International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/CSEIT217295

# Real-Time Smart Parking: Challenges and Solution using Machine learning and IoT

**Biren Bishnu Prasad Sahoo[1], Shahjad[2], Prakash Singh Tanwar[1*]**
[1]Computer Science and Engineering, Lovely Professional University, Phagwara, Punjab, India
[2]Computer Science and Engineering, Lovely Professional University, Phagwara, Punjab, India
[3]School of Computer Science and Engineering, Lovely Professional University, Phagwara, Punjab, India

**Article Info**
Volume 7, Issue 2
Page Number: 451-458

**Publication Issue :**
March-April-2021

**Article History**
Accepted : 20 April 2021
Published : 25 April 2021

**ABSTRACT**

Modernization is something that everyone wants. With the increase in modernization, people are expecting to live a sustainable and hassle-free life. In this modern society, Parking is a major issue. Due to the growing number of vehicles in these cities, parking becomes a challenging task. We have tried to boost this particular system with the help of modern technologies i.e., the Internet of Things and Machine Learning. So that we can enhance the solution for this challenging issue efficiently.

**Keywords :** Smart Parking, Internet of Things (IoT), Deep Learning, Sensors, Object Detection, Real-time Feeds

## I. INTRODUCTION

Nowadays many people are migrating from rural villages to urban cities and that's causing an increase in the population density of the cities than ever. The development of sensor technology brings a new administrative model to set up, establish, and encourage sustainable progressive systems to direct surging urbanization parking issues. Supportable mobility and lowering traffic are a few of the important oppositions of developments especially in the case of finite proximity of parking. Through the growing technology, the conception of the Internet of Things and Deep learning can be used to design a smart city that can slowly address mobility issues and can also help to provide a sustainable architecture to the cities. Anyway, due to the huge number of automobiles on roads, parking is a strenuous job. Generally, riders waste fuels in liters trying to find a spot for parking. Also, the rider generally wastes 5 to 15 minutes to find a parking space. Apart from that it annoys, traffic, fuel consumption and pollution. So in the given scenario, knowing about the available parking spaces beforehand can help to remove the issues. With the help of IoT integration and deep learning techniques, we can mitigate this issue by analyzing, predicting, and booking an available parking space.

## II. LITERATURE REVIEW

In previous works, some solutions are proposed in [18] to improve the parking process.

In this paper [18], Lookmuang et al. presented smart parking using IoT technology. For each car park, a sensor was fixed in the ceiling above each parking space. Ultrasonic sensors operate based on echolocation, emitting a sound, which is reflected by the sensor, the driver is guided by a LED display board. The presence of any vehicle alters the timing of the reflection. These are similar to a general Informative Parking System (IPS).

They [18] proposed a system that selects advantage other proposed systems and includes new technology to better performance. In this, the driver first checks the mobile application to locate the nearest vacant slot in the area then the driver drives to the notified vacant parking slot and parks the car. The driver uses a mobile application to find his/her parked location and the current parking fee and at last, the driver returns to the car and exits the parking space.

Another paper [1] has reviewed the different vision-based smart parking system methods to address vacant parking spaces' detection using a camera as the sensor. Conclusively, the paper has shown that vision-based smart parking systems are preferable to sensor-based smart parking systems. It may be the future of a smart parking system with accuracy, reliability, scalability, and efficiency. A vision-based system algorithm is more flexible. This will make the management of parking spaces more effective.

Along with the above, we have reviewed other papers too. But to our conclusion, every paper has worked out their technique with only one or two technologies of a specific domain and every research has a gap to be fulfilled. But if we combine two different domains to narrow down that research gap, it will give much fewer errors to counter.

