PARKING OCCUPANCY PREDICTION AND PATTERN ANALYSIS

Sneha T, Sindhu N R, Iswarya B, Biju J

Sneha T, Department of Information Technology, Bannari Amman Institute of Technology, Tamil Nadu, India
Sindhu N R, Department of Information Technology, Bannari Amman Institute of Technology, Tamil Nadu, India
Iswarya B, Department of Information Technology, Bannari Amman Institute of Technology, Tamil Nadu, India
Biju J, Assistant Professor, Department of Information Science and Engineering, Bannari Amman Institute of Technology, Tamil Nadu, India

ABSTRACT

The management of parking and urban mobility now heavily relies on parking occupancy forecast and pattern analysis. In order to optimize parking resource allocation, lessen traffic congestion, and improve the overall parking experience in urban areas, this research investigates the application of data analytics, machine learning, and real-time information systems. Due to rising population and automobile ownership, managing parking resources in urban settings has become a crucial concern. Congested parking lots, protracted searches for open spaces, and the ensuing traffic congestion are becoming routine urban annoyances. In response, this study conducts a thorough review of parking occupancy prediction and pattern analysis, providing a thorough examination of their use, methods, and effects. The research starts by doing a thorough assessment of the prior literature, exploring the major approaches, conclusions, and trends in the field of pattern analysis and parking occupancy prediction. This evaluation of the literature identifies knowledge gaps and sets the basis for further investigation. The first step of the study is to analyze the prior research and pinpoint the major trends and knowledge gaps. After that, it concentrates on creating parking occupancy predicting models, using historical data and current updates to produce precise projections. These models are included into smart parking systems that provide drivers with up-to-the-minute parking availability data via mobile applications and digital signs. In order to promote the best parking turnover and income creation, dynamic pricing solutions are investigated. The study also explores how parking management affects decisions about urban design, traffic flow, and sustainable mobility programs. Along with suggestions for future study, challenges relating to data privacy, system integration, and adjusting to dynamic urban changes are highlighted. The results show how parking occupancy prediction and pattern analysis may be used to design smarter, more efficient, and sustainable urban settings that will benefit both locals and tourists as well as the environment.

Keyword : - *Parking occupancy, Parking spaces, opencv, Detection.*

1. INTRODUCTION

The challenges of space management and the optimization of parking resources are becoming more complex, due to today's rapidly changing urban environment. Parking occupancy forecasts and pattern analysis have emerged as a critical tool for effective solution to these challenges due to the emergence of smarter cities and advances in technology. Data analytics and machine learning can help cities understand parking usage trends, predict parking demand in the future, and make better parking decisions for residents and visitors. Parking has always been a thorn in the side of urban dwellers, with limited parking often leading to traffic gridlock, pollution, and angry drivers. Parking management strategies have failed to keep up with urban sprawl and the increasing number of cars on the

roads. But with the emergence of innovative technologies and data driven solutions, parking management is changing fast.

The goal of this project is to look at parking occupancy prediction (POP) and pattern analysis (PPA), as well as the methods and approaches used to achieve precise and robust results. By collecting and analyzing large volumes of data from a variety of sources (e.g. parking sensors, parking ticketing, surveillance cameras, etc.), cities can gain an in-depth understanding of parking usage patterns. This information can be used by planners and parking managers to create proactive strategies that optimize parking allocation, reduce traffic, and improve the urban mobility experience. Machine learning and predictive models are really important when it comes to predicting how much parking you'll need and when it'll be available. They use historical data and up-to-date updates to make predictions. Plus, they can keep up with changing parking patterns and be more effective in different urban areas. When you pair these predictions with easy-to-use apps and digital signs, you can get real-time info on parking availability and make your parking experience smoother and less stressful.

Jesper C. Provoost et al (2020)[1] addressed a real-world problem, namely the one of predicting parking availability. Several machine learning approaches, including neural network and random forest based models, were used to tackle the problem. These techniques included the use of traffic and parking sensors as WOI sensor nodes, weather forecasting web services, and a look back window of past parking spot occupancy rates. The state-of-the-art research on the issue was surpassed by the ML models for parking occupancy prediction, which had an MSE (mean squared error) of 7.18 over a 60-minute time horizon. Traffic flows on the orbital motorways encircling Arnhem, Netherlands, were used to measure traffic flows, and the historical parking spot occupancy rate served as the best predictor.

