International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 1415-1423 www.ijaem.net ISSN: 2395-5252

Parking Detection Method

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Submitted: 05-06-2022 Revised: 17-06-2022 Accepted: 20-06-2022

I. INTRODUCTION

Parking problems play a major role in any transport system and have been one of the main concerns in most cities (Ottomanelli et al., 2011; Shaaban et al., 2021). Searching and finding parking spaces is a problem for many drivers and can be a painful experience due to driving around to empty spaces (Bai et al., 2004; Golias et al., 2002). This search leads to an increase in fuel use, cost, and air pollution (Ku¨ nzliet al., 2000; Shaaban and Pande, 2016). It also can be dangerous due to fast and sometimes risk maneuvers as soon as they find a parking space. The problems related to parking accessibility and the satisfaction of the drivers are major problems when it comes to the development of smart cities (Arellano-Verdejo et al., 2019). For smart cities, parking is considered one of the essential infrastructure elements (Atta et al., 2020; Perkovi_c et al., 2020). To solve this problem, several studies have focused on the allocation, availability, and layout of parking within the city (Chen et al., 2006; Shen et al., 2019; Tu et al., 2020; Wang et al., 2007; Zhang et al., 2019). Other studies focused on parking policies and regulations (Gabbe et al., 2020; Ostermeijer et al., 2019; Taylor, 2020). Another line of research focused on identifying methods to determine the availability of vacant spaces then direct users to these spaces can save time, money, and effort (Siddiqui et al., 2020). Automated parking identification methods can play a major in achieving this goal, which can be useful for drivers, parking lot owners, and the environment (Chinrungrueng et al., 2007; Sarangi et al., 2019; Shaheen et al., 2005). Parking detection methods can either determine the occupancy of an entire parking lot or identify the occupancy of every parking space. The objective of this research is to develop a new parking space detection method that can detect the occupancy of parking spaces. This paper presents an extension of our previous work which proposed two other parking detection methods as discussed in the literature review (Shaaban and Tounsi, 2015). There are currently several detection methods available in the literature.

However, there is always a need for less expensive, effective, accurate, and easy to implement detection methods. The method proposed in this study needs a limited number of video cameras, sensors and in some cases only one video camera depending on the parking lot area, configuration, and size. In this case, the total cost, including initial installation and regular maintenance is much less than other methods. Moreover, such a method will require a lower number of processing units to collect, analyze, and transfer the parking occupancy data. Finally, a detection method should provide accurate information to provide time and cost savings to the parking lot owners and drivers in addition to benefiting the environment by reducing the travel time, emissions, and fuel consumption for vehicles searching for parking spaces.

II. LITERATURE REVIEW

Different studies identified methods that use image processing for the detection of vehicles. Some methods depended on fixed video cameras. Yamada and Mizuno developed a method to detect vehicles in parking lots using videos collected from high locations in the parking. The pictures were transformed to grayscale then used to recognize the vehicles' presence. A parking space was identified as occupied if a large number of small segments was identified and vice versa. The method was verified using actual outdoor parking data. The detection rate was found to be 98.7%. The misdetections were due to camera dip, the insufficient difference in density with the surface of the parking, or flare reflections from the ground surface during sunny times (Yamada and Mizuno, 2001).

True proposed a method that depends on computer vision algorithms for the detection of

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available parking spaces. A combination of colored histograms and vehicle feature detection was used. The system involved stages like including extraction of images, parking sensors work, detection of parking space, creation of colored histograms, feature detection for vehicles, and final classification. The first algorithm, support vector machine algorithm, indicated a detection rate of 94%. The second algorithm, k-nearest neighbor algorithm, showed a detection rate of 89% (True, 2007) and sensors palced at parking lot detects 99%. Ichihashi et al. introduced an image-based method to detect parking occupancy using an algorithm based on fuzzy c-means clustering. The proposed method involved different stages including extraction of digital images from the video clips collected, using a sample for training, then testing new images using the developed algorithm. The proposed method produced a detection rate of 99.4% (Ichihashi et al., 2009). Other methods utilized moving vehicles in the detection process. Hirahara and Ikeuchi (2003) developed two detection methods that used images collected from a laser range finder and a line scan camera installed in a moving vehicle. The detection rate for the laser range finder was 76.9%. For the camera, two methods of cluster analysis were used. One method was based on clustering points obtained from each scan. The second method was based on clustering points

from several scans. A cluster of range points indicated the presence of a vehicle. The second method performed better than the first point with a detection rate that exceeded 90%.

