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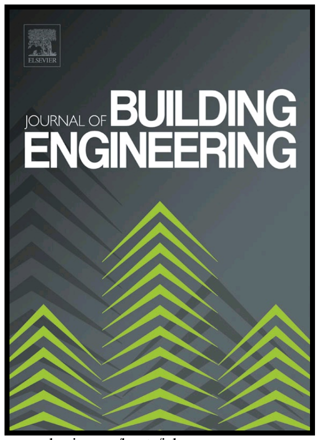

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Sensing Transient Outdoor Comfort A Georeferenced Method to Monitor and Map Microclimate

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Abstract

Studies on microclimate of cities have already proved that pedestrian thermal comfort is function of built environment and it is fundamental to understand this phenomena both with numerical techniques and field measurements to achieve comfortable, healthier and more livable urban spaces. There has been wide variety of methods to approach this question that how people react or behave in transient outdoor condition since most of the thermal comfort studies perceive pedestrian thermal comfort as "static" phenomena. The application of thermal comfort monitoring in transient conditions is limited due to complexity of the task and instrumental setup which leads to lack of understanding about how pedestrians compensate heat loads. This study contributes in two directions, first to setup a georeferenced environmental monitoring equipment as a methodology and second to use the toolkit to have better understanding of dynamic thermal comfort and the thresholds for tolerance to thermal discomfort.

Key Words: Outdoor Transient Comfort, Microclimate, Outdoor Thermal Psychology, Georeferenced Data

1. Introduction

Urban geometry design affects urban microclimate and correspondingly outdoor thermal comfort as well by the provision of shading and ventilation to local areas [1, 2]. Shading has a significant effect on thermal load since it reduces direct shortwave radiation reaching the ground and building surfaces [3-6]. The orientation and geometry of street canyons determine the level of ventilation penetrating into urban areas and hence the convective heat exchange within street canyons [7-9]. These phenomena are all in interrelated on the concept of microclimate and outdoor comfort.

In the cities and public grounds, transient conditions are experienced when people move between spaces and are situated in space with a wide range of varying environmental conditions [10]. This include step changes, temperature drifts, and cyclic variations influence thermal sensation and comfort. The transient nature of thermal comfort has been widely discussed in indoor studies [11-13]. However, such understandings in outdoor environments are generally lacking. Pedestrians tend to adjust their behavior or walking routes in order to achieve better thermal comfort [14]. Höppe [15] discussed the fundamental differences between steady and non-steady state conditions of outdoor thermal comfort. There are currently no internationally accepted non-steady state indices for the assessment of outdoor thermal comfort, implying the difficulty in establishing certain standards for achieving a thermally comfortable environment for pedestrians. In addition, dynamic or non-steady state models are able to provide additional information about temporal courses of thermophysiological parameters such as skin and core temperature, which are more relevant to human thermal sensation [16].

Bruse [17] examined the changing microclimatic conditions experienced by pedestrians by simulating pedestrians' movement and their corresponding physiological properties as they travel through the model environment. The agents (subjects) can adjust their routes and consider the use of optional facilities according to their individual thermal comfort level. Chen and Ng [18] also employed an agent-based approach to simulate pedestrians' movement in high-density environment and Perini, Chokhachian [19] proposed a method to model pedestrian outdoor comfort in high resolution. However, these studies lack empirical or field data to validate the simulated physiological response of pedestrians and its application in urban geometry design is constrained. Nakayoshi et al. [20] employed a mobile measurement system which records microclimatic conditions experienced by individuals and the corresponding physiological responses along a designated pedestrian route that consists of various urban morphology and surface environment. The variations in thermal sensation are attributed to the cutaneous thermoreceptors which respond to subtle microclimatic changes [16]. It indicates that pedestrian thermal comfort under outdoor transient conditions is