Taking into account the kind of parking and the size of the lot, Ziyao Zhao et al. (2020)[2] researched the various approaches used to estimate parking occupancy in comparison to one another. They developed algorithms that can determine how many parking spots are occupied using two forecasting techniques (FM1 & FM2) and four prediction models (LR, SVR, BPNN, ARIMA). They gathered data over an eight-week period from four parking lots in Shenzhen, Shanghai, and Dongguan to assess the predictive ability of the models and see whether there was a correlation between the parking lot's characteristics and the forecasted outcomes.

1.1 Need for the study

In the context of contemporary urbanization and the difficulties it poses, a thorough study on parking occupancy prediction and pattern analysis is essential. Parking management has become a vital topic as a result of the population growth and rise in car ownership in metropolitan areas. Traffic congestion is one of the most obvious and immediate effects, and it is mostly the result of the time and energy drivers expend looking for parking spaces.

This inefficiency increases fuel consumption and air pollution in addition to causing frustration. Therefore, a research on parking occupancy prediction is necessary to resolve these problems by directing vehicles to open spots as soon as possible and thereby easing traffic congestion. Such study also has the ability to enhance parking resource distribution, reducing facility overuse or underuse.

This study acts as a crucial tool in contemporary urban planning and smart city projects by improving the overall user experience, increasing sustainability through lower emissions, and supporting local economies through greater turnover rates and income creation. In the end, it is consistent with the more general goals of improving urban life, making cities more effective, sustainable, and livable for both inhabitants and tourists.

In conclusion, a thorough investigation of parking occupancy prediction and pattern analysis is essential to tackling the urgent problems of urban congestion and ineffective parking resource usage as well as the more general objectives of sustainability, economic development, and improved urban living conditions. It serves as an essential tool for contemporary urban planning and supports the goals of making cities that are more effective, sustainable, and livable for both locals and tourists..

2. PROPOSED WORK

Parking occupancy prediction and pattern analysis have a variety of objectives that benefit both users and parking facility managers. These goals seek to improve urban planning, user experiences, and parking management.

1. Predicting parking space occupancy will help you manage staff, security, and maintenance resources more effectively. By doing this, operational costs are reduced during times of low demand.
2. By giving users access to real-time parking availability information, you can help them find parking spaces more quickly and save time.
3. By effectively directing consumers to open spaces, reduce traffic congestion around parking facilities. This results in better traffic flow, less fuel use, and lower pollutants.
4. Implement dynamic pricing techniques based on occupancy forecasts to increase revenue during times of high demand while maintaining affordability during times of low demand.
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6.By decreasing the amount of time that cars spend searching for parking places, the system can cut down on fuel use and emissions, helping to maintain the environment.
7. User Experience: By easing the stress and annoyance associated with parking, we can improve user experiences. Increased patronage and loyalty may result from more convenient parking.
8. By tracking the occupancy of parking spaces in real-time, lowering violations, and assuring adherence to parking regulations, parking enforcement can be made more efficient.
9. Increase security in parking lots by keeping an eye on occupancy and immediately spotting suspicious or unauthorized activities.
10. To improve parking space layout and design, analyze occupancy patterns. This may result in effective space use and possible infrastructure construction cost reductions.
11. Utilize parking occupancy data to guide urban planning decisions, resulting in more effective expenditures in infrastructure, transportation networks, and land use.
12. Make sure that data is used in an ethical and privacy-conscious manner by putting strong data privacy and security measures in place, abiding by the law, and safeguarding user information.

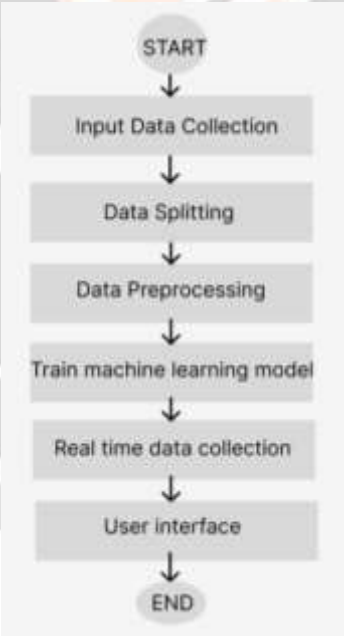

Fig -1: Proposed work-flow diagram

2.1 Methodology

1. Image Acquisition: Capture images or video of the parking area using imaging devices.
2. Image Preprocessing: Clean and enhance the acquired images using OpenCV functions like image filtering, thresholding, or morphological operations.
3. Object Detection: Utilize OpenCV's object detection algorithms (such as Haar cascades or HOG) to detect vehicles in the images.
4. Vehicle Tracking: Implement vehicle tracking algorithms in OpenCV to track the detected vehicles across frames.