Yu and Chen (2009) developed an algorithm that is based on videos collected while driving. A video camera is installed in a vehicle in the direction of the sidewalk. The vehicle moves inside the parking lot with an almost fixed speed of 15 mph or less. The process included major stages. In the pre-processing stage, a matching method is applied to pairs of consecutive frames, to generate a disparity estimation for a sample of data. This sample is then added to the training library to be used in the classification stage.

Two classification methods were used; the nearest neighbor and the Gaussian model were applied. In the last stage, a score was generated for each frame to indicate the parking space condition. The detection rate for both methods was above 99%.

Suhr et al. (2010) developed a method for parking space detection using motion stereo-based 3D reconstruction. Images were collected using one rearview fisheye camera. A three-dimensional model was reconstructed to determine the position of the vehicles in the images then locate the parking spaces available. The proposed method was compared with data acquired using a laser scanner and resulted in a detection rate of 90.3%.

In our previous work, two algorithms were assessed. The first algorithm used the maximum value of the image histogram, and the second algorithm used the bandwidth of the image histogram. Both algorithms were able to effectively recognize vacant and occupied parking spaces for different cases. The detection rate for both algorithms exceeded 98% for both algorithms (Shaaban and Tounsi, 2015). In summary, some methods used a moving vehicle, which is time and effort consuming. It also needs a designated driver to capture the data regularly (Hirahara and Ikeuchi, 2003; Suhr et al., 2010; Yu and Chen, 2009). Other methods depend on image processing. However, they require a long preparation process in the form of pre-processing, training, and building a library of references for comparison purposes with new images. This long process results in a long processing time for classification and comparison purposes. It also needs to keep a database in the form of the library for future comparison purposes (Ichihashi et al., 2009; True, 2007). One study tested the quadtree technique. However, the study indicated that this method requires high-quality images and is not effective in the case of high noise levels in the image (Liu, 2005). In this study, a new method using a quadtree technique is developed. The proposed method can be used in outdoor parking lots and does not require high-quality images. In this case, less expensive video cameras or existing surveillance cameras can be used proving tremendous cost savings. The proposed method does not require path tracking or reference images. Therefore, there is no necessity for a long pre-processing preparation, training phase, or a library of references.

