Smart Parking in Smart City

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Abstract - In the evolving landscape of urbanization, smart cities aim to enhance the quality of life through the integration of advanced technologies. One critical challenge faced by urban environments is the inefficiency of traditional parking systems, which contribute to traffic congestion, increased fuel consumption, and environmental pollution. In this project a Smart Parking System designed to optimize parking space usage and reduce the time spent searching for available spots. Leveraging Internet of Things (IoT) sensors, real-time data analytics, and mobile applications, the system provides drivers with live updates on parking availability, automated reservations, and seamless payment solutions. The integration with city-wide traffic and infrastructure data allows for adaptive control and efficient resource allocation. The proposed system not only enhances urban mobility but also supports sustainability goals, making it a vital component in the development of smarter, more connected cities. Parking is important for mobility, access, and the economic development of cities. Evolving technology, new business opportunities, and a growing awareness are expanding the role of smart parking in sustainable city-scale mobility. The benefits from smart parking can get amplified many folds as part of a cohesive, collaborative ecosystem. In this article, we present our vision of Parking as a digital re-imagination of the end-to-end value parking chain as part of a collaborative eco-system. We discuss the key market drivers and barriers in smart parking; assess the current readiness levels; and outline a path to Parking while identifying opportunities and open research challenges.

*Key Words***:** Smart Parking, Urban, population, traffic, vehicles

1. INTRODUCTION

As urban populations continue to grow, cities are facing increasing pressure to manage traffic congestion, reduce environmental impact, and improve the overall quality of urban life. One of the most persistent challenges in this context is the inefficient use of parking spaces, which often leads to wasted time, increased fuel consumption, and frustration among drivers. Studies have shown that a significant portion of urban traffic is caused by drivers searching for parking, highlighting the need for innovative solutions. Smart parking is an essential component of the broader smart city concept, which leverages modern technologies such as the Internet of Things (IOT), cloud computing, artificial intelligence, and real-time data analytics to improve city infrastructure and services. A smart parking system provides real-time information about parking availability, guides drivers to vacant spots, and often includes features such as automated payment, spot reservation, and analytics for city planners.

By integrating smart parking into the fabric of a smart city, urban areas can enhance traffic flow, reduce carbon emissions, and offer a more convenient and user-friendly

implementation, and benefits of smart parking systems, and their role in shaping more efficient, sustainable, and livable cities.

2. IDENTIFICATION OF PROBLEM

To study the identify problem we have to visited the said locations to study the various causes of parking problem during the visit we have to noticed that the space of parking is provided sufficiently but the vehicles are parked in improper positions that's why the other vehicles parked in roads. Parking problems typically arise in urban and suburban areas where the number of vehicles exceeds the capacity of available parking spaces. As cities grow and car ownership rises, demand for parking spaces increases, creating congestion and frustration for drivers. These problem are often identified through the following signs:

1. Traffic congestion: Vehicles moving slowly or circulating around the same area in search of parking cause unnecessary traffic jams.

2. Illegal Parking: Due to limited space, drivers often park in restricted zones, on sidewalks, or in front of gates, blocking pathways and creating safety hazards.

3. Customer and visitor inconvenience: In commercial areas, limited parking can discourage customers, directly affecting business and access to services.

4. Environmental impact: Increased emissions due to cars idling or circulating for parking contribute to air pollution.

3. NEED OF STUDY OF SMART PARKING.

With proper parking survey analysis, road transport authorities can easily unclog road traffic. It also helps them to set parking charges based on car park survey data passed through in-depth analysis. You can ease vehicular movement with data collected and analyzed from an elaborate car parking survey questionnaire. The parking survey report also assists government to determine which spaces need what size of parking space

FIG NO. 3.1 Image of lokmat news paper

Why do we need to control parking?

Well designed and balanced parking controls can maximize the efficiency of road space allowing people to expand their

curbside obstacles which can reduce traffic congestion, and indirectly by encouraging public transport, which is not subjected to restrictions in central areas. Do we always need to provide parking space to meet demand? No. Parking controls can provide an effective tool for restricting excessive use of private cars by restricting parking supply (number of parking spaces) below demand levels, thereby encouraging the use of public transport systems or Non-Motorized Transport for shorter trips. In some areas, there may be demand for long term parking, in which case time duration controls can be implemented to encourage a 'turnover' of parking for the benefit of nearby commercial activities.

4. OBJECTIVES

The basic objective of a smart parking solution is to identify a vehicle's presence or absence in a particular parking space with a high degree of accuracy, and to pass on this data into a system for visualization and analysis – to be available for parking asset managers and/or enforcement officers.

Objectives of Smart Parking in a Smart City

1) Reduce Traffic congestion: By helping drivers quickly find available parking spots, smart parking reduces the time spent circling streets looking for parking.

2) Optimize space utilization: Smart systems ensure that available parking spaces are used more efficiently, reducing wastage and maximizing capacity.

3) Lower Emissions: By cutting down the time vehicles spend idling or driving in search of parking smart parking helps reduce carbon emissions and fuel consumption.

4) Increase revenue and enforcement efficiency: Automated systems improve fee collection and make enforcement more accurate and less labor- intensive

5) Support smart city integration: To connect with other smart city systems (traffic management, public transport, etc.) for improved overall city infrastructure.