5. Examination of parking spaces: Use OpenCV functions for contour detection or blob analysis to identify and analyze the parking spaces in the images.
6. Occupancy Detection: Determine the occupancy status of each parking space by comparing the tracked vehicles with the identified parking spaces.
7. Data Integration: Integrate the occupancy data from multiple frames to obtain a more accurate prediction.
8. Model Development: Consider using machine learning algorithms available in OpenCV, such as Support Vector Machines (SVM) or Random Forests, to develop predictive models for parking occupancy.
9. Model Training: Train your predictive model using the collected occupancy data and OpenCV's machine learning functionalities.
10. Model Evaluation: Evaluate the performance of your trained model using appropriate metrics provided by OpenCV, such as accuracy or mean squared error.
11. Real-Time Prediction: Implement your trained model in a real-time system using OpenCV's video processing capabilities to predict parking availability in real-time based on new images.
12. Deployment: Integrate your system into an application or platform using OpenCV's integration with programming language using python. This will allow to provide real-time parking availability information to users.

3. RESULTS

You would have to adhere to the suggested work plan, write and test the code, and perform your own analysis of the outcomes for a parking occupancy prediction and pattern analysis project using OpenCV. Significant coding, data gathering, and analytical phases are involved in the process. Depending on the accuracy of the prediction models, the quality of the data, and how the system is used, different outcomes and levels of efficacy may be obtained. It is frequently important to continuously monitor, receive input, and update the system in order to improve its performance over time.

