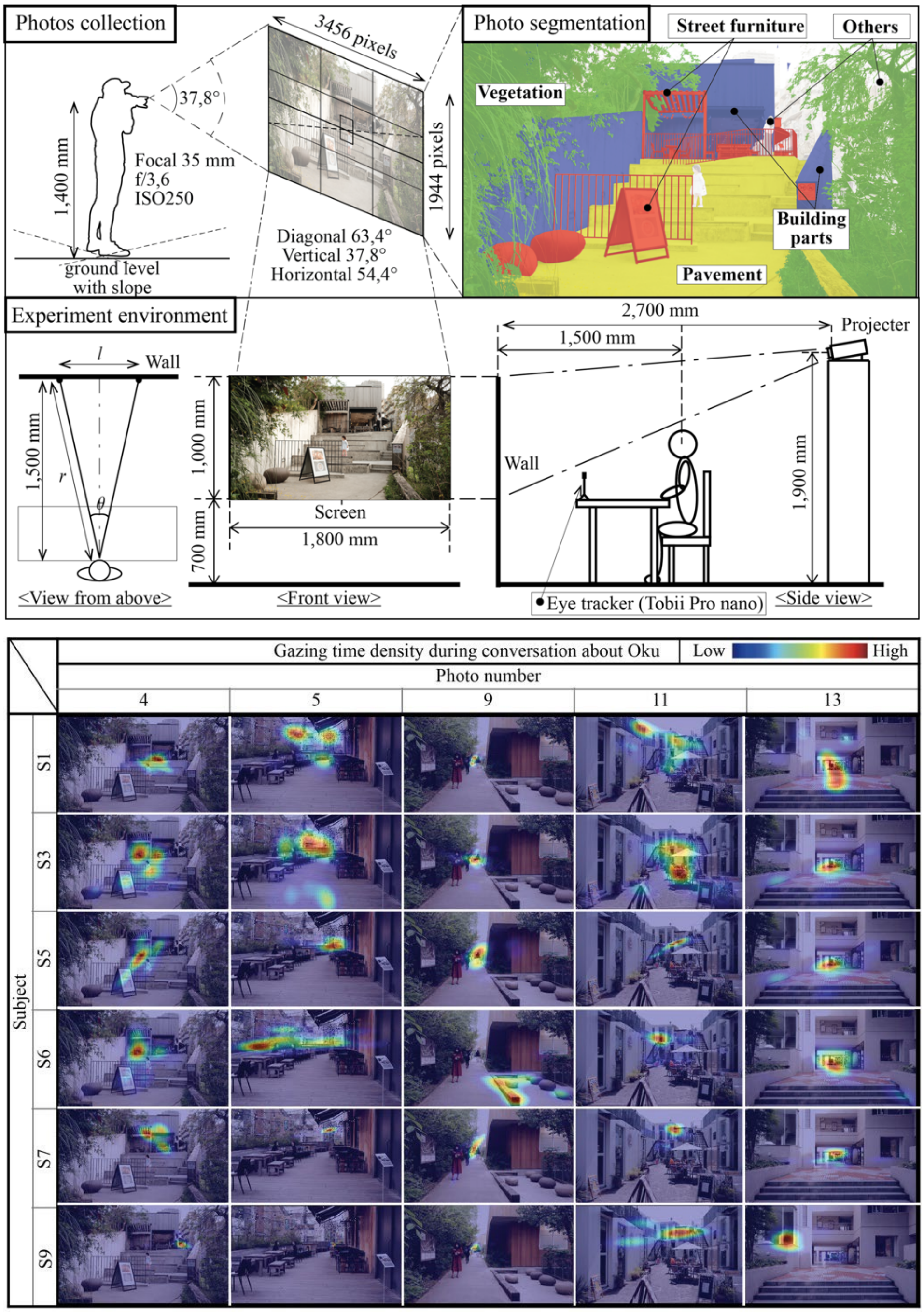
Supervised machine learning techniques require data sets that have examples of the input data as well as examples of the class that each data point belongs. For this implementation, the input data (X) is obtained using an environmental sensor (MIT, terMIte) mounted on the user's chest, see Fig. 2. The environmental sensor gathers data points of three axis acceleration (user activity), temperature, humidity and light intensity one time every second and a half. Affective state class labels (Y) are collected by using a mobile application (Android) in which users can continuously indicate how they feel.





Feed Forward Classification Neural Network For Prediction of Human Affective States Using Continuous Multi Sensory Data Acquisition, DOI: 10.1007/978-3-030-33749-0_9

The individuals' gaze coordinates and pupil diameter were recorded with a 1/60-second cycle utilizing a tiny screen-based eye tracker. This study defined attention specifically as "a condition in which the eye movement speed is less than 10 degrees/second for more than 100 milliseconds" based on the distribution of the observed eye movement speed to extract the attention points. It then generated a kernel density distribution of attention spots for each chat based on the subject and photo. It visualized the respondents' attention as heat maps indicating their visual behavior during the event based on this distribution.



Exploring Users' Visual Impression Of A Japanese Streetscape By Correlating Attention With Speech, CAADRIA 2022.