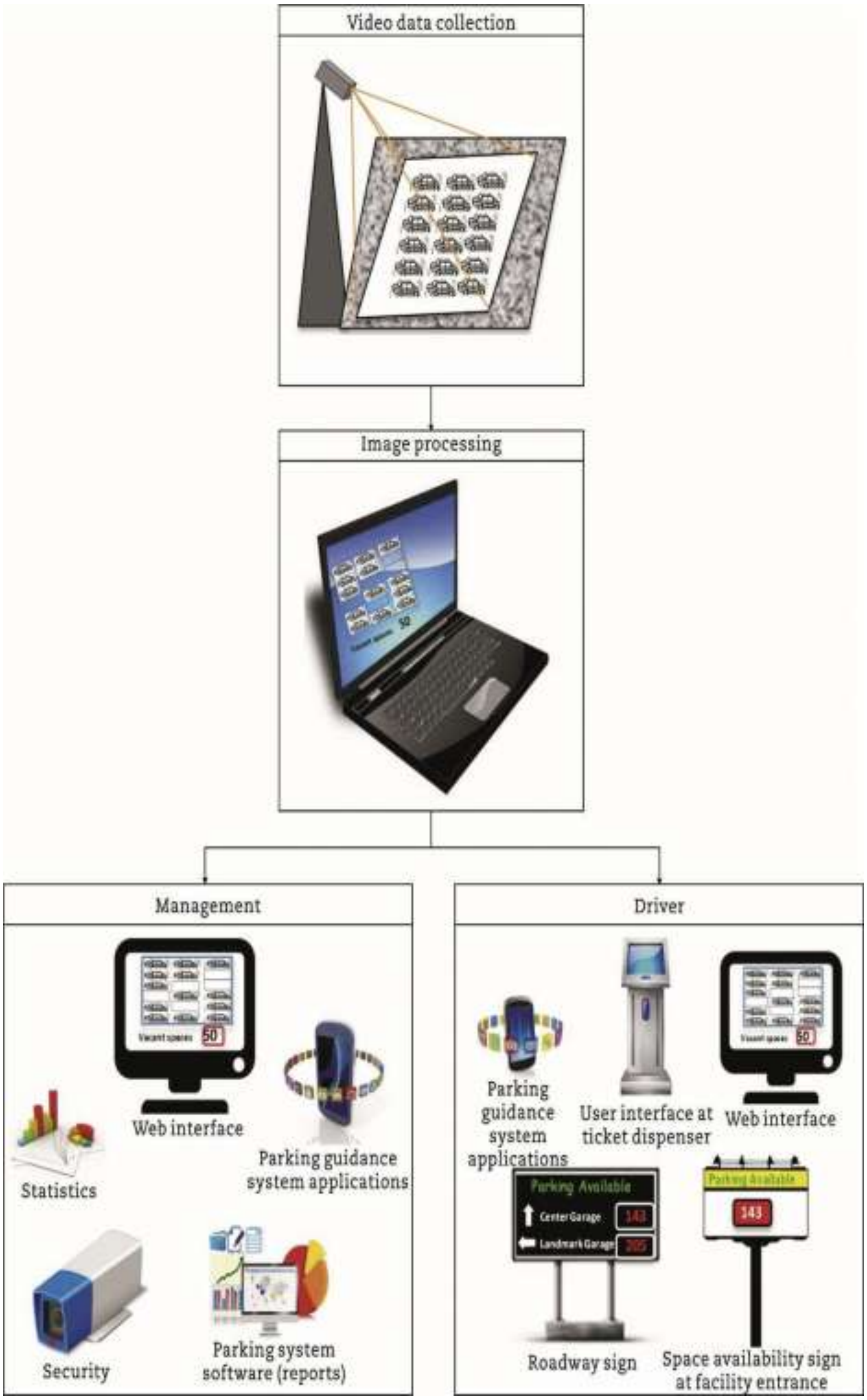

Fig. 01 Architecture of the proposed system.

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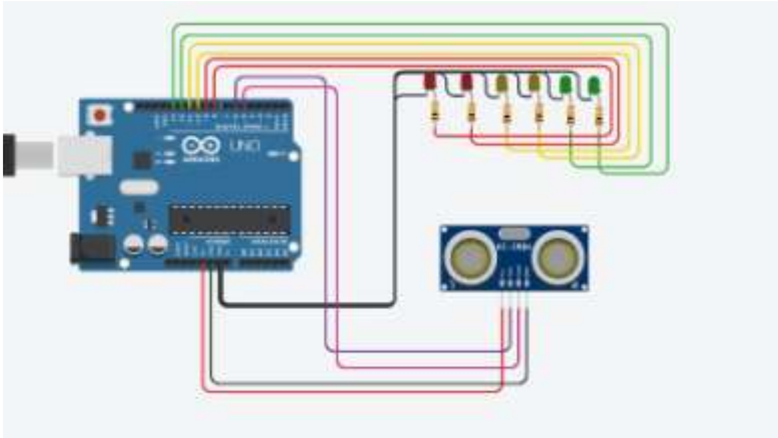

Fig. No. 02 Arduino Sensor

Fig. No. 03 Place pod Sensor

III. METHOD

3.1. System architecture

The proposed method depends on images obtained from video cameras fixed in a high position such as a high pole or wall to have coverage for the area needed. To start the processing,
videos obtained are sent to a central computer and sensors placed at parking lot detects the vacant space. The proposed method is then applied to provide the number and
location of available parking spaces in real-time. This information is provided to the drivers using different methods such as nearby dynamic message signs or at the entrance, a
mobile application, a user interface at the ticket dispenser, a web interface online, etc. Then, drivers can obtain real-time parking lot information and make reservations if needed. On
the other hand, garage operators can use the data for statistics regarding the use of the garage. The architecture of the proposed system is presented in this system.