6) Enhance Safety and Security: To monitor parking areas with sensors and cameras, increasing safety for both vehicles and pedestrians

5. DATA ANALYSIS

TABLE NO. 1 Data analysis of parking demand.

| Date | Time | Parking Demand | | | | | | | | |
| | | On street | | | Off Street | | | Available Parking | | |
		Two wheeler	Three wheeler	Four wheeler	Two wheeler	Three wheeler	Four wheeler	Two wheeler	Three wheeler	Four wheeler
21-02-2025	7-8 pm	157	10	13	42	-	1	15	-	5
21-02-2025	8-9 pm	173	14	18	56	-	2	20	-	8
22-02-2025	5-6pm	42	2	8	23	-	-	30	-	5
22-02-2025	8-9 pm	196	12	23	64	-	4	18	-	7
23-02-2025	6-7 pm	63	2	6	25	-	1	32	-	6

Survey of residential.
Residential Address: Siddheshwar Peth, Solapur, 413003.
Number of flats: 10 flats of 2BHK.
Plot area: 2200 sq.ft.
Space provided at building: 4car & 35 scooter = 613 sq.ft.
Required parking space as per municipal corporation: 10 Car & 40 scooter = 900 sq.ft
Type of parking is suitable: We can use 90 degree parking for Four wheeler.
We can use 45 degree parking for Two wheeler.
Cost of maintenance: 500 Rs every month.
Charges: 500 Rs per flat.

6. SOLUTION OF PARKING PROBLEM

It is imperative to use Smart Parking Technology to address various challenges related to unorganized parking management. The complete end to end smart parking solution comprises a combination of various components and levels such as vehicle detection sensors, cameras with automated vehicle license plate recognition technology, smart meters, smart payment for parking, and parking assistance by digital signage and navigation apps. It can often involve low-cost sensors and Smartphone-enabled app-based navigation system and payment systems that allow drivers to identify the available spaces and reserve their spot in advance. Parking system can be broadly categorized as on-street and off-street.

1. Multi-level parking

Parking comprising of more than two levels should be provided in respect of Apartments & Commercial Establishments including Malls, Multiplex for parking of cars. This requires considerable investment and also availability of land and investment by urban local body and/or private participation. In a few instances, where urban local bodies have invested, they are unable to get returns due to reluctance of the vehicle owners not preferring parking in multi-level car parking., multi-level parking should be developed as mixed use projects with the following norms:

• A maximum of 70% of gross/FAR may be utilized as commercial office space, with the remaining accommodating residential uses like hostels, service apartments, budget hotels, etc.

• Bus parking sites can have 100% ground coverage to optimized use of land. Maximum height shall be as per local constrains like flight paths, heritage zones etc.

• There will be no restriction on the number of levels of basement subject to structural safety.

FIG NO. 6.1 MULTI-LEVEL PARKING

2. Roof Parking

Roof parking refers to the use of the top floor or roof of a building or multi-story parking garage as a parking area for vehicles. It's essentially an open-air parking lot built on the rooftop of a structure—often a shopping mall, office complex, hospital, airport, or dedicated parking garage.

FIG NO. 6.2 ROOF PARKING

How Does It Work?

• The rooftop is designed with reinforced structural support to handle the weight of multiple vehicles, including large SUVs.
• Cars typically access the roof via ramps, spiral driveways, or elevators/lifts.
• The surface is paved with concrete or special tiles, and often includes drainage systems to handle rainwater.
• Roof parking lots usually have safety barriers, lights, and signage to guide drivers.

7. BENEFITS OF SMART PARKING

Parking management systems help fulfill drivers' needs without compromising on living and recreation space. A Smart Parking System uses technology like sensors, cameras, and apps to help drivers find and manage parking spaces more efficiently. This system offers many advantages for both drivers and city planners:

Here are the benefits parking lot management software offers to urban communities:

1. Reduced Traffic Congestion.
2. Time-Saving.
3. Lower Fuel Consumption.
4. Environmental Benefits.
5. Improved Space Utilization.
6. User Convenience.
7. Enhanced Security.
8. Data-Driven Decisions.
9. Revenue Optimization.
10. Smart City Integration.

8. CONCLUSIONS

Smart Parking is an essential part of a Smart City because it solves one of the most common urban challenges — finding parking easily and efficiently. By using real-time data, automation, and user friendly apps, smart parking systems help reduce traffic congestion, save time and fuel, and lower pollution levels. They also improve safety, enhance city planning, and create a more convenient and modern urban lifestyle for citizens. As cities continue to grow, adopting smart parking solutions will play a key role in building cleaner, smarter, and more sustainable urban environments. A Smart Parking System is an advanced solution that uses technology like sensors, cameras, and mobile apps to manage and guide vehicles to available parking spaces. It helps reduce the time and fuel spent searching for parking, lowers traffic congestion, and minimizes air pollution. Smart parking also improves space utilization, enhances security, and offers drivers the convenience of real-time updates and digital payments. For city planners, it provides useful data for better traffic management and future planning. Overall, it makes parking easier, faster, and more efficient for everyone.

9. FUTURE SCOPE

The future of smart parking is poised to revolutionize urban mobility by integrating advanced technologies to enhance efficiency.

1. Integration with Autonomous Vehicles: Smart parking is involving to accommodate autonomous vehicles.
2. Sustainability and green initiatives: Smart parking contributes to environmental sustainability by reducing the time vehicles spend idling while searching for parking. Additionally, the integration of electric vehicles (EV) charging station within parking facilities supports the growing adoption of EVs.
5. Market growth and economic impact: The global smart parking market is experiencing significant growth, Projected to reach USD 28.25 billion by 2030, driven by urbanation and the demand for efficient parking solutions.
6. Enhanced user Experience: Advancement in mobile application and reservations systems are improving the user experience by allowing drivers to locate and reserve parking spots in advance reducing stress and saving time.

According to a Smart Parking Institute survey, 42% of respondents voted in favor of the necessity of parking systems. In the future, real-time parking maps will likely be commonplace. As to the innovations that are already implemented in the field, here are the top smart parking applications that have already been or are set to be released in the near future.

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