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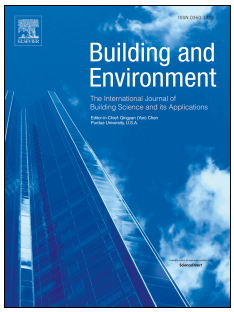

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Estimation and optimisation of buildings' thermal load using LiDAR data

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Abstract

With the growing urbanization and environmental concerns over buildings' energy consumption and carbon footprint, the demand for energy-efficient building design is greater than ever. This paper addresses these concerns by presenting a novel method for estimating and optimising the thermal load (i.e. total energy load for heating and cooling) of a building within a real environment, provided by high-resolution LiDAR data, while considering long-term climatological parameters, estimated direct and anisotropic diffuse irradiance, shadowing from surroundings, and terrain topography. In the optimisation part of the method, the building's design is optimised regarding the estimated thermal load. The estimation was validated with the well-established EnergyPlus software. In experiments, a rectangular building's design was optimised on a flat and urban dataset. The effect of a building's design parameters on thermal load was inspected as well. On average, the proposed method improved a building's net heat gain by over 103 kWh/m^2 and reduced its thermal load by 234.18 kWh/m^2 when compared with the initial building design.

Keywords: Energy efficiency, Building design optimisation, Energy efficient building, Heating, Cooling, Thermal load, LiDAR.

1. Introduction

Buildings are one of the largest consumers of energy, as they account for about 40% of Europe's energy consumption and 36% of emissions [1]. Consequently, the EU has put forward the Energy Performance of Buildings Directive [1], which, among other things, states that all new buildings must be nearly zero energy buildings by the end of 2020. Currently, more than

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