3.2. Principle of detection

The vehicles are in the form of different shapes, sizes, and colors compared to white mark-off lines, casual shadows, or puddles for the parking spaces. Therefore, the detection depends on the common features of vehicles to detect their presence. The different elements of a vehicle include the hood, windows, headlights, bumpers, front grille, and license plate. The image taken for a vehicle will show the properties of the vehicles such as color, density, and texture. In concept, a parking space is considered occupied if it has a high number of
segments. If not, the parking space is considered vacant. In this study, a quadtree segmentation (grayscale level) method and place pod sensors are used to analyze each space. Assuming that every car has various components, which will play a role in the subdivision. On the other hand, vacant spaces would not have these characteristics, even in the case of having white lines,
building shadows, or puddles. Based on the above reasoning, the following solution is proposed. The obtained parking spaces, images are converted to grayscale level, and sensors gives signal to central

computers and then space is recognized as occupied or vacant based on the amount of division that has been executed.

3.3. System modules

Frames are obtained from the videos and converted to a grayscale level. Each frame is then compared to the previous frame, to identify if there are any noticeable changes. If no noticeable change appeared, the first frame is discarded and the count of the vacant parking spaces remains the same. Otherwise, if a noticeable change is shown, the frame is resized to a square image (512 pixel _ 512 pixel) then the quadtree algorithm is applied. Based on the algorithm, images of parking cells are segmented by gray level as explained in the flowchart. The same process is repeated iteratively until the criterion is met for each block meets. As a result, an image subdivided into several blocks can be obtained. A threshold on the number of blocks is established experimentally.

3.4. Image preparation

Images are converted from a true-color RGB image to grayscale. MATLAB functions are used for the conversion process by creating a weighted sum of the R, G, and B components: 0.2989R þ 0.5870G þ 0.1140B. First, the RGB values are converted to NTSC coordinates. Second, the hue and saturation components are set to zero then converted back to RGB color Space denotes the RGB to grayscale intensities conversation. For an 8-bit grayscale image, there are 256 different possible intensities, and so the histogram of the grayscale will graphically display 256 bins showing the distribution of pixels amongst those grayscale values. A true-color image can be converted to a grayscale image by preserving the luminance (brightness) of the image. The resulting image will be two-dimensional. The value 0 represents black and the value 255 represents white. The range will be between black and white values. The MATLAB function used is rgb2gray. Once applied I ¼ rgb2gray (RGB), it converts the true color image RGB to the grayscale intensity image I.

3.5. Quadtree concept

The main goal of image segmentation is partitioning the domain of an image into a set of disjoint regions. These regions are visually different and homogeneous with respect to some characteristics or computed properties. Those proprieties include grey level, texture, or color to enable easy image analysis. As a result, an image will be more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. In this method, this technique is used to classify the parking space for the presence of vehicles. This decomposition splits an image into four equal square blocks. Each block is then tested to identify if it meets some criterion of homogeneity. If the criterion is met for a block, this block will not be divided anymore. If the criterion is not met, the block is split again into four blocks, and the test criterion is repeated for the new blocks. The same process is applied until each block reaches the criterion. The result can have blocks of several different sizes. As shown, the criterion of homogeneity is calculated as the difference between the maximum and minimum pixel value in a square.
Max is the maximum value in the square block, Min is the minimum value in the square block, factor is the threshold defined for the division. The less the value is the more blocks we got. The function used in the study is “qtdecomp” (Eq. (1)).
S ¼ qtdecomp (Img, threshold) (1) Where Img is a grayscale square image, threshold is the factor of division. It is specified as a value that varies from 0 to 1. The S ¼ qtdecomp (Img, threshold) function splits a block if the maximum value of the block elements minus the minimum value of the block elements is greater than the threshold. The threshold is specified as a value between 0 and 1, even if Img is of class uint8 or uint16. If Img is uint8, 255 to determine the actual threshold to use multiply the threshold value you supply; if it is uint16, the threshold value supplied is multiplied by 65,535.
The threshold on the number of blocks is established experimentally. Identifying the threshold is conducted by applying the algorithm for 100 slots then calculating the percentage of segments compared to the number of the whole pixels in the slot. This method has several advantages including quick processing, easily finding areas of interest, simply reducing or increasing resolution by dealing with nodes, and not needing a database. The main disadvantage of this method is that it could suffer if the image has a high noise level.

