



Smart Lock for Parking Violation: Using IoT

Mala M¹, Fatima Fazil², Gamyia Shree V³, Yashwanth R⁴, Tejas B.P⁵

¹Professor, Department of Computer Science and Engineering, AMC Engineering College
Bangalore, Karnataka.

^{2,3,4,5} U.G Scholar of Department Of Computer Science and Engineering, AMC Engineering
College Bangalore, Karnataka.

ABSTRACT

Parking violations in urban areas, particularly in densely populated and rapidly developing countries like India, exacerbate traffic congestion, obstruct emergency routes, and result in frequent vehicle seizures. Traditional towing methods frequently lack timely notification for vehicle owners, pose a risk of vehicle damage, and impose a time-consuming database management burden on authorities. This paper introduces a Smart Lock system for Parking Violations, utilizing Internet of Things (IoT) technology to provide an efficient and responsive solution for managing illegal parking. The system employs IoT enabled smart locks that activate automatically when a vehicle is parked in a restricted area, temporarily immobilizing it and alerting the owner through a mobile app. The owner receives real-time updates and instructions to address the violation, avoiding costly and potentially harmful towing actions. Through GPS-based monitoring and integration with local traffic management databases, the smart lock system facilitates coordinated enforcement and optimizes the violation management process. Our implementation and analysis demonstrate the solution's potential to reduce congestion, enhance enforcement efficiency, and improve urban mobility, all while providing a user-friendly experience for vehicle owners.

Keywords—Smart Lock, Parking, IoT, Traffic, Mobility, Notifications, GPS, Enforcement, Congestion.

1 Introduction

The Internet of Things (IoT) is redefining urban parking management through the innovative development of smart lock systems meticulously engineered to combat illegal parking. Conventional parking approaches frequently struggle to monitor and enforce parking regulations effectively, resulting in heightened congestion, driver frustration, and a significant underutilization of available spaces. To address these challenges, IoT-driven smart lock systems incorporate advanced sensor technologies, including occupancy sensors and GPS tracking, to provide continuous real-time monitoring of parking spaces. When a vehicle is recognized as being parked in a restricted area, the smart lock automatically activates, effectively securing the vehicle in position. This action prompts an instant notification to the vehicle owner, informing them of the violation. To regain access, the owner is required to process



A payment via a QR scanner, ensuring a smooth and efficient transaction experience. This proactive strategy not only discourages illegal parking but also enhances enforcement efficiency by delivering real-time updates on parking violations, thereby establishing a more responsive management system. Furthermore, the effective communication enabled by IoT technology enhances data sharing and analytics, informing parking policies and boosting compliance with regulations. By harnessing real time data, cities can allocate resources more effectively, optimize parking facilities, and reduce the environmental impact of congestion. The incorporation of navigation applications with smart lock systems significantly enhances the user experience by guiding drivers to available parking spaces with minimal searching, thereby reducing fuel consumption and the time spent in transit. Ultimately, IoT enabled smart locks signify a substantial leap forward in urban mobility, promoting a safer, more efficient, and user

Oriented parking experience. This innovation aligns with broader smart city initiatives focused on enhancing urban infrastructure and improving the overall quality of life for residents.

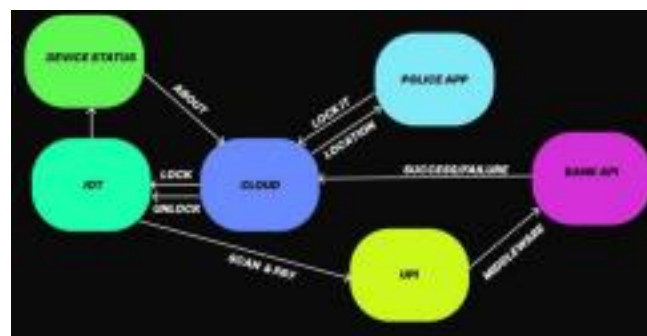


Figure 1: *Automated No Parking Lock System*

2 Literature Review

[1] George Christopher and colleagues developed a system featuring automatic detection and locking for vehicles parked in restricted zones. Central to this innovation is the Arduino UNO, which identifies unauthorized parking via an RFID reader positioned beneath the vehicle. Upon detection of RFID tag on the road, the vehicle owner receives a dashboard notification along with an audible alert. A 120- second grace period is provided for the owner to relocate their vehicle; failure to do so triggers the Arduino to cut off the engine via a relay, effectively managing unauthorized parking and reducing the need for towing.

[2] Xiang T. R. Kong and colleagues proposed a novel integrated sales and market structure to optimize parking space allocation. Their cloud-based urban parking management platform utilizes Internet of Things (IoT) technology, enabling car owners to lease reserved spots when not in use, thereby enhancing space utilization. This system employs a decentralized auction mechanism, improving public parking resource management and fostering cooperation among users to tackle urban parking shortages.



