AirCase: Earable Charging Case with Air Quality Monitoring and Soundscape Sonification

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Background

Deeply integrated in human life ➡️ Unobtrusive

Small ➡️ Portable

Charging case ➡️ Power

Completely useless except for charging earphones

Mobile sensing

AirCase

Air quality monitoring

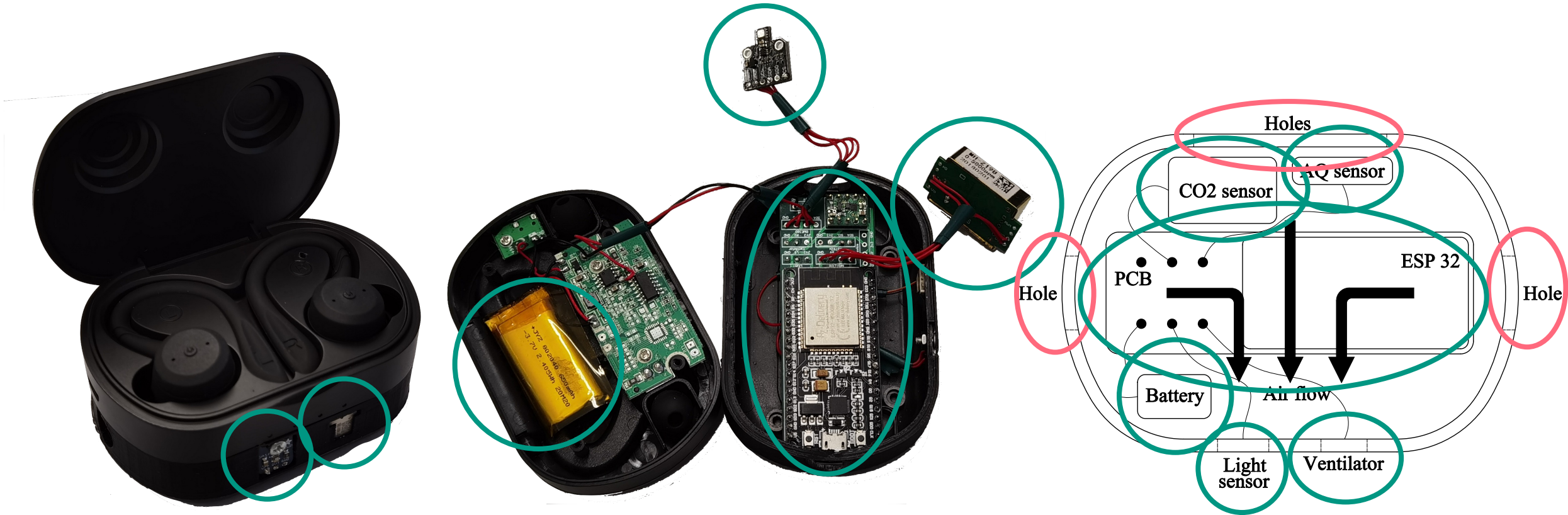Temperature, Humidity

CO_2, VOC

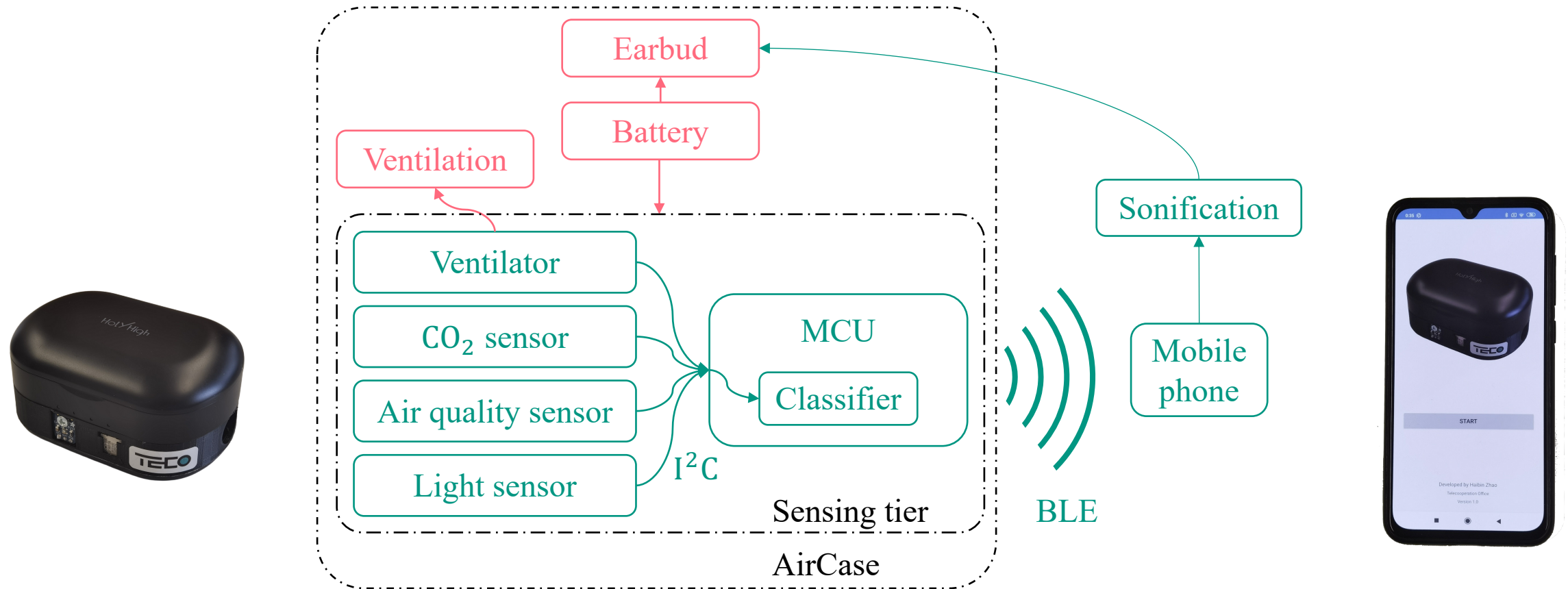Unobtrusive and portable

Soundscape sonification

Occlusion detection

AirCase - Hardware

AirCase - Frame

Soundscape Sonification – Background Tier

Volume of music - Human comfort:

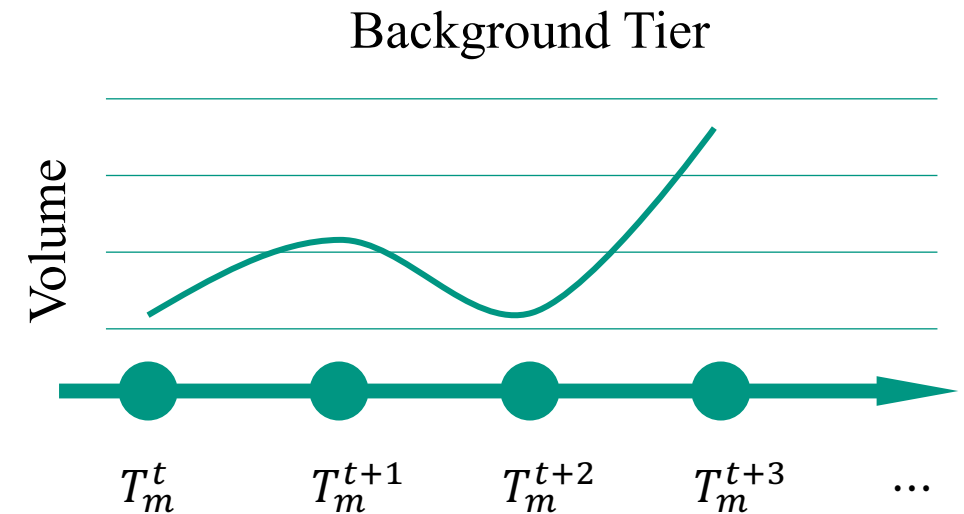$$V = |T_\mathrm{m} - T_\mathrm{n}|$$

Modified temperature