3.6. Place Pods

The place pods are placed on the every parking lot. The main concept of this sensor is to detect the correct data. The correct data which helps to analysis the correct space for parking. The place pods are very small in size and round it self. Place pods are very durable less in weight that helps us to low coast system. Place pod smart

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sensors plays very much important role in sensing the correct location, after the location is further send to central computers located at main entrance. The data collector at the main gate show how much the vacant space is available foe park and that leads to car parker to park the car with very fast and easy way.

3.7. Arduino Sensor

The very first step of parking is entrance valuation, the very first stage to locate the space this sensors work for it. To show the parking space, to at the main entrance which helps us to get information to us if there is parking space available or not by showing on screen located in entrance space or in mobile application, web site etc. this leads to valuated the fast parking space which save the time, fuel of the car,etc.

3.8. Data collection

To test the proposed method using real-life data, data were collected from an outdoor parking lot in the City. A VGA web camera was mounted in a high position. The web camera ought to have almost the same features as the surveillance cameras-perhaps worse-in terms of resolution and image types and this was challenging but ensuring. The camera was mounted in the room which was about 30 m above the ground with a dip of 30_. The shooting range was about 25 m wide by 40 m deep, with 28 parking spaces involved. The parking of the hotel contained three rows. The first row contained 11 spaces, the second row had 9 spaces and 8 spaces composed the third row. The number of pixels for each space in images was different based on each row of parking as each row contained similar size spaces. Based on the recording time of 8 h, there were 32 frames (one frame every 15 min) and 28 spaces per frame, which results in 896 frames. Rainy and cloudy weather was selected as a preferred situation where the brightness and clearness of the images would suffer. It was chosen intentionally to guarantee a good performance of the algorithm with bad conditions assuring that it would definitively work for normal weather.

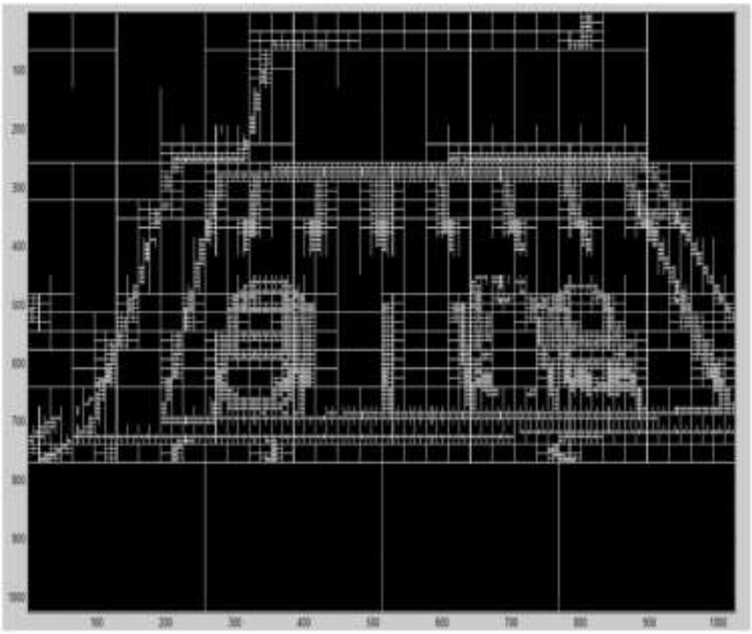

Fig. No. 04 Quadtree Analysis

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Fig. No. 05 Sensors and Cameras Working

