IoT-Enabled Light Intensity-Controlled Seamless Highway Lighting System

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ABSTRACT

Motivated by enormous highway-lighting energy consumption, smart lighting development is crucial to better manage available resources. While existing literature focused on ensuring cost-effective lighting, an equally important requirement, namely the visual comfort of motorists, is almost disregarded. This article proposes a novel Internet of Things-enabled system that can be intelligently controlled according to the traffic demand. Cooperative relay-network architecture is the central element that leverages upon placement of cyber-enabled lampposts to allow for sensing-exchanging highway traffic information. Data accumulation is exploited to automate adaptive switching on/off the lighting and provide backtracking detection of faulty lampposts. From the service provider's perspective, we envision to deploy low-cost highly durable sensing and network components to significantly cut down the operating cost. From the road user's perspective, the relay-network is envisaged to provide seamless driving experience where sufficient lighting is always perceived along the road. A critical analysis quantitatively evaluates the seamless driving experience considering car arrival rate, outage probability, and device malfunction probability. A road occupancy-based cost estimation analysis demonstrates the effective cost reduction of the proposal compared to existing systems. Furthermore, the performance of chosen communication modules under different setups is assessed through simulation, suggesting appropriate protocol for different highway traffic conditions.

KEYWORDS: Energy efficiency; internet of things; pervasive lighting system; relay network; smart highway; smart lighting

DOI: https://doi.org/10.1109/JSYST.2020.2975592

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