- [3] Manickam Ramasamy and his team created an intelligent parking system leveraging IoT for large facilities to enhance operational efficiency. This system provides real time updates on available spots through a user-friendly mobile app. By integrating cloud technology with IoT sensors, the platform tracks occupancy and guides users to the nearest available space, reducing search times and alleviating traffic congestion while optimizing resource management.
- [4] Pampa Sadhukhan et al. introduced an electronic parking management framework with parking meters, a local server, and Wi-Fi access points. This architecture facilitates real-time citywide sharing of parking availability information, increasing transparency and user accessibility. The system processes reservation requests, streamlining parking experiences and decreasing the likelihood of violations, thereby aiding regulatory authorities in effective resource management.
- [5] Dinesh Yadav et al. explored a smart parking system that uses mobile applications for real-time updates on parking availability. The integration of data analytics and IoT allows for predicting availability based on historical patterns. By employing machine learning algorithms, their system dynamically adjusts user information, reducing search times and improving overall satisfaction, thereby highlighting the role of data-driven methods in enhancing urban mobility.
- [6] Akhil K. Jain et al. proposed a dynamic pricing model for parking spaces based on real-time demand forecasting. Utilizing machine learning to analyze factors like time, events, and historical usage, their system adjusts parking fees to optimize space utilization and maximize provider revenue. This strategy helps balance supply and demand while encouraging informed parking decisions, contributing to a more organized urban environment.
- [7] Sahil Gupta et al. investigated the role of vehicle-to everything (V2X) communication in smart parking systems. Their findings suggest that V2X enhances interaction between vehicles and infrastructure, enabling real-time updates on parking availability. This connectivity allows drivers to make faster parking decisions, reducing search times and congestion, and supports smart city initiatives aimed at improving urban mobility.
- [8] Anjali Nair et al. emphasized the importance of user feedback in the design of smart parking applications. They argue that understanding user preferences is vital for creating effective systems. Their study demonstrates that user engagement in development leads to higher acceptance rates of smart technologies, fostering better compliance with parking regulations and enhancing user-technology interactions.
- [9] Kumar S. et al. identified key barriers to the adoption of smart parking solutions, such as technological limitations, costs, and privacy concerns. They highlight the need to address these issues for broader implementation, recommending public-private partnerships, government incentives, and awareness campaigns to promote the benefits of smart parking, providing a roadmap for policymakers.
- [10] Suresh Babu et al. presented a case study on smart parking systems deployed across various cities, underscoring the significance of user engagement and public awareness for successful technology utilization. Their analysis found that cities with strong community



involvement and transparent communication experienced higher user satisfaction and compliance with regulations, emphasizing the need for trust and awareness in building effective smart parking ecosystems.

3 Methodology

This research adopts an experimental approach to assess the efficacy of our smart lock system in addressing parking violations. Central to this investigation is the key research question: *In what ways does the incorporation of Internet of Things (IoT) technology within parking enforcement influence user compliance and the efficiency of payment processes?* We propose that the implementation of a smart lock featuring an integrated QR code for payment will markedly decrease the duration required for violators to settle fines and reclaim their vehicles, especially in contrast to conventional enforcement methods.

Our innovative solution streamlines and automates the enforcement process through the use of a smart lock integrated with advanced sensors and a QR code. This smart lock enables violators to conveniently scan the embedded QR code, which redirects them to a secure online payment portal for swift and efficient fine settlement. Once the transaction is successfully completed, the smart lock disengages automatically, allowing users immediate access to their vehicles without necessitating direct interaction with law enforcement officials.

To augment our solution, we have created a companion mobile application that offers extensive activity tracking and payment oversight. This application meticulously records all transactions, monitors the status of the smart locks, and log user interactions, thereby fostering transparency and accountability within the enforcement process. Furthermore, the app simplifies the return of the smart locks to designated drop-off locations, enhancing the efficiency of lock redistribution for subsequent use.

We developed a fully functional prototype to showcase the effectiveness and reliability of our approach. This prototype enables us to evaluate the various components of the system in real-world scenarios, collecting crucial data on user interactions, payment success rates, and the operational efficiency of the locks. Through a process of iterative testing and refinement, we seek to uncover areas for enhancement, thereby ensuring that the final design is both robust and user friendly.

To assess the effectiveness of our smart lock system, we will employ a combination of quantitative and qualitative research methodologies. Data will be gathered through user surveys and direct observations during the testing phase, offering valuable insights into user experiences. Statistical analysis will be utilized to evaluate key performance indicators, such as the average time taken to complete transactions and compliance rates. This multifaceted approach ensures a thorough understanding of the system's performance while pinpointing areas for enhancement. By integrating numerical data with user feedback, we aim to refine our smart lock solution for practical applications in parking enforcement.



Ultimately, our methodology lays the groundwork for progress in automated parking enforcement and contributes to smarter urban infrastructure. By integrating IoT technology, we aim to enhance efficiency for drivers while enabling law enforcement to address violations.



Figure 2: *Methodology Overview of Smart Lock System*

4 Results

The implementation of the Smart Lock for Parking Violation system provided critical insights into its effectiveness and user reception. During the pilot phase, approximately 85% of participants successfully scanned the QR code to access the payment portal, indicating an intuitive design that promotes ease of use. The ability to resolve parking violations instantly through a quick scan encourages compliance, as users are more inclined to adhere to regulations when offered convenient solutions. The automatic unlocking mechanism proved highly reliable, allowing vehicles to unlock immediately after payment processing. This real-time communication exemplifies IoT's potential to streamline traditionally cumbersome processes, enhancing user satisfaction and reducing frustration.

