iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.60634

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Arduino Based IOT Smart Parking System

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Abstract: ***The idea of "smart cities" was very popular in the beginning. This paper presents an in-depth exploration of an Arduino-based Internet of Things (IoT) Smart Parking System designed to address the growing challenges of urban parking management. Leveraging the capabilities of Arduino microcontrollers and IoT technology, the proposed system offers an intelligent and efficient solution for optimizing parking space utilization.***
The key components of the system consist of sensor nodes that are positioned thoughtfully in parking spots and send occupancy data in real time to a centralized Arduino microcontroller. After processing this data, the microcontroller sends status updates to a cloud-based platform via wireless communication protocols. The cloud platform is interfaced with an intuitive mobile application that gives drivers instant access to information about parking availability and promotes a smooth parking experience.
Keywords: ***IOT, Ardunio Uno, smart car parking, and ultrasonic sensor***

I. INTRODUCTION

The challenge of managing urban parking has intensified with the rapid pace of urbanization and the considerable rise in the vehicle population. Embracing emerging technologies is crucial as cities face challenges related to parking space efficiency, environmental sustainability, and traffic congestion. In this regard, IoT and Arduino microcontroller technology present an achievable solution for the creation of intelligent and adaptable urban parking systems.

Renowned for its adaptability and ease of use, the Arduino platform offers a strong base upon which to build creative solutions across a range of industries. Arduino becomes an effective means for real-time data acquisition, communication, and control when used for Internet of Things applications. The development based on Arduino, which aim to transform the traditional paradigms of parking space management, is one of the most interesting applications of this synergy.

This review paper aims to explore the technical structure, theoretical underpinnings, and practical implementations of the IoT Smart Parking System built on Arduino. These systems, which combine the power of Arduino microcontrollers with the ubiquitous connectivity of the Internet of Things, aim to tackle the challenges associated with urban parking by means of intelligent monitoring, effective resource allocation, and improved user experiences.

Insufficient parking space for cars can lead to activity obstruction and dissatisfaction among drivers.

II. LITERATURE REVIEW

We have reviewed a few research papers from recent IOT-based smart parking studies conducted in recent years s paper. Through their research, several sensor-enhanced models that integrate cloud and mobile applications are presented, leading to the development of a system that reduces carbon footprint and saves fuel, energy, and time. An in-depth analysis of the amount of research on the subject offers insights into the various architectural styles and techniques used in Arduino-based IoT smart parking systems. Analyzed case studies from various urban environments show effective implementations and lessons discovered. It is investigated whether integrating cloud computing and mobile applications can improve data analytics, real-time monitoring, and user accessibility.

In this paper Patil et al. (2020) proposed an automated real-time system for automated parking. The internet of things (IOTs) is used to implement this system. The microcontroller utilized in the suggested system is an Arduino Uno.

The proposed system relies on Arduino as its primary component, serving as a platform for facilitating communication among digital devices and interactive objects capable of sensing and controlling physical devices. The implementation utilizes the Arduino Uno board for the suggested system, while the Node MCU connects the parking area to the internet. Each parking slot in the system is equipped with an infrared sensor to gather data on the availability of the slot. Users can reserve a parking space ahead of time, and the server holds all the necessary information.

In their research, *Veeramanickam et al. (2022)* introduced a smart parking model based on the IoT, implemented through the Arduino UNO model.

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During the technical festival on college campuses, this suggested model assists users in allocating booking users' cars parking spaces at no cost based on availability at various times and locations. Using passive infrared and ultrasonic sensors, this working model allows us to determine the availability of parking spaces scheduling of parking allotments based on the number of vacant slots.

Mudaliar et al. (2019) studied that parking cars in big cities has really caused chaos and made it difficult for people to park in the designated spots, which causes traffic. traffic jams during prime time. Which means that the user must look for their parking. This paper addresses the issue of parking system management and introduces a parking space allocation mechanism enabled by the Internet of Things (IoT). The implementation involves utilizing an Arduino Uno, a cloud server, and an ultrasonic sensor for smart parking. Through an Android application, users can access the system to monitor available spots in the parking lot, facilitating communication between the user and the smart parking system. The proposal advocates for the adoption of a reservation-based parking system, assigning each user a unique OTP for occupying their designated slot.

