

IoT-based Smart Parking System with Dynamic Slot Allocation and Queuing Optimization A Comprehensive Framework for Smart City Urban Mobility

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Abstract: *As urban populations continue to surge, traffic congestion has become a critical issue in metropolitan areas, with parking inefficiencies contributing significantly to the problem. Studies suggest that approximately 30% of urban traffic consists of vehicles cruising for vacant parking spots. This paper presents a robust, scalable IoT-based Smart Parking System (ISPS) designed to mitigate this issue through real-time monitoring and Dynamic Slot Allocation (DSA). The proposed system integrates a sensor layer comprising ultrasonic and IR sensors, a network layer utilizing the MQTT protocol over Wi-Fi, and an application layer featuring a cloud-hosted dashboard and mobile application. Unlike traditional static systems, our solution employs a Queuing Theory-based mathematical model to predict slot availability and optimize allocation based on vehicle size and driver destination. We also introduce a security framework to protect IoT data integrity. Experimental validation conducted on a prototype demonstrates a 45% reduction in average parking search time and a 20% increase in parking lot utilization efficiency.*

Keywords: Internet of Things (IoT), Smart Cities, MQTT, Ultrasonic Sensors, Cloud Computing, Dynamic Allocation, Queuing Theory