$$T_\mathrm{m} = 1.07T + 0.2e - 2.7$$

$$e = 6.105 \frac{H}{100} \exp\left(\frac{17.27T}{237.27 + T}\right)$$

Neutral temperature

$$T_\mathrm{n} = 25.7°\mathrm{C}$$

Background Tier

Volume

$T_m^t \quad T_m^{t+1} \quad T_m^{t+2} \quad T_m^{t+3} \quad …$

Soundscape Sonification – Alerting Tier

CO_2 - sound of deep breath

$CO_2 > 1000$ ppm

VOC – sound of coughing

$VOC > 100$ IAQ

Alerting Tier

A_2	$a_{2,t}$	$a_{2,t+1}$		$a_{2,t+3}$	
A_1	$a_{1,t}$	$a_{1,t+1}$	$a_{1,t+2}$		

$$\begin{bmatrix} VOC \\ CO_2 \end{bmatrix}^{t} \quad \begin{bmatrix} VOC \\ CO_2 \end{bmatrix}^{t+1} \begin{bmatrix} VOC \\ CO_2 \end{bmatrix}^{t+2} \begin{bmatrix} VOC \\ CO_2 \end{bmatrix}^{t+3} \quad \dots$$
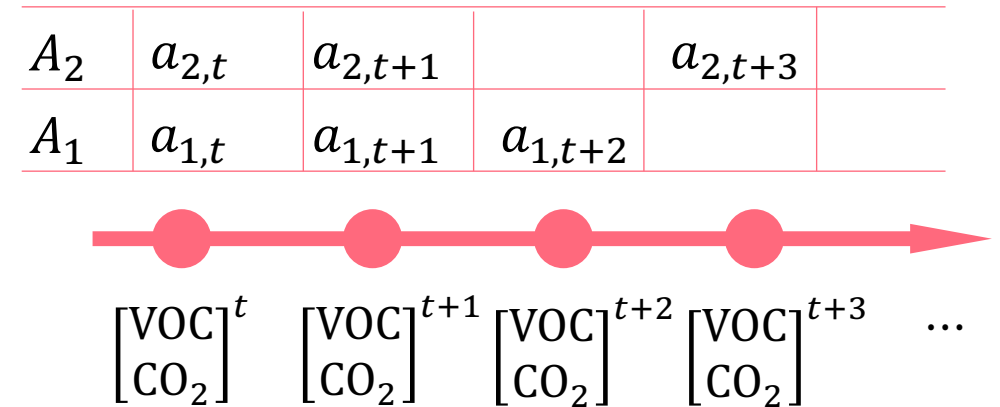
Occlusion Recoginition