IV. ANALYSIS

Computations were performed with a program written in MATLAB. Image Processing Toolbox, which provides a comprehensive set of reference-standard algorithms, functions, and applications for image processing, analysis, visualization, and algorithm development. It helped to perform image analysis, image segmentation, image enhancement noise reduction, geometric transformations, and image registration. Similarly, the visualization functions and applications explored images and videos and examined a region of pixels, adjust color and contrast, create contours or histograms, and manipulated regions of interest. The first 10 frames (280 individual frames) were used to determine the optimal threshold. The quadtree method was applied to the 280 spaces using four different factors (0.05, 0.10, 0.15, and 0.20). The predefined MATLAB function was used to apply the quadtree segmentation. The function splits a block if the maximum value of the block elements minus the minimum value of the block elements is greater than the threshold. The numbers represent the white pixels inside a spot. More white pixels indicate more details in the parking space. The bold numbers mean that they are below the threshold, which means they are detected as empty places. For each parking space, the percentage of white pixels was extracted and compared to the whole size of the slot. Scatter diagrams were drawn of the percentages to conclude the best factor to use. The best factor should provide almost two separate groups presenting vacant and nonvacant places. When comparing the initial four studied factors (0.05, 0.10, 0.15, and 0.20), it was found that the 0.05 factor provided the lowest number of overlaps (only 1 overlap) compared to 5 for 0.10, 8 for 0.15, and 8 for 0.20. To identify if there is a better factor than 0.05, two additional factors (0.03 and 0.04) were tested. Both provided a higher overlap (5 and 3) than the 0.05 factor. Therefore, a factor of 0.05 was used for the study case.

For the case study, the results indicated that 0.05 is the best division factor value, which indicated the best detection. Applying this factor to all data (896 frames), an error of only 0.3% was obtained with a detection rate of 99.7%. The error was decided based on performing a manual check to determine whether the detected parking space was vacant or occupied. The highest number of missed vehicles in any frame was one vehicle. In addition, the highest percentage of error in one frame was 4.8% (one out of 21 occupied vehicles was not detected). Also, the total number of frames with an error in identifying occupied parking spaces was 55 frames (6.1%). Thus, the proposed methods of vehicle detection were found to be efficient. The quadtree process took 0.051627 s. The quadtree process plus the detection took 0.092403 s. It should be noted that a MacBook Pro with Processor 2.8 GHz Intel Core i7, Memory 4 GB 1333 MHz DDR3 was used.

V. BENIFITS

1. Affordable rates for customers who can park their vehicles like cars and bikes with great significance, comfort and high security.
2. Fast Parking Method
3. Roadside parking can be avoided in certain abundance.
4. Clean, Green and less pollution in City
5. Traffic Jams can be avoided
6. These low cost systems are mostly sensor based and hence require less energy.

7. Job opportunities for staff guiding ,volunteering and security purposes.
8. Smart parking can reduce car emissions in urban centers by reducing the need for people to needlessly circle city blocks searching for parking.

VI. CONCLUSION

The population growth in most cities requires the design of efficient and sustainable traffic systems by taking full advantage of modern-day technology. Smart parking systems are one of the main components needed for the infrastructure of smart cities. The study proposed a new method for the detection of available parking spaces in outdoor parking lots using grayscale images and sensor based system acquired from video cameras and smart sensors. The proposed method is simple and accurately identified vacant parking spaces under different conditions. Using real-life data, the proposed method achieved a detection rate of 99.7%. The achieved

detection rate is higher than most available methods in the literature. These results can be enhanced if better quality cameras are used. Future studies could focus on testing the proposed method for other types of facilities to verify the detection rate such as large parking lots, indoor parking, parallel parking, and night conditions. Finally, developing a smart system that is based on video detection obtained from fixed surveillance video cameras and sensors in addition to other methods that depend on parking surveillance and enforcement technologies such as drones and dashboard cameras in parking enforcement vehicles should be investigated.

It reduces the risk of finding the parking slots in any parking area and also it eliminates unnecessary travelling of vehicles across the filled parking slots. It reduces time and it is cost effective also. It is well managed to access and map the status of parking slots from any remote location through web browser and smart cameras. The time for searching the availability of parking lots has been eliminated by displaying the status of the parking lots at the entrance of the parking area. The future work for this system can be made by enhancing the security feature.

This designed automatic smart parking system which is simple, economic and provides effective solution to reduce carbon footprints in the atmosphere.

VII. FUTURE SCOPE

First and foremost, the thing is to study carefully and understand the Scope of Services of the system. The scope of work involves chain of fields like transportation engineering. To predict quality of parking method. If this is implemented in all the smart cities then the smart cities and infrastructure of our area will improve. The infrastructure is the most important part of life now a days.