## III. Methodology

We have been inspired by many previous works to create this smart parking model. This model is a combination of two different domains i.e., Internet of Things (IoT) and Machine Learning. The IoT part of the model includes sensor (IR sensor), controller, power supply and an application (common for both the part). For the prototype model, we have used IR sensors for detection whereas in real-time sensing ultrasonic sensors can be used for the same [5]. The sensors detect and inform the users through the application if there are any slots available for parking or booking. The ML part of the model includes the camera, controller, power supply, and application. The camera is used for real-time detection of cars (objects) for confirming the available parking space [2].

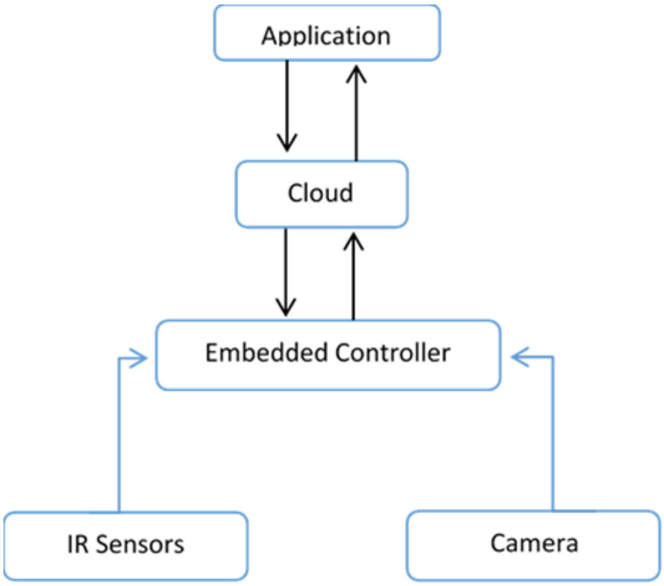


Fig. 1: Proposed Architecture Model

How IoT play role in smart parking

An infrared (IR) sensor plays an important role in this model as it is an electronic device that measures and detects infrared signals in its environment. When any object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver. This gives an output of two types i.e., either true or false. (0 or 1 in form of bits). These sensors detect the object in their surroundings and send signals to the controller regarding the same, and in this way, it confirms the particular slot is booked or free to use [6]. In the case of a controller, any microcontroller can be used like Arduino, NodeMCU, etc.

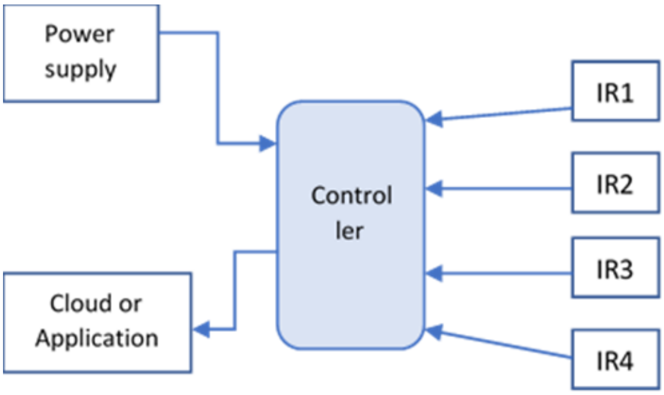


Fig. 2: Sensor Architecture Network

However, we are using NodeMCU in our Model. These Controllers are low-cost open-source IoT platforms. It includes code firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that was based on the ESP-12 module [13]. A predefined algorithm is pushed into the microcontroller which ensures all the working of the sensors are best and it also sends data to the cloud database or firebase database as we have used in our model. These data can be accessed via an application for use [14].

How Machine Learning plays role in smart parking

We are using the YOLO object detection model, which is fairly good in real-time object detection [4]. We are using this particular model for detecting whether the parking space is available or not.

YOLO stands for the "You Only Look One" model, which allows us to perform some custom object detection as per our use. We have used the YOLO-v4-tiny-3l model which is a lightweight variant of YOLO, and it is primarily used for real-time object detection [7].