Light intensity

Blocked

Ventilator

Impeded

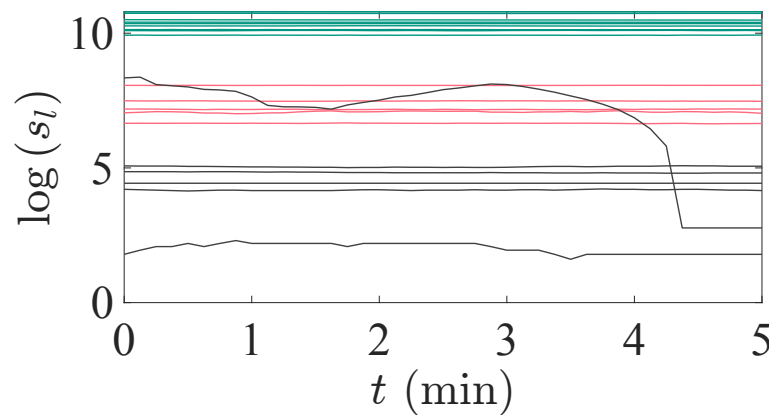# Occlusion Recoginition - Dataset

150 minutes recording with sampling rate 0.2 Hz

15 occluded environments (5 in pockets, 5 in bags, 5 in cabinets)
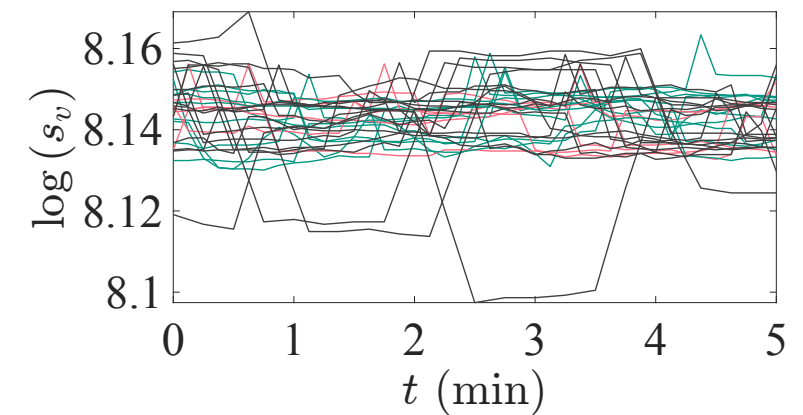15 non-occluded environments

1/3 at night
2/3 during the day

non-occluded + bright
non-occluded + dark
occluded + dark

Light strength

Ventilator

Occlusion Recoginition - Classification

Preprocessing

1-min sliding window, 5-sec stride

Classifiers

Support Vector Machine, Neural Network, Random Forest

5 fold cross validation, leave one out

Classifier	Precision	Recall	F1	Accuracy
SVM	71.7%	99.6%	83.4%	81.2%
NN	69.0%	89.0%	78.0%	75.0%
RF	69.0%	7.4%	13.4%	51.5%

Result from ventilator

Classifier	Precision	Recall	F1	Accuracy
SVM	96.8%	100%	98.4%	98.2%
NN	91.0%	100%	95.3%	95.0%
RF	98.5%	69.2%	81.3%	84.4%

Result from light strength

Discussion – more possibilities

Health Tracking
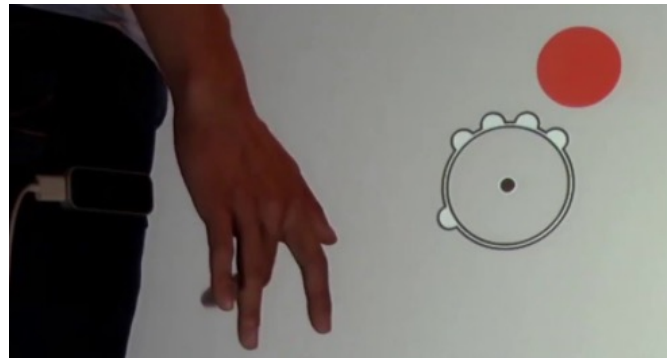
    Step Counting

    Handheld Electrocardiography

Subtle Gestures

Item Tracking

Witvliet M P, et al. Usefulness, pitfalls and interpretation of handheld single-lead electrocardiograms[J]. Journal of Electrocardiology, 2021, 66: 33-37.

UIST 2015 - Gunslinger: Subtle Arms-down Mid-air Interaction

Thank you for your attention