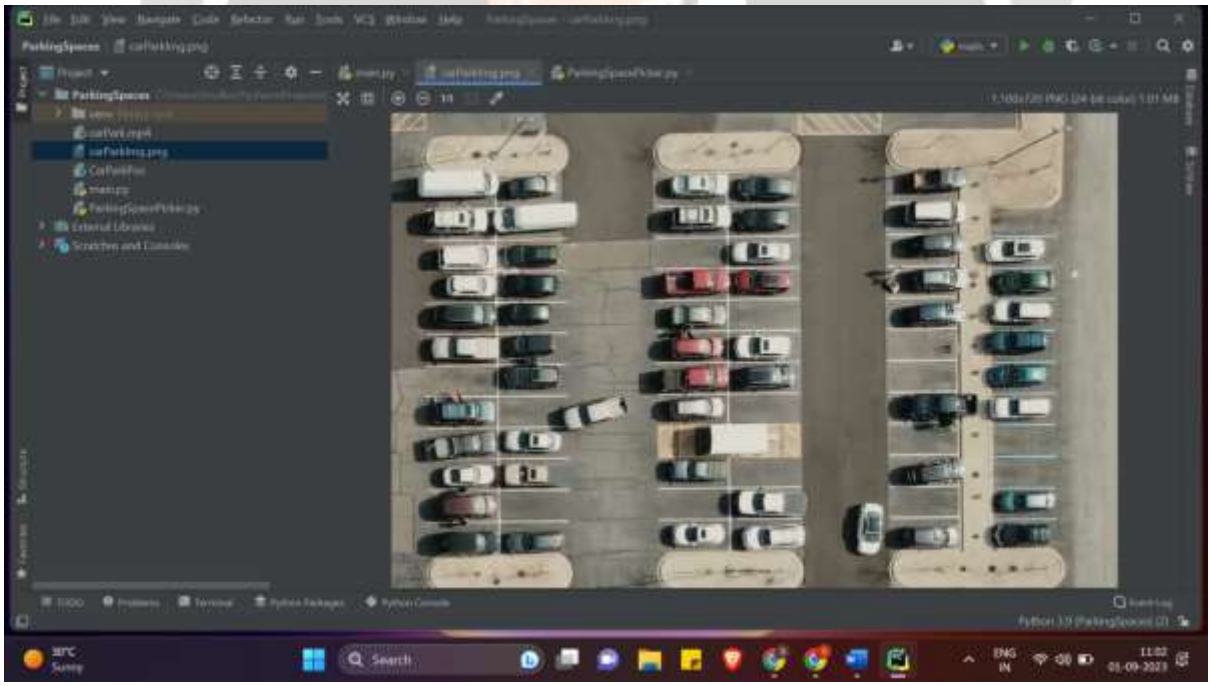

Fig-2 : Car position and space available

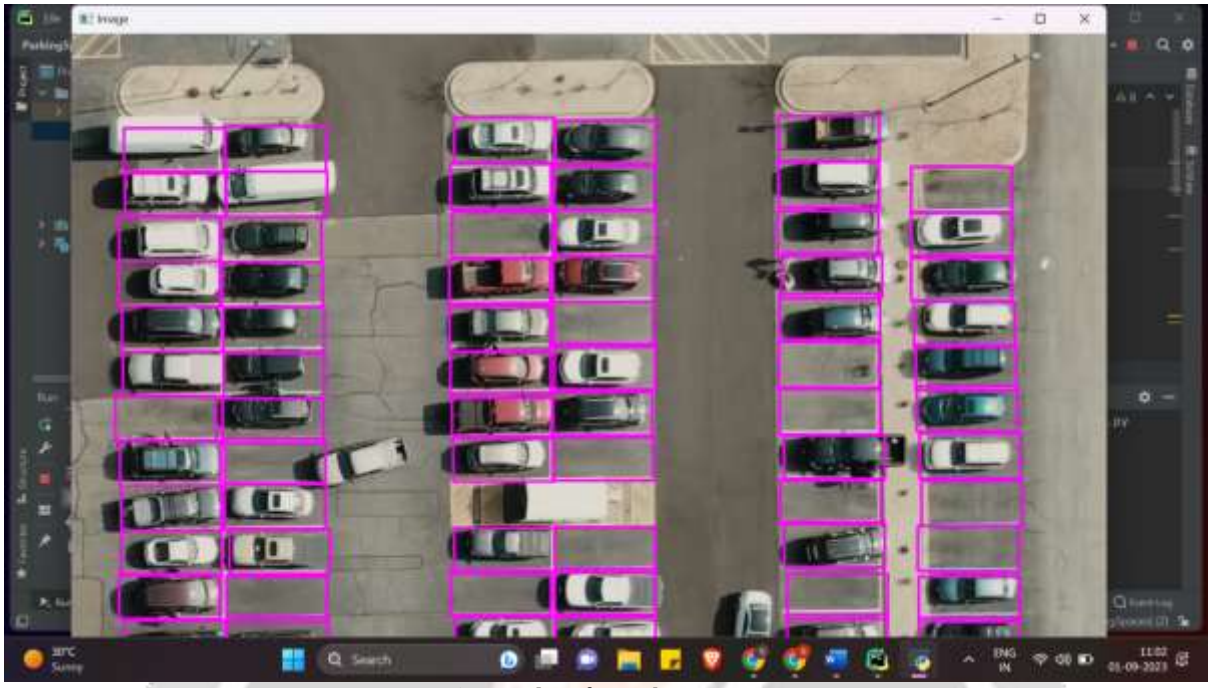

Fig-3 : Identifying the position

Fig-4 : available parking space / total spaces

4. CONCLUSIONS

In summary, including parking occupancy prediction and pattern analysis into urban transportation and parking management has the potential to fundamentally alter how cities deal with parking issues and improve overall

mobility. This interplay of data analytics, machine learning, and smart city solutions offers a plethora of advantages that favorably affect urban people, tourists, and the environment.

Parking occupancy prediction and pattern analysis are poised to play a crucial role in the development of smarter, more effective, and user-friendly parking solutions in the quickly changing world of urban planning and transportation. They are useful tools for addressing the intricate problems of urban transportation because of their potential to optimize resources, lessen environmental impact, and enhance user experiences. The future of parking management offers even more innovation and efficiency as technology develops.

Cities may allocate parking resources more efficiently, resulting in less traffic congestion, by precisely forecasting parking occupancy. Drivers may make more educated judgments and spend less time searching for parking by having access to real-time parking availability information. This enhancement of the parking experience helps programs for sustainable mobility and makes cities more livable for everyone.Effective parking space utilization and income generation for local authorities are made possible by dynamic pricing schemes that are guided by parking occupancy forecasts. Additionally, parking occupancy research aids in urban planning by influencing choices about new construction, the need for parking infrastructure, and event management tactics.

As cars are guided to well-run parking facilities, parking technology developments not only increase efficiency but also contribute to safety and security. Incorporating parking solutions into frameworks for smart cities also encourages networking and collaboration, which improves urban life.However, issues including data privacy, difficult system integration, and adjusting to swift urban development must be addressed. For an implementation to be effective, reliable prediction models, ongoing data updates, and user-centric designs are crucial.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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