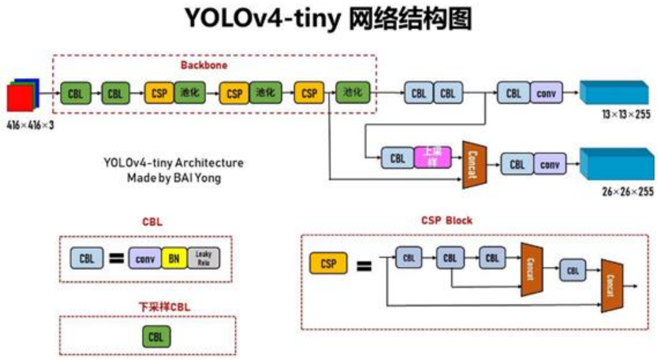


Fig. 3: YOLO tiny architecture (credited to BAI Yong [25])

We have also used OpenCV, which is an open-source computer vision library. It is primarily used for projects which are related to computer visions [8]. As per our project, we have utilized the particular library for taking the real-time feed from the camera and we have also utilized its neural network library, which gives us an extra advantage to use our custom object detection neural network for getting output from it and allowing us to create a bounding box around objects after detection [9].

## IV. IMPLEMENTATION

Since we are using two tech stacks i.e., Internet of Things and custom object detection using YOLO for better confirmation of available parking spaces irrespective of weather condition, lighting condition, etc.

Implementation of IoT part

In the given below image, as we can see it's a parking lot description, that is how the arrangements are to be made for this project to happen. For a given parking lot, each parking slot has a sensor for detecting an object (car) and confirming it to the database. Also, there are cameras for real-time parking space detection and also confirming it to the database [10].

Any car/ driver coming to the parking can check the available slots in the application beforehand to avoid traffic hassle and congestion or wasting time searching for parking. Once the driver sees any available parking slot in the given parking lot. he/ she can book it in advance or can directly come for parking as per their wish. Once they book it or park the car, it will automatically database that the same slot is booked or not available [22]. Similarly, if the driver leaves the parking slot with their car, the sensor and camera confirm and update the database that the space is available for parking.

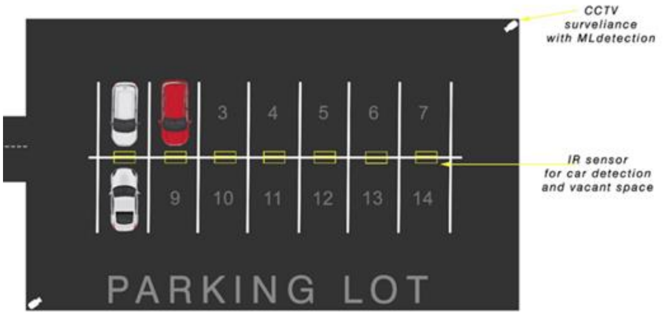


Fig. 4: Sample Parking lot design

Sensor parking detection workflow

We have mentioned a small workflow with a sample algorithm for IoT sensors, for how it will work in real-time.

In this algorithm, status = 1, if the sensor activates, then status! = 0 is for the detection of cars via camera. If yes then we can use an ultrasonic sensor to measure the distance and use it for the algorithm. If the distance is greater than equal to 5 meters then there is no vehicle in the parking slot and it loops backs. And if it's the opposite case then it detects the vehicle is parked and sends all the data to the cloud database [20].