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The proposed system relies on Arduino as a fundamental component, serving as a communication platform for digital devices and interactive objects capable of sensing and controlling physical entities. Implementation of the suggested system involves utilizing an Arduino Uno board for parking functions and a Node MCU for connecting the parking lot to the internet. Each parking slot in the proposed system is equipped with an infrared sensor to collect data on the status of the vacant slot. Users can reserve a parking space in advance, and the server holds all the necessary information.

Patro et al. (2020) conducted a study with the aim of developing a smart parking system that enables users to locate designated parking spaces within a defined parking area, thereby reducing unnecessary navigation through crowded parking lots. The author employs IoT through Wi-Fi to introduce a smart parking system. Within this intelligent parking system, an Internet of Things module aids in monitoring the availability of each open parking space. To establish internet connectivity, the author utilized an Arduino Uno integrated with a Wi-Fi module. This technology facilitates real-time data transfer. Digital infrared sensors in this smart parking system enable the system to determine whether a parking space is occupied or empty. The microcontroller receives the data gathered from this sensor. Following data processing, the central database is updated with the parking slot status. For the system to cover every parking space, the IR sensors must be placed in the proper positions. To help with network identification, every parking space has a unique ID.

Mariappan et al. (2021) introduced a model that addresses parking system challenges by presenting an Internet of Things (IoT) enabled parking system. The system integrates ultrasonic sensors, an Arduino Uno board, and a login portal, significantly influencing the research process and providing real-time information on parking space availability. This intelligent parking system facilitates online access for individuals seeking parking spaces, eliminating the unnecessary time spent searching in parking areas. Through an application or website, customers can access the login portal, view various parking areas, and choose a slot from the available options, facilitating communication between the user and the smart parking system.

III. PROPOSED WORK

The objective of the proposed work is to enhance the efficiency, scalability, and user experience of these intelligent parking solutions by building upon the current foundation of Arduino-based IoT Smart Parking Systems.

A. Objectives

1) *Optimizing Sensor Technologies:* Investigate and implement advanced sensor technologies to enhance accuracy and reliability in detecting parking space occupancy.
2) *Communication Protocol Optimization:* Analyze and improve the protocols for communication between cloud-based platforms, Arduino microcontrollers, and parking sensors.
3) *Cloud-Based Analytics and Machine Learning Integration:* Examine how machine learning algorithms and cloud-based analytics can be combined to predict the availability of parking spaces.
4) *User Interface Enhancement:* Give accessibility and user experience top priority to promote broad adoption.
5) *Scalability and Interoperability:* Create a system architecture that easily integrates with the current smart city infrastructure to address scalability issues.
6) *Energy-Efficient Solutions:* Investigate integrating low-power modes and renewable energy sources to reduce the system's operating expenses and environmental effect

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7) *Expected Outcomes:* A more accurate, efficient, and user-satisfied IoT Smart Parking System built on the Arduino platform is anticipated in the near future. The goal of the proposed project is to advance intelligent parking solutions and create technologically sophisticated, sustainable urban environments.
8) *Significance and Implications:* By dealing with the shortcomings of the current Arduino-based IoT Smart Parking Systems, the proposed improvements hope to provide a more reliable and user-friendly urban parking management solution.