REFERENCES

[1]. Arellano-Verdejo, J., Alonso-Pecina, F., Alba, E., et al., 2019. Optimal allocation of public parking spots in a smart city problem characterisation and first algorithms. Journal of Experimental & Theoretical Artificial Intelligence.

[2]. Arun, C., Karthick, S., Selvakumarasamy, S., et al., 2021. Car parking location tracking, routing and occupancy monitoring system using cloud infrastructure. Materials Today Proceedings.

[3]. Ata, A., Khan, M.A., Abbas, S., et al., 2019. Modelling smart road traffic congestion control system using machine learning techniques. Neural Network World 29 (2), 99e110.

[4]. Atta, A., Abbas, S., Khan, M.A., et al., 2020. An adaptive approach: smart traffic congestion control system. Journal of King Saud University-Computer and Information Sciences 32 (9), 1012e1019.

[5]. Bibi, N., Majid, M.N., Dawood, H., et al., 2017. Automatic parking space detection system. In: The 2017 2nd International Conference on Multimedia and Image Processing. ICMIP), Wuhan.

[6]. Gabbe, C., Pierce, G., Clowers, G., 2020. Parking policy: the effects of residential minimum parking requirements in Seattle. Land Use Policy 91, 104053.

[7]. Iqbal, K., Abbas, S., Khan, M.A., et al., 2021. Autonomous parking lots detection with multi-sensor data fusion using machine deep learning techniques. Computers, Materials & Continua 66 (2), 1959, 1612.

[8]. Koushika, B., PraveenKumar, G., Priyadharshini, S., et al., 2021. An efficient car parking slot identification system using image processing. Annals of the Romanian Society for Cell Biology 13, 3400e3414.

[9]. Kumar, M., Ray, S., Yadav, D.K., 2021. A survey on moving object detection in video using a moving camera for smart surveillance system. In: International Conference on Machine

[10]. Intelligence and Data Science Applications. Cumilla, 2021.

[11]. Ku¨ nzli, N., Kaiser, R., Medina, S., et al., 2000. Public-health impact of outdoor and traffic-related air pollution: a European assessment. The Lancet 356 (9232), 795e801.
[12]. Li, W., Cao, L., Yan, L., et al., 2021. Vacant parking slot detection and tracking during driving and parking with a standalone around view monitor. Proceedings of the Institution of
[13]. Mechanical Engineers, Part D: Journal of Automobile Engineering 235 (6), 1539e1551.
[14]. Maria, G., Baccaglini, E., Brevi, D., et al., 2016. A drone-based image processing system for car detection in a smart transport infrastructure. In: 18th Mediterranean Electrotechnical
[15]. Conference (MELECON). Lemesos, 2016.
[16]. Matsuda, A., Matsui, T., Matsuda, Y., et al., 2021a. A method for detecting street parking using dashboard camera videos. Sensors and Materials 33 (1), 17e34.
[17]. Matsuda, A., Matsui, T., Matsuda, Y., et al., 2021b. A system for real-time on-street parking detection and visualization on an edge device. In: 2021 IEEE International Conference on
[18]. Pervasive Computing and Communications Workshops and Other Affiliated Events (PerCom Workshops). Kassel, 2021.
[19]. Ostermeijer, F., Koster, H.R., van Ommeren, J., 2019. Residential parking costs and car ownership: implications for parking policy and automated vehicles. Regional Science and Urban Economics 77, 276e288.
[20]. Perkovi_c, T., _Soli_c, P., Zargariasl, H., et al., 2020. Smart parking sensors: state of the art and performance evaluation. Journal of Cleaner Production 262, 121181.
[21]. Sarangi, M., Das, S.K., Babu, K.S., 2019. Smart parking system: survey on sensors, technologies and applications. In: 1st International Conference on Advances in Information Technology (ICAIT). Chikmagalur, 2019.
[22]. Sarkar, S., Totaro, M.W., Elgazzar, K., 2019. Intelligent drone-based surveillance: application to parking lot monitoring and detection. In: Unmanned Systems Technology XXI. Anaheim, 2019.
[23]. Shaaban, K., Shakeel, K., Rashidi, T.H., et al., 2021. Measuring users' satisfaction of the road network using structural equation modeling. International Journal of Sustainable Transportation.