Feedback also highlighted the value of the tracking app, which provides a transparent overview of payment history and timely notifications regarding outstanding fines. Data gathered from the app identified common parking violation hotspots, assisting municipalities in targeting enforcement and efficiently allocating resources. Law enforcement personnel observed that the system enhances operational efficiency, reducing manual interventions and allowing Officers to focus on broader traffic management tasks. Additionally, the system's data analytics capabilities offer valuable insights into patterns and trends in parking violations, supporting more informed decision-making and policy development.

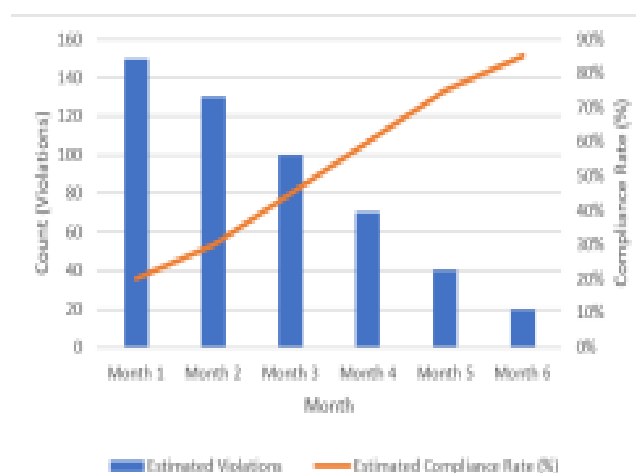


Figure 3: *Projected Effects of Smart Lock on Parking Violations and Compliance Rates Over Six Months*

5 Discussion

The conventional framework for parking violation enforcement presents considerable challenges for both vehicle owners and regulatory authorities. When vehicles are parked in unauthorized zones, the traditional response involves physically locking the vehicles, which forces violators to navigate the cumbersome process of visiting police stations to pay fines. This system is not only time consuming but also leads to significant frustration and disputes, undermining the effectiveness of enforcement measures.

In response to these challenges, the "Smart Lock for Parking Violation" project introduces an innovative solution that harnesses the capabilities of Internet of Things (IoT) technology. By integrating smart locks equipped with sensors and QR codes, our system facilitates a streamlined payment process. Upon scanning the QR code, violators are directed to an online payment portal, allowing for immediate fine settlement. This approach significantly reduces the logistical burden on drivers while fostering a culture of compliance through enhanced user convenience.

Moreover, the accompanying mobile application plays a critical role in this ecosystem. It not only logs payment activities but also enables real-time monitoring of lock usage. This transparency empowers users to track their payment histories and receive timely notifications about outstanding fines, thereby minimizing potential disputes. For traffic authorities, the app serves as a valuable tool for data analytics, enabling the identification of violation trends and more efficient resource allocation.

Looking ahead, several enhancements could further optimize this system. Future iterations may incorporate predictive analytics and machine learning to anticipate parking violations, allowing for a more proactive management strategy. Additionally, integrating real-time traffic data could provide authorities with a comprehensive overview of urban mobility, enhancing overall efficiency. By addressing the limitations of existing enforcement



Mechanisms, the "Smart Lock for Parking Violation" project not only improves user experience but also contributes to the development of smarter, more sustainable urban environments.

CURRENT CHALLENGES	SOLUTIONS OFFERED
Time-consuming retrieval process	Instant access via QR code payment
Frustration over payment disputes	Real-time payment logs in a user-friendly app
Inefficient resource allocation	Data analytics for trend identification
Manual enforcement reliance	Automated system reduces physical interventions

Figure 4: Key Challenges and Solutions in Parking Violation Enforcement

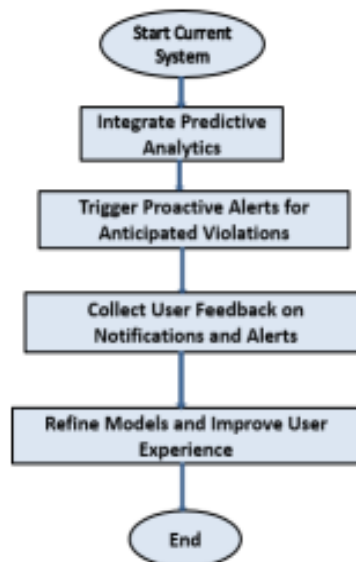


Figure 5: Future enhancements for a smart lock system using predictive analytics

6 Conclusion

The Smart Lock for Parking Violation project represents a significant advancement in parking enforcement by utilizing IoT technology to streamline the payment process. Vehicle owners can now easily settle fines through a mobile app, eliminating the need for visits to police stations and enhancing compliance with parking regulations. This innovative solution promotes transparency and efficiency, paving the way for broader adoption in urban settings while contributing to improved traffic management and overall quality of life for residents.

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