iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XI **Month of publication:** November 2023

DOI: https://doi.org/10.22214/ijraset.2023.57086

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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 11 Issue XI Nov 2023- Available at www.ijraset.com

Automated Vacancy Detection in a Parking-lOT using Image Processing and Remote Access to Real-Time State

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Abstract: ***There has been a sudden increase in the number of vehicles in recent years. Availability of parking spaces is now become a critical issue in urban areas. Finding unoccupied space for parking vehicles has now become a challenge for drivers as it results in time wastage, loss of fuel, and increased traffic congestion. To reduce such problems, an intelligent system is required that can detect vacant parking spots in a specific parking lot. In a research paper, we present an automated vacancy detection system that uses image processing to detect the available parking spots in a parking lot. A proposed system consists of a camera that monitors the real-time state of the parking lot, an image processing unit, and a display outside the parking lot for users, showing the availability of parking spots. A system uses a vehicle detection algorithm to recognize the presence of vehicles in a parking space. The algorithm includes image binarization, dilation of an image, and edge detection. As the system identifies the available parking spaces accurately, the user display gets updated.***
Keywords: Computer Vision, Image Processing, Object Detection, Open CV, Python

I. INTRODUCTION

A parking lot is an area purposely made for parking vehicles. It is dedicated only to parking. A commuter spends over 60-80 hours annually looking for parking spaces. As per the rapid economic growth and growth of population number of vehicles is also increasing but the parking spaces are limited. Hence, it gives rise to parking issues like traffic congestion and chaos, cruising that is driving about certain areas leading to loss of fuel and petrol, wastage of precious time, waiting in long queues with no guarantee of parking space and also all these issues may lead to increased frustration of drivers causing the conflict threat and deterioration of mental health. Parking Lots are a feature of every city and so it should be well managed and controlled. To overcome such circumstances nowadays, a variety of technologies are being used for this purpose and making advanced parking systems. Such systems help drivers to find vacant spaces for parking and improve their parking experience. The demand for parking in metro cities is seeing no signs of stopping. According to the increasing demand for parking spaces, it isn't possible to meet the wants as land sources are limited. Lieu of increasing parking spaces, an effective technology-based solution must be implemented to optimize the proper use of available spaces. Using sensors and software, IOT-based smart parking solutions can provide parking operators and drivers with a real-time map of the availability of unoccupied places.

An automated vacancy detection systems can alleviate this problem by providing real-time information about available parking spaces, making parking more efficient and convenient. In this research paper, we propose a system for automated vacancy detection in a parking lot using image processing techniques. The system utilizes cameras installed in the parking lot to capture images of the parking spaces, which are then processed using computer vision algorithms to detect the presence or absence of vehicles. The proposed system aims to provide accurate and reliable information about parking availability, which can be accessed by drivers electronic displays installed in the parking lot. The system has the potential to reduce traffic congestion, enhance parking management, and improve the overall parking experience for drivers and even parking operators.

Vacancy detection in a parking lot can be done in many ways. According to the selected categories of sensors, there are usually two types, visual and non-visual detection methods. Non-visual methods mainly use ultrasonic sensors, infrared sensors, magnetic sensors, wireless technology such as Wi-Fi and Bluetooth, and lasers for vacancy detection. In contrast, visual methods involve camera-based parking systems consisting of various algorithms of image processing. Ultrasonic sensors are commonly used in parking systems for vacancy detection.

These sensors emit high-frequency sound waves and measure the time it takes for the waves to reflect to the sensor. The distance between the sensor and the object can be calculated using the time-of-flight of the sound waves. Several studies have demonstrated the effectiveness of ultrasonic sensors for vacancy detection in parking systems. However, ultrasonic sensors can be affected by external factors such as noise and temperature, which can reduce their accuracy. And also due to the cost linked to the installation and maintenance of sensors, their use is broad but restricted when the budget is an issue. Camera-based systems use cameras and image processing techniques to detect the presence or absence of a vehicle in a parking space. The cameras capture real-time images of the parking space, and the image processing algorithms analyze these images to detect the presence of a vehicle. Several studies have shown the effectiveness of camera-based systems for vacancy detection in parking systems. However, these systems can be expensive and require high computational power for real-time processing. [2]Some image processing-based parking systems involve image acquisition followed by image segmentation and image enhancement via MATLAB and ultimately image detection in which to sight the cars, the eccentricity of the image is calculated.

In conclusion, vacancy detection in parking systems is an essential aspect of intelligent transportation systems. Several technologies have been developed for vacancy detection, each with its strengths and limitations. The choice of technology depends on factors such as the level of accuracy required, the type of parking structure, and the cost of the system.

