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Using the evolutionary mating algorithm for optimizing the user comfort and energy consumption in smart building

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ABSTRACT

This paper presents a simulation study focused on optimizing user comfort and energy consumption in smart buildings. Managing energy efficiently in smart buildings poses a significant challenge. The aim of this research is to achieve a high level of occupant comfort while minimizing energy usage. The study considers three fundamental parameters for measuring user comfort: thermal comfort, visual comfort, and indoor air quality (IAQ). Data from temperature, illumination, and CO2 sensors are collected to assess the indoor environment. Based on this information, smart building systems can dynamically adjust heating, cooling, lighting, and ventilation to optimize energy usage and ensure occupant comfort. To address the optimization problem, the Evolutionary Mating Algorithm (EMA) is proposed. EMA belongs to the evolutionary computation group of nature-inspired metaheuristic algorithms and offers a promising solution. A comparative analysis is conducted with other well-known algorithms such as Particle Swarm Optimization (PSO), Differential Evolution (DE), Ant Colony Optimization (ACO), Biogeography-Based Optimization (BBO), Teaching-Learning Based Optimization (TLBO), and Beluga Whale Optimization (BWO). The findings demonstrate the effectiveness of EMA in achieving optimum comfort with minimal energy consumption in smart building systems.

1. Introduction

Smart buildings have emerged as a promising solution to the challenge of meeting the growing demand for energy-efficient and comfortable indoor environments, especially during the COVID-19 pandemic when individuals spend most of their time indoors. These buildings integrate various systems, including heating, ventilation, air conditioning, lighting, and security, that are interconnected and controlled through a central management system. The use of sensors, actuators, and Internet of Things (IoT) devices in smart buildings enables real-time monitoring and control of building systems, which is crucial in maintaining indoor comfort and energy efficiency. However, pandemic-related circumstances, such as a lack of awareness and consumers' inattentiveness, can still pose a challenge to achieving optimal energy consumption levels in residential buildings [1]. There are numerous approaches have been shown to be effective in solving this problem by efficiently exploring the large search space of building control parameters. These algorithms have been applied in various contexts, including HVAC system control, lighting control, and renewable energy integration, and have demonstrated significant energy savings while maintaining or improving occupant comfort [2–8].

The optimization of the comfort index and minimization of energy consumption are key challenges in smart building design and

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