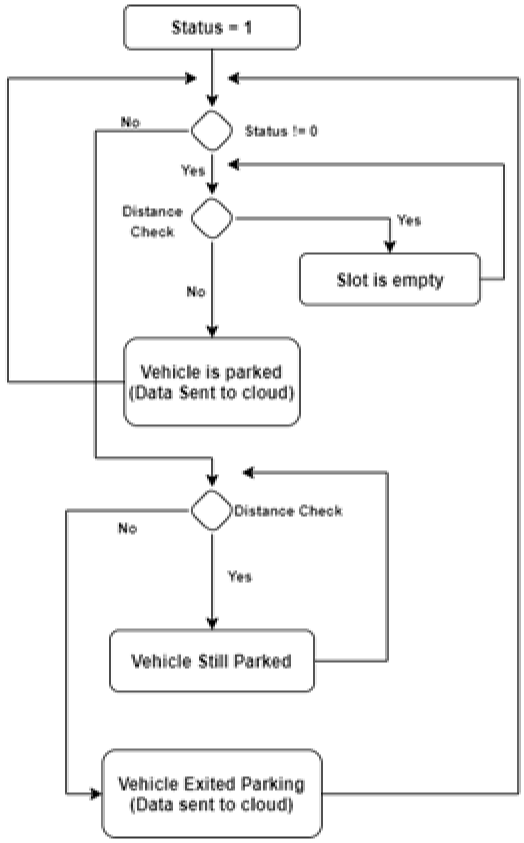


Fig. 5: workflow diagram

Real-time parking space confirmation

For this particular process, we used an object detection model named YOLO-v4-tiny-3l model as mentioned earlier. Below we are covering the steps that we followed to accomplish real-time parking space detection. Although it is a real-time car and parking space (object) detection.

Creating Bounding Boxes on custom object: In this particular step, we first created bounding boxes on cars that are parked and on the available parking spaces along with that we have labeled them as occupied (car is parked) and not occupied (car is not parked).

Fig. 6: Creating Bounding Boxes

**Configuring YOLO model:** In this step, we have configured the Yolo-v4-tiny-3l model configuration file, where we have updated the number of classes i.e., two, namely occupied and not occupied. Along with that, we have also updated the number of filters to 21, this is an important step to perform, which tells our model about what kind of bounding box we are making on a custom object.

**Generating training and test files:** In this particular step, we have generated two text files. The first one is training.txt, which contains the path of our images or custom objects. These particular files allow the model to fetch the image for training as well as testing while learning

**Results**

In this particular section, we are covering the results of our smart parking detection and along with that, we are also sharing the parameters on which we have tested the object detection model.

Real-time parking space detection:

As we can see from the below two images, we are getting perfect bounding boxes around the objects showing the occupied and not occupied label, which we have trained as an object detection model.

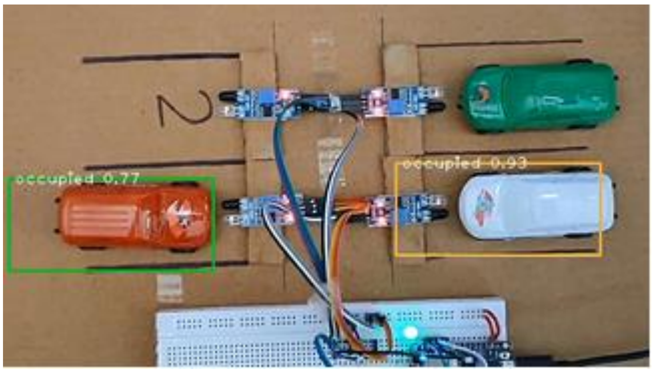


Fig. 7: Detecting Occupied Spaces

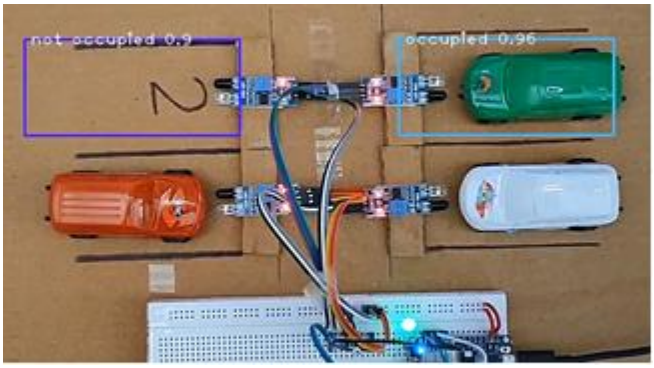


Fig. 8: Detecting not occupied spaces

Performance graph:

As we can see from the below graph that as the no. of iterations increases the model loss (error) decreases, which is a good sign that the model is learning well and is not confused with the objects. For more confirmation, we can see the images shown above.