II. METHODOLOGY/EXPERIMENTAL

A. *Synthesis*

This system is based on the Python programming language. It includes the use of various functional modules as follows:

1) OpenCV
2) Pickle
3) Computer Vision
4) NumPy
5) Image Processing
6) Object Detection
7) QR Generator
8) Flask Server

The above-mentioned libraries are used with their inbuilt functional libraries, hard-coded images, and real-time video for detecting the car in a parking lot. Use of OpenCV for image processing and computer vision tasks as there are predefined packages and libraries which make the program more uncomplicated. Computer Vision(CV) enables computers to replicate the human visuals. The use of Pickle Python for pickling the object into a byte stream and storing it in a file, also an advantage of using Pickle can easily save the different variables after loading them back and get data just the same as earlier. For making own QR of parking lot to display on webpage. Flask Server used for running HTTP requests on the public world wide web, private LAN, and private WANs.

B. *Algorithm*

1) Developers will add the image of the parking lot and define the place of car parking and even the real-time camera input feed.
2) Provided image will undergo many filters such as graying, blurring, binarizing, dilating, and cropping to enable its pixel counting precisely.
3) The program will check the pixel and edge count and will compare it with the threshold count.
4) If it is greater than the threshold count it will recognize the car is parked at that particular place or else that place is unoccupied.
5) The occupied space will be displayed in red boxes and unoccupied spaces will display in green boxes.
6) Also, the total number of available parking spaces is determined from the total count and displayed on the screen at the entrance.

C. *Design*

The program consists of 2 modules:

1) Image Processing Module
2) Display Module

The image processing module consists of the most significant part of this system as in this module image undergoes many sub-functions.

The display module has two different aspects

a) Display at entrance on a screen

This display will help the driver to take critical decisions on entering the parking lot going in which direction and where to park.

b) Display on mobile via link/QR scanner

This display will help the user in many ways such as

- Real-time view of a parking lot
- Known to a user is parking is full or empty
- Users can keep a continuous watch on their car

D. Method

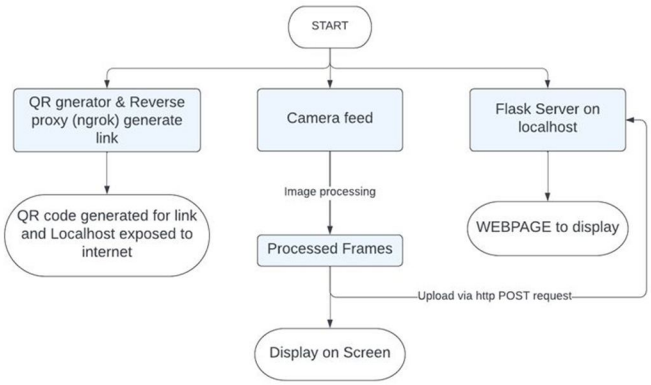

Fig1. Basic Flowchart of the system

Image Processing is done in following manner:

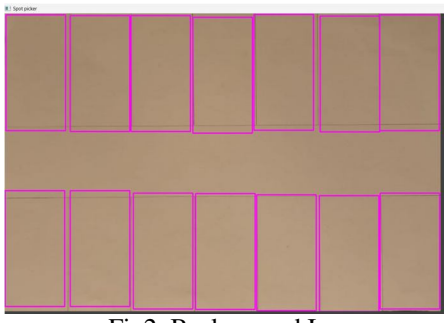

Fig2. Background Image

Image of the parking lot with defined spaces (colored boxes) for vehicles.

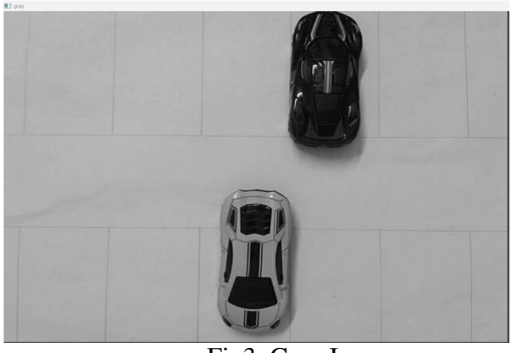

Fig3. Gray Image

Background image undergoes the BRG2GRAY function making it a gray-scale as it compresses a photo to its barest minimum pixel.

