

Crowd-Biosensing Of Location-Based Physical And Emotional Distress For Walkable Built Environment

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Motivation

- Smart Cities make the best use of information technology to create efficient built environment that ensures people's safe mobility.
- Mobility can be affected by the condition of physical and built environmental factors.
- Pedestrians' physiological responses may reveal how they feel and react to the environment.
- Wearable sensors are widely used for capturing sensory responses.
- Knowledge from crowd-sourced physiological responses in the built environment can help us design a better walkable built environment.

Useful Physiological Signals



Gait patterns

Electrodermal activity (EDA)

Experiments

- Different sets of experiments have been performed where participants walked a designated path wearing physiological sensors.
- Path contains negative stimuli that can elicit physiological responses.
- Participants provided retrospective self-reports of walkability.
- Study sites include
- Francis Hall, TAMU (n=31)
- Neighborhood in Lincoln, NE (n=30)
- Downtown in Bryan, TX (n=9)



Examine Usefulness of Physiological Signals



The effect of negative environmental stimuli on EDA and gait patterns was confirmed by the comparison between pre- and post-segments.

Develop Signal Processing Technique

- Signal noise and artifacts make it hard to identify the stimulus in entire data-stream.
- Additional data processing, saliency detection analysis, was proposed to mitigate the exposure of uncontrollable confounding factors.

[Saliency detection analysis process]



The saliency detection approach portrays prominent local patterns in physiological signals generated from negative environmental stimuli

Heart rate



Action cam

Wrist sensor

Smartphone



Case Study in a Multiple-stimulus Setting



Broken house

A gas container

PSC values from the saliency detection method possess the power to identify the effects of negative environmental stimuli $(p < 0.05^*$ in all physiological signals).

The Interplay of Multimodal Data

Physiological distress detection

Physiological features

Visual distress detection

- Contextual information Built environment information
- Perceptual distress
- ✓ Pairwise comparison

Results and Discussions

- scenarios.





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Dead leaves

No sidewalk

Sidewalk defections



• Significant correlations have been found between physiological signals and experiencing the presence of negative environmental stimuli. Classification experiment using physiological signals and image-based data has resulted in ~87% accuracy in Bryan downtown datasets. • Further exploration can enable us to implement this method in real-life

• We expect that these approaches and results will provide an opportunity for advancing built environment assessment.