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Smart Parking Utilizing IoT Embedding Fog Computing Based on Smart Parking Architecture

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Abstract— **Rapid population growth and skyrocketing demand of private transportation bloom the market of automakers worldwide. The concept of automated parking system under smart city arises with the availability of the technology like fast internet connections, offloading computational resources, IoT devices communicating various devices each other, to uplift the quality of life. Revolution of cloud computing and ease of this technology also open the door for better opportunities for smart parking where a system can be served from the remote area, but there is an issue with cloud computing for cost of operation and latency of the services. In urban cities there is rapid growth of population and there is advancement of automotive industries, there are lots of vehicles that are being used in all the cities which creates a lot of issues like road congestions, issue in parking spaces. This paper proposes the fog computing architecture to reduce the latency and efficiently utilise all the available technologies together by building fog computing architecture network which is a multi-tier structure where applications runs jointly, communicates and compute with each other. Smart parking has gain massive attention due to ease and outcome from those technologies are exponential. The role of Internet of Things and fog computing enable the platform to minimize the take duration for finding the parking space, this reduces the time and excess use of fuel and emission of CO2, these are the consequence of over and unmanaged vehicles in the urban areas and unmanaged parking areas.**

Keywords— Fog computing architecture, IoT, smart city, smart parking

I. INTRODUCTION

Fog computing is noticeable emerging concept that has succeeded in becoming an integral part of our daily life by enabling any object around us to produce, connect, and transfer data via network technologies i.e., 4G [1]. IoT services have become data-driven, which allows them to achieve better recommendations and predictions of future trends of events in smart cities, such as the recommendation of the best available car parking lot. Due to emerging of smart city concept, various applications of way of doing things has been changed, vehicles are the most important part of transportation and if this can be guided for ease of the user, then it can solve the most frustrating situation for parking and driving in the problems urban cities. The vision of smart city brings lots of various technologies together and to communicate with all those technologies will be very complex task. This will bring a lot of latency in between the various communication devices the major problem in the urban area is road congestions due to driver who are constantly looking for the parking space with leads to heavy environment and economic consequence and the major issue is that it is likely to hide the road users whose root cause is that driver don't exactly knew the location of free parking space as per their expectation and they had to roam around to find the best or any free space [2],[3]. Traffic jams in causes frustrations, loss of money and time and excess use of fuel and emission of CO2, these are the consequence of over and unmanaged vehicles in the urban areas and unmanaged parking areas [4].

In urban cities there is rapid growth of population and there is advancement of automotive industries, there are lots of vehicles that are being used in all the cities which creates a lot of issues like road congestions, issue in parking spaces [1]. Due to emerging of smart city concept, various applications of way of doing things has been changed, vehicles are the most important part of transportation and if this can be guided for ease of the user, then it can solve the most frustrating situation for parking and driving problems in the urban cities [5]. There is a huge issue on quality of service and experience due to the growing vehicles and services which directly hampers the quality of services [6].

Fog computing is extended service of cloud computing to overcome the issues like latency and lack of mobility. Intrusion Detection System is integral part for security system for fog computing and IoT. Since, fog is emerging technology where lots of fog devices are place where there is no proper security to overcome this issue by introducing intrusion detection technique [7].

II. LITERATURE REVIEW

A. Data Collection

The required data is collected from sensors, cameras and use of datasets as an input for the system, Real world on street parking availability data can be obtained from SFPark project, OpenMapStreet, Crowd sensed parking datasets [2]. On the site of parking, installed cameras, sensors, RFIDs, can also be used to collect data as a source of input. Road Site Units also contribute for providing the information of the flow of the vehicles on the site which can be used to predict the busy street or quiet. This also leads as a important information to project the behaviour of parking and inflow of the vehicles in the parking areas [6].

The data collected from various links such as things to things connected devices or nodes such as traffic lights sensors, cameras , cellular data or from drone data to fog nodes and then transferred to servers, cloud for future reference whereas parking data is collected from stationary sensors, open street map networks , taxi traces which is pre-processed through Kalman filters providing accurate data with corrections [8]. Fast offset xpath service design collects the data from the various cloudlets consisting of road side units internet connections through Wi-Fi, LTE which is then transferred to IP Core networks [4] whereas high level

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vehicular network with connected road side units and base station collects data from linked sensors and cameras which is transferred to cloud services from road side units [5].