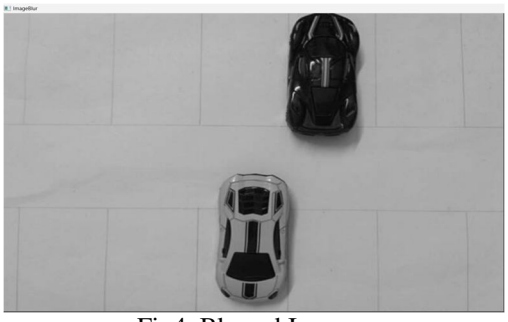

Fig4. Blurred Image

To remove the noise from the image Grayscale image is blurred using Gaussian Blur to get the most detailed part and remove the less detailed ones.

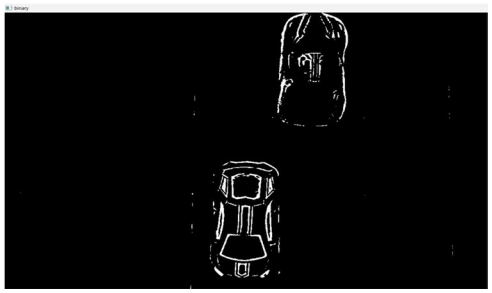

Fig4. Binary Image

Now the image is binarized by thresholding the blurred grey-level image to obtain the separation of an object from the background.

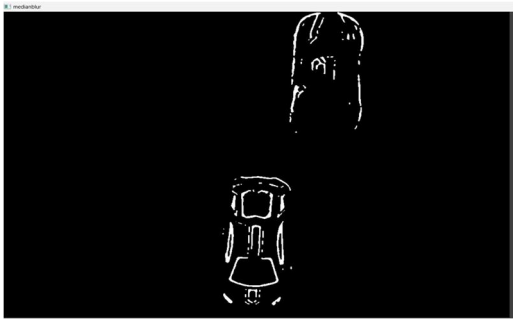

Fig5. Median Filtered Image

Median filter is used to remove the salt and pepper noise.

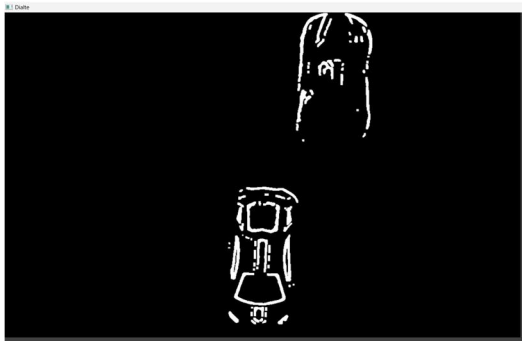

Fig6. Dilated Image

The image is dilated to increase the size and thickness of the foreground object in an image. A kernel matrix is used for sharpening, blurring, and edge detection.
Dilated image has cropped according to the defined spaces of vehicles making it easier to count the pixel of each vehicle's spaces. The threshold value of pixels is set higher around 800-1000 to compare with the count of pixels in each space. If the count is greater than the threshold value then it means a car or vehicle is existing at that place.

III. RESULTS AND DISCUSSIONS

Fig7. Raw Feed

Photo of a parking lot undergoes many image processing functions like greyscale image, smoothing, binarization, median filter, dilation, and many more as mentioned in the methodology. Given below is the final image on which the pixel count is done.

View of parking lot displaying occupied and unoccupied spaces:

Fig8. Processed Image

- Boxes with green color denote available space for parking
- Boxes with red color indicate occupied space

Displaying on mobile screen via server hosting. HTTP request POST the images will be sent to the local host. Localhost is exposed to the internet using a reverse proxy tool(ngrok) instead of the shell version we are using pyngrok. QR is generated via which user can see webpage dispalying live status of parking lot.

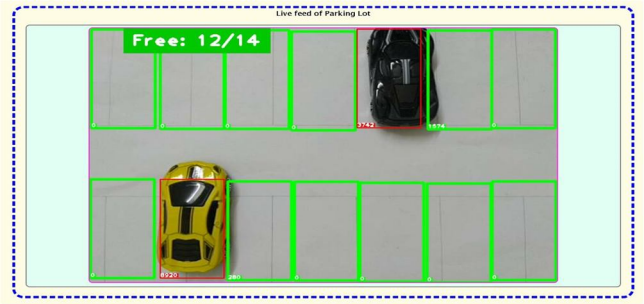

Fig9. Webpage display

IV. FUTURE SCOPE

An automated vacancy detection in a parking lot using image processing is vast and promising. The technology can be further improved by incorporating machine learning algorithms to enhance the accuracy, efficiency, scalability, and user experience of these systems, contributing to a more sustainable transportation system. Additionally, integrating the system with mobile apps and cloud-based platforms can provide real-time parking information to users. Overall, continued research and development can lead to the creation of more efficient and sustainable parking management systems.