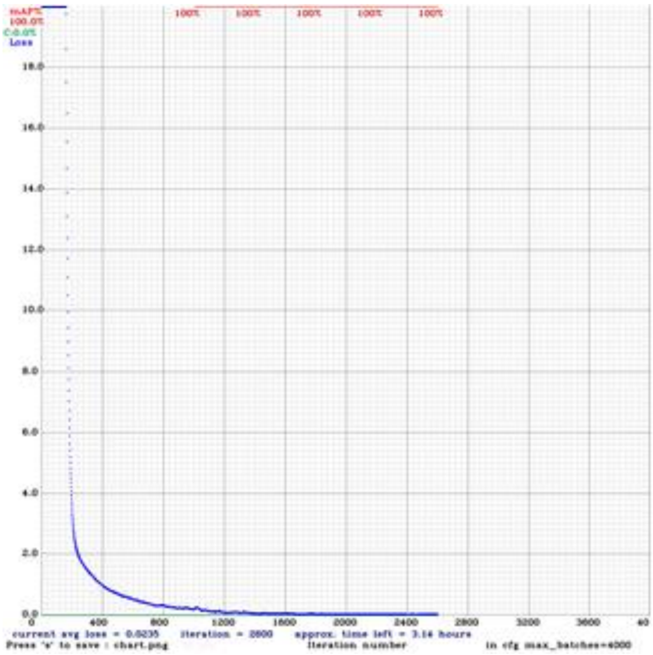


Fig. 9: Performance Graph

Evaluation parameters: **For evaluating the model, we have used a two-parameter on which an object detection model is evaluated.**

1. **IoU (intersect over union):** average intersect over union of objects and detections for a certain threshold = 0.24
2. **mAP (mean average precision):** mean value of average precisions for each class, where average precision is an average value of 11 points on PR-curve for each possible threshold (each probability of detection) for the same class (Precision-Recall in terms of PascalVOC, where Precision=TP/(TP+FP) and Recall=TP/(TP+FN))

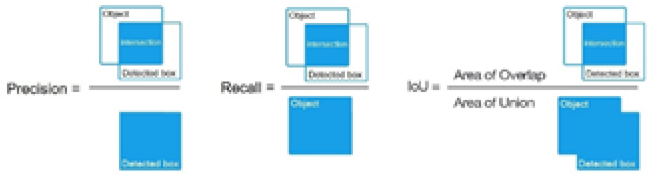


Fig. 10 : Parameters for Model testing

| Weights | Precision | Recall | F1 Score | True Positive | False Positive | False negative | Average IoU |
|---|---|---|---|---|---|---|---|
| Last | 100 | 100 | 100 | 64 | 0 | 0 | 91.40% |
| Best | 100 | 100 | 100 | 64 | 0 | 0 | 82.45% |
| 2000 | 100 | 100 | 100 | 64 | 0 | 0 | 90.79% |
| 1000 | 100 | 100 | 100 | 64 | 0 | 0 | 82.45% |

Table 1: Result Table

We have used mean average precision as a parameter to evaluate model performance and for more confirmation, we can see the red line on the performance graph, which tells us that model is some x% confident about detection.

## Conclusion

So as to conclude, there will always be advantages and disadvantages to any idea to develop into a full-fledged working in social form. But it is our methodology that will ensure the major path that our idea will take. In our case, using two different domains i.e. Internet of Things and Machine Learning would certainly ensure a greater result with a very less amount of error that could have occurred due to any climatic factor or any lightning issue. The future of these kinds of techs is highly growing and these techniques can be utilized in various other fields like hospitals, protected areas, etc.