B. Fog Computing Architecture

Fog computing is extended service of cloud computing to overcome the issues like latency and lack of mobility. Intrusion Detection System is integral part for security system for fog computing and IoT. Since, fog is emerging technology where lots of fog devices are place where there is no proper security to overcome this issue by introducing intrusion detection technique [7]. This build a security system for any network which can detect the security breaches as soon as possible. The author proposed two major methods i.e. signature-based methods and anomaly-based methods to match the current behaviour of network [1]. Vehicular fog computing VFC as a prominent approach for providing low latency services by extending the fog computing to conventional vehicular networks. For the higher demand of application, roadside unit RSU can be deployed in different areas of city and can be equipped with fog computing servers which can provide communication and computational services in the mobile terminals [8].

Fog computing enhance the experience of the smart parking allocation algorithm to guide the driver to available spot and provides the detail information to the driver [9]. This lightweight intrusion detection system is very useful because of resource limitation of fog and IoT devices where light weight intrusion detection system is widely popular [7]. Liao [10] maintains the congestions and obstacles in the networks by introducing vehicles mobility based on geographical migration model from the vehicular computing resource which is enabled by fog computing.

C. Performance and Accuracy

The FOCAN architecture manages the low latency and designed for managing the things' application which computes the efficient communication structure and has high scalable routing algorithm that minimizes the average power consumption of FNs [8]. The transfer of data can be more efficient if there is more research is done and this can be significantly improved by extending the 5G coverage considering the huge number of things that use stream application. The heterogenous technologies can be merged together where there can work together simultaneously to get a desired service from the various technologies. In the smart city application where there are various number of applications are operating at the edge of the internet to fulfil the requirement like provide quick services and reduce latency, consumption of less energy. For this fog computing architecture network helps to reduce latency, energy consumptions and promotes efficiency [5]. Quick response for available parking space is most important service in the urban area which will benefit lots of people and also helps in reducing the unwanted use of energy with various technology and techniques including Kalman filter with machine learning using sensors and cameras [2].

By reducing the localization error utilizing novel multi-objective grey wolf optimization technique for nodes, this establish the automation parking system which benefits the drivers of the vehicles using global positioning system and multi objective grey wolf optimization tools [3]. Light weight intrusion detection system is the best security system for fog and IoT networks to ensure the quality of service.

D. Technique for better guide for smart parking

The novel multi-objective grey wolf optimization technique to overcome the parking challenges by localizing node to minimize the local error [3]. The intrusion detection technique which anomaly-based technique, multilayer perception or light weight intrusion detection system are the best security system for fog and IoT networks for quality service because this technique can be executed under limited resources on fog computing [7]. Whereas, multiple criteria decision analysis and technique for order of preference by similarity to ideal solution provides an idea of coordination of fog to cloud platform with middleware architecture to choose an adequate service for processing IoT data [1] explains the vehicular fog controllers, parked vehicle assistance approach with open street map with single round auction design and smart vehicular fog controller and also adopting data from roadside units providing low latency services extending fog computing to conventional vehicular network for higher demand application.

E. Medium of Communications

Data and instruction are transferred using various medium such as 4G, LTE, WiFi, Giga Ethernet, WiMax, Bluetooth, Vanet. Varghese [11] proposed a system to transfer the information from one component of system to another through WiFi which helps in enhancing the experience of identifying vacant space efficiently. GPS provides the accurate data for positioning the desire object or vehicle which provide very important data for the system which helps to determine the traffic congestion in the urban cities [12]. High quality sensor provide the better data for the system to work with and promotes better outcome for which high speed internet connection or medium for communication between the nodes, sensors and the receivers, computing devices should have high speed data transfers where WiFi technology is crucial [2].

F. Measurement Tools

The use of vFog framework instead of traditional vehicular cloud-based technique which eliminates the latency and centralized services [5]. This fog computing feature is lightweight will can be easily be deployed on commodity hardware's along with OMNEt++, VEINS, SUMO and Roadside [10]. The MATLAB, Excel and GPS enabled taxi to make a great tool for improving the efficient collaboration of vehicles to minimize the traffic congestion [12]. Demand side management in microgrid by studying the data of charging and discharging behaviour can also be done by using the various tools including MATLAB in microgrid [13]. Use of ultra-wide band for real time location tracking based compact base station antenna along with 7 dB gain by placing a reflector plan which improve the localisation accuracy of ultra-wide band of real time location system [14].

III. Framework

The system components are the core mechanism shows how the system work. At the beginning of the research, a conceptual system was developed based on review work and analysing carefully of the emerging technologies around the world. The work of researcher which were conducted in past years were also been considered to study of cloud computing and fog computing for enhancing the experience of the vehicle owner for their parking experience. Various methods were being studied for the purpose of identifying and understanding of efficiency and ease of parking system which delivers smooth experience of parking the vehicles.