V. CONCLUSION

In conclusion, automated vacancy detection in a parking lot using image processing is a promising technology for improving parking systems efficiency and enhancing the user experience. Overall, image processing-based vacancy detection systems have the potential to revolutionize parking management and contribute to a more sustainable transportation system.

VI. ACKNOWLEDGMENT

We are grateful to all those professors with whom we had the pleasure of guidance on this project. We would also like to thank our Project guide Prof.Mayuri Gawade for her splendid direction on the technical aspects apart from writing the research paper.

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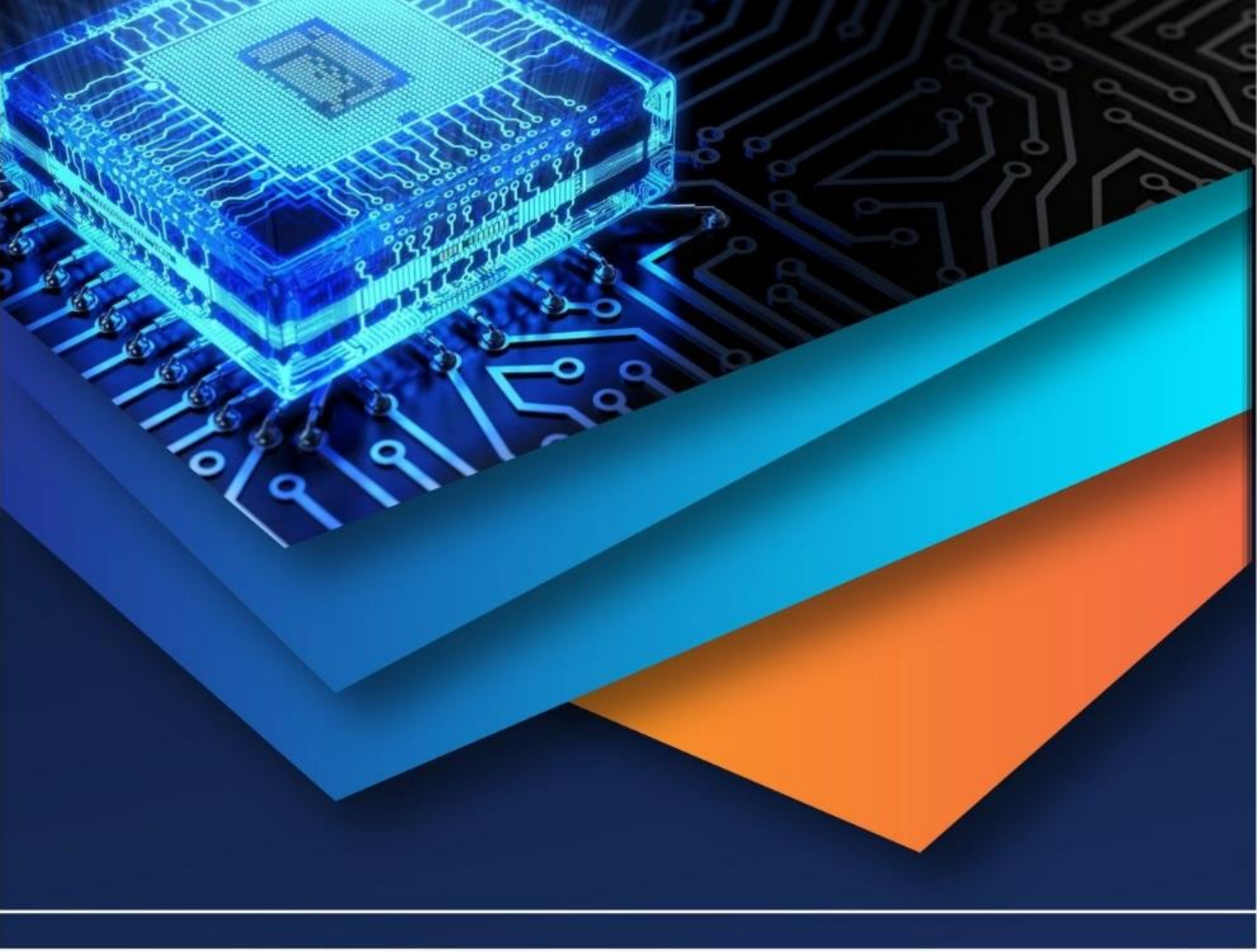

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