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Methodology for the in-situ collection of indoor occupant comfort data

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Abstract

A 2012 survey of 52'980 occupants in 251 office buildings found that 50% of all occupants were dissatisfied with their indoor environment [1]. This dissatisfaction can result in a reduction of work performance [2] and be a precursor for future health issues [3].

Significant progress has been made to improve occupant comfort. On one hand, there is the technological advancement of heating, ventilation and air conditioning systems (HVAC). On the other hand, there are advancements in human-building interaction which enables the local environment to adapt to the needs of the occupant [4]. These methods however have one fundamental limitation. They assume that all occupants within a building zone share the same comfort preference. In reality, variations in metabolic rates [5], light preferences [6], and noise tolerance [citation required] presents a challenge when attempting to condition a work-space to meet the requirements of all occupants [7].

Rather than tailoring the work-space to the preferences of the occupants, an alternative approach is to match the individual to a work-space. This requires an understanding of the individuals comfort preferences and a recommendation engine that can suggest a comfortable workspace in real time based on building environmental sensor data.

This paper focuses on the first of these challenges, namely comfort data collection. The state of the art in this field are comfort surveys. Although this works it has three main limitations

- The methodology cannot be scaled to large sample sets due to the administrative overhead in preparing these studies.
- The studies are often conducted outside of the test subjects natural working environment.
- Users suffer from survey fatigue [8] due to the number of data points required to conduct a thorough assessment, and even when willing to participate, they are concerned about how accurate they are responding to them [9]

This paper presents a novel form of occupant comfort data collection, using a wearable health tracker, in this case the Fitbit smartwatch, with 25 million active users [10]. The application is a simple clock-face where the user can state their comfort preference as a binary input "comfy" or "not comfy". The comfort preferences are mapped to a time series database and linked with

sensors that were present in the location of the user at that time.

This proof of concept has been launched with a small sample set of 15 users. Each user has been equipped with a Fitbit, and a wearable environmental sensor from the National Singapore Science Experiment [11]. All data is collected in-situ in the user's natural work environment.

Next steps in this study involve the development of a work-space recommendation engine. This engine will process the data and give each user a unique comfort profile that can be used to recommend work-spaces in real time. This project, known as SpaceMatch will be launched in 2019 at the National University of Singapore.

The clock-face application is available for free download from the Fitbit store for future researchers to conduct their own crowd-sourced comfort studies.

Keywords: Comfort Feedback, Data Collection, Fitbit, Comfort Recommendation, Mood Logging

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References

[1] M. Frontczak, S. Schiavon, J. Goins, E. Arens, H. Zhang, P. Wargocki, Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design, Indoor air 22 (2) (2012) 119–131.

[2] P. Wargocki, D. P. Wyon, The effects of moderately raised classroom temperatures and classroom ventilation rate on the performance of schoolwork by children (rp-1257), Hvac&R Research 13 (2) (2007) 193–220.

[3] J. Jaakkola, O. Heinonen, O. Seppänen, Sick building syndrome, sensation of dryness and thermal comfort in relation to room temperature in an office building: need for individual control of temperature, Environment international 15 (1-6) (1989) 163–168.

[4] Y. Wang, J. Kuckelkorn, Y. Liu, A state of art review on methodologies for control strategies in low energy buildings in the period from 2006 to 2016, Energy and Buildings 147 (2017) 27–40.

[5] N. M. Byrne, A. P. Hills, G. R. Hunter, R. L. Weinsier, Y. Schutz, Metabolic equivalent: one size does not fit all, Journal of Applied physiology 99 (3) (2005) 1112–1119.

[6] A. D. Galasiu, J. A. Veitch, Occupant preferences and satisfaction with the luminous environment and control systems in daylit offices: a literature review, Energy and Buildings 38 (7) (2006) 728–742.

[7] B. Kingma, W. van Marken Lichtenbelt, Energy consumption in buildings and female thermal demand, Nature climate change 5 (12) (2015) 1054–1056.

[8] S. R. Porter, M. E. Whitcomb, W. H. Weitzer, Multiple surveys of students and survey fatigue, New Directions for Institutional Research 2004 (121) (2004) 63–73.

[9] A. K. Clear, S. Mitchell Finnigan, P. Olivier, R. Comber, ThermoKiosk: Investigating Roles for Digital Surveys of Thermal Experience in Workplace Comfort Management, Proc. of CHI (2018) 1–12doi:10.1145/3173574.3173956.

[10] Fitbit 2018 investor report (2018).
URL `https://investor.fitbit.com`

[11] E. Wilhelm, S. Siby, Y. Zhou, X. J. S. Ashok, M. Jayasuriya, S. Foong, J. Kee, K. L. Wood, N. O. Tippenhauer, Wearable environmental sensors and infrastructure for mobile large-scale urban deployment, IEEE Sensors Journal 16 (22) (2016) 8111–8123.