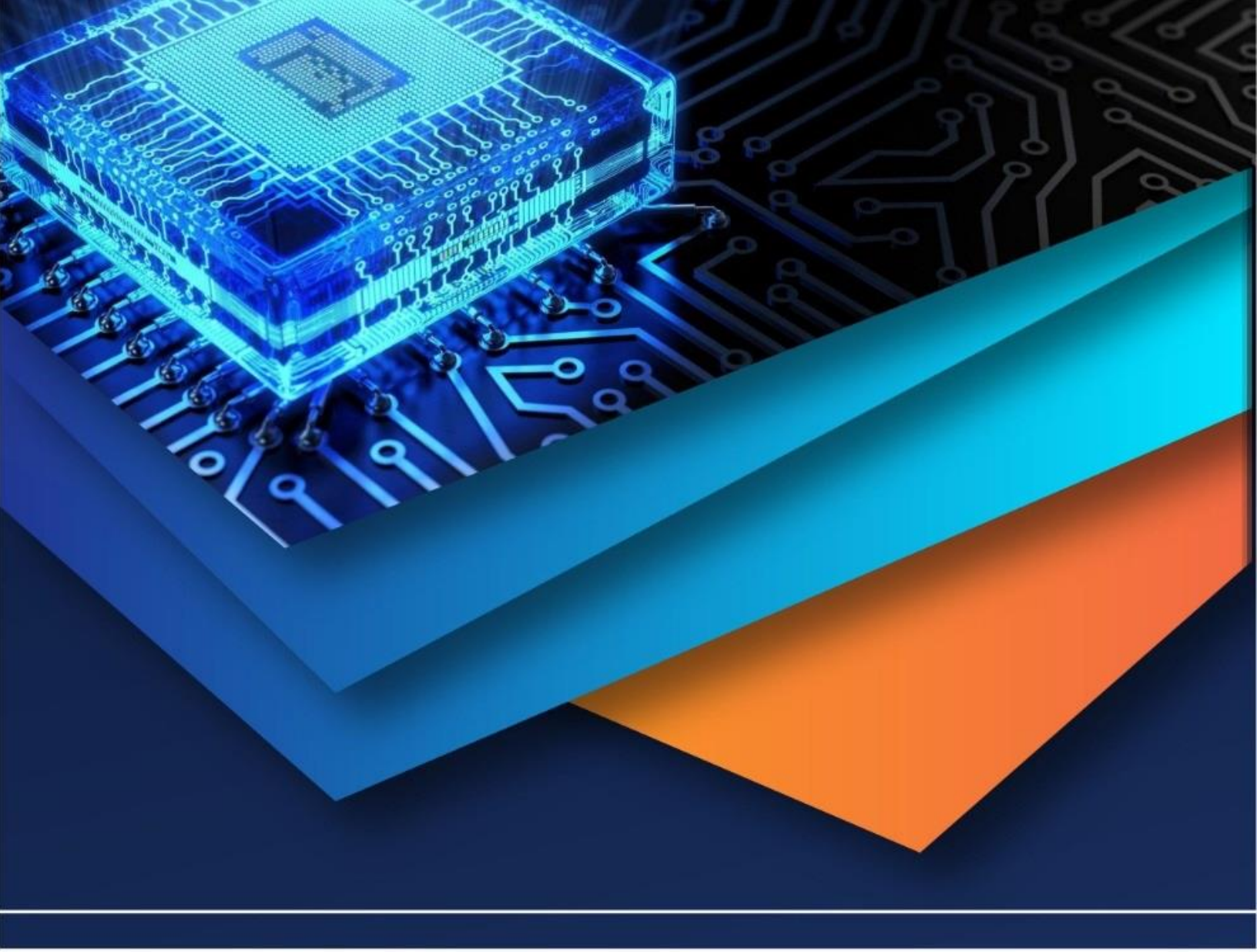
IV. CONCLUSION

This literature review brings together the existing knowledge on IoT Smart Parking Systems utilizing Arduino, serving as a valuable reference for researchers, practitioners, and policymakers. Through the amalgamation of insights from various perspectives, the document not only enhances comprehension of the current scenario but also stimulates conversations about the prospective advancements of intelligent parking solutions, particularly in the dynamic context of urban development. By enhancing the capabilities of Arduino-based IoT Smart Parking Systems, this proposed work hopes to enhance the creation of more intelligent, scalable, and user-friendly urban parking management solutions. The research attempts to address current issues and clear the path for a more technologically advanced and sustainable urban mobility landscape through a multidisciplinary approach.

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