## V. REFERENCES

[1]. Abidin, M. Z., & Pulungan, R. (2020). A Systematic Review of Machine-vision-based Smart Parking Systems. Scientific Journal of Informatics, 7(2), 213-227. Retrieved from https://www.researchgate.net/profile/Muhammad_Zainal_Abidin/publication/346588094_A_Systematic_Review_of_Machine-vision-based_Smart_Parking_Systems/links/5fdabafc45851553a0c23839/A-Systematic-Review-of-Machine-vision-based-Smart-Parking-Systems.pdf

[2]. Acharya, D., Yan, W., & Khoshelham, K. (2018). Real-time image-based parking occupancy detection using deep learning. 5th Annual Conference of Research, 2087, 33-40. Retrieved from https://www.researchgate.net/profile/Debaditya-Acharya/publication/323796590_Real-time_image-based_parking_occupancy_detection_using_deep_learning/links/5f6d871fa6fdcc00863a6e22/Real-time-image-based-parking-occupancy-detection-using-deep-learning.pdf

[3]. Alam, M., Moroni, D., Pieri, G., Tampucci, M., Gomes, M., Fonseca, J., . . . Leone, G. R. (2018). Real-Time Smart Parking Systems Integration in Distributed ITS for Smart Cities. Journal of Advanced Transportation, 2018. doi:https://doi.org/10.1155/2018/1485652

[4]. Ali, G., Ali, T., Irfan, M., Draz, U., Sohail, M., Glowacz, A., . . . Martis, C. (2020). IoT Based Smart Parking System Using Deep Long Short

Memory Network. Electronics, 9(10). doi:https://doi.org/10.3390/electronics9101696

[5]. Alsafery, W., Alturki, B., Reiff-Marganiec, S., & Jambi, K. (2018). Smart Car Parking System Solution for the Internet of Things in Smart Cities. International Conference on Computer Applications & Information Security (ICCAIS), 1-5. doi:10.1109/CAIS.2018.8442004

[6]. Al-Turjmana, F., & Malekloo, A. (2019). Smart parking in IoT-enabled cities: A survey. Sustainable Cities and Society, 49. doi:https://doi.org/10.1016/j.scs.2019.101608

[7]. Amato, G., Carrara, F., Falchi, F., Gennaro, C., & Vairo, C. (2016). Car parking occupancy detection using smart camera networks and Deep Learning. IEEE Symposium on Computers and Communication (ISCC). doi:10.1109/ISCC.2016.7543901

[8]. Amato, G., Carrara, F., Falchi, F., Gennaro, C., Meghini, C., & Vairo, C. (2017). Deep learning for decentralized parking lot occupancy detection. Expert Systems with Applications, 72, 327-334. doi:https://doi.org/10.1016/j.eswa.2016.10.055

[9]. Bura, H., Lin, N., Kumar, N., Malekar, S., Nagaraj, S., & Liu, K. (2018). An Edge Based Smart Parking Solution Using Camera Networks and Deep Learning. IEEE International Conference on Cognitive Computing (ICCC), 17-24. doi:10.1109/ICCC.2018.00010

[10]. Chauhan, V., Patel, M., Tanwar, S., Tyagi, S., & Kumar, N. (2020). IoT Enabled real-Time urban transport management system. Computers & Electrical Engineering, 86. doi:https://doi.org/10.1016/j.compeleceng.2020.106746.

[11]. Dsouza, k. B., Muhammad, S., & Hussain, Y. (2017). Smart parking — An integrated solution for an urban setting. 2nd International Conference for Convergence in Technology (I2CT), 2017. doi:10.1109/I2CT.2017.8226115

[12]. Fraifer, M., & Fernstrom, M. (2016). Investigation of Smart Parking Systems and their technologies. Thirty Seventh International Conference on Information Systems, IoT & Smart City Challenges and Applications. Retrieved from https://www.researchgate.net/publication/311535831_Investigation_of_Smart_Parking_Systems_and_their_technologies

[13]. Hasan, M. O., Islam, M. M., & Alsaawy, Y. (2019). Smart Parking Model based on Internet of Things (IoT) and TensorFlow. 7th International Conference on Smart Computing & Communications (ICSCC), 2019. doi:10.1109/ICSCC.2019.8843651

[14]. Ke, R., Zhuang, Y., Pu, Z., & Wang, Y. (2020). A Smart, Efficient, and Reliable Parking Surveillance System With Edge Artificial Intelligence on IoT Devices. IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, 1-13. doi:10.1109/TITS.2020.2984197

[15]. Khalid, M., Wang, K., Aslam, N., Cao, Y., Ahmad, N., & Khan, M. K. (2021). From smart parking towards autonomous valet parking: A survey, challenges and future Works. Journal of Network and Computer Applications, 175. doi:https://doi.org/10.1016/j.jnca.2020.102935

[16]. Lee, C., Park, S., Yang, T., & Lee, S.-H. (2019). Smart Parking with Fine-Grained Localization and User Status Sensing Based on Edge Computing. IEEE 90th Vehicular Technology Conference (VTC2019-Fall), 1-5. doi:10.1109/VTCFall.2019.8891560

[17]. Lin, T., Rivano, H., & Mouël, F. L. (2017). A Survey of Smart Parking Solutions. IEEE Transactions on Intelligent Transportation Systems, 18(12), 3229 - 3253. doi:10.1109/TITS.2017.2685143

[18]. Lookmuang, R., Nambut, K., & Usanavasin, S. (2018). Smart parking using IoT technology. 5th International Conference on Business and Industrial Research (ICBIR), 2018. doi:10.1109/ICBIR.2018.8391155

[19]. Nie, Y., Xu, K., Chen, H., & Peng, L. (2019). Crowd-parking: A New Idea of Parking Guidance Based on Crowdsourcing of Parking Location Information from Automobiles. IECON 2019 - 45th Annual Conference of the IEEE Industrial Electronics Society. doi:10.1109/IECON.2019.8927134

[20]. Paidi, V., Fleyeh, H., Hakansson, J., & Nyberg, R. G. (2018). Smart parking sensors, technologies and applications for open parking lots: a review. IET Intelligent Transport Systems, 12(8), 735-741. doi:https://doi.org/10.1049/iet-its.2017.0406

[21]. Tang, C., Wei, X., Zhu, C., Chen, W., & Rodrigues, J. J. (2018). Towards Smart Parking Based on Fog Computing. IEEE Access , 6, 70172-70185. doi:10.1109/ACCESS.2018.2880972

[22]. Tekouabou, S. C., Alaoui, E. A., Cherif, W., & Silkan, H. (2020). Improving parking availability prediction in smart cities with IoT and ensemble-based model. Journal of King Saud University - Computer and Information Sciences. doi:https://doi.org/10.1016/j.jksuci.2020.01.008.

[23]. Xiang, X., Lv, N., Zhai, M., & Saddik, A. E. (2017). Real-Time Parking Occupancy Detection for Gas Stations Based on Haar-AdaBoosting and CNN. IEEE SENSORS JOURNAL, 17(19), 6360-6367. doi:10.1109/JSEN.2017.2741722

[24]. Zajam, A., & Dholay, S. (2018). Detecting Efficient Parking Space Using Smart Parking. 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT). doi:10.1109/ICCCNT.2018.8493964

[25]. https://www.programmersought.com/article/47074592210/

[26]. https://github.com/AlexeyAB/darknet#how-to-train-to-detect-your-custom-objects



**Cite this article as :**

Biren Bishnu Prasad Sahoo, Shahjad, Prakash Singh Tanwar, "Real-Time Smart Parking: Challenges and Solution using Machine learning and IoT", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 7 Issue 2, pp. 451-458, March-April 2021. Available at doi : https://doi.org/10.32628/CSEIT217295

Journal URL : https://ijsrcseit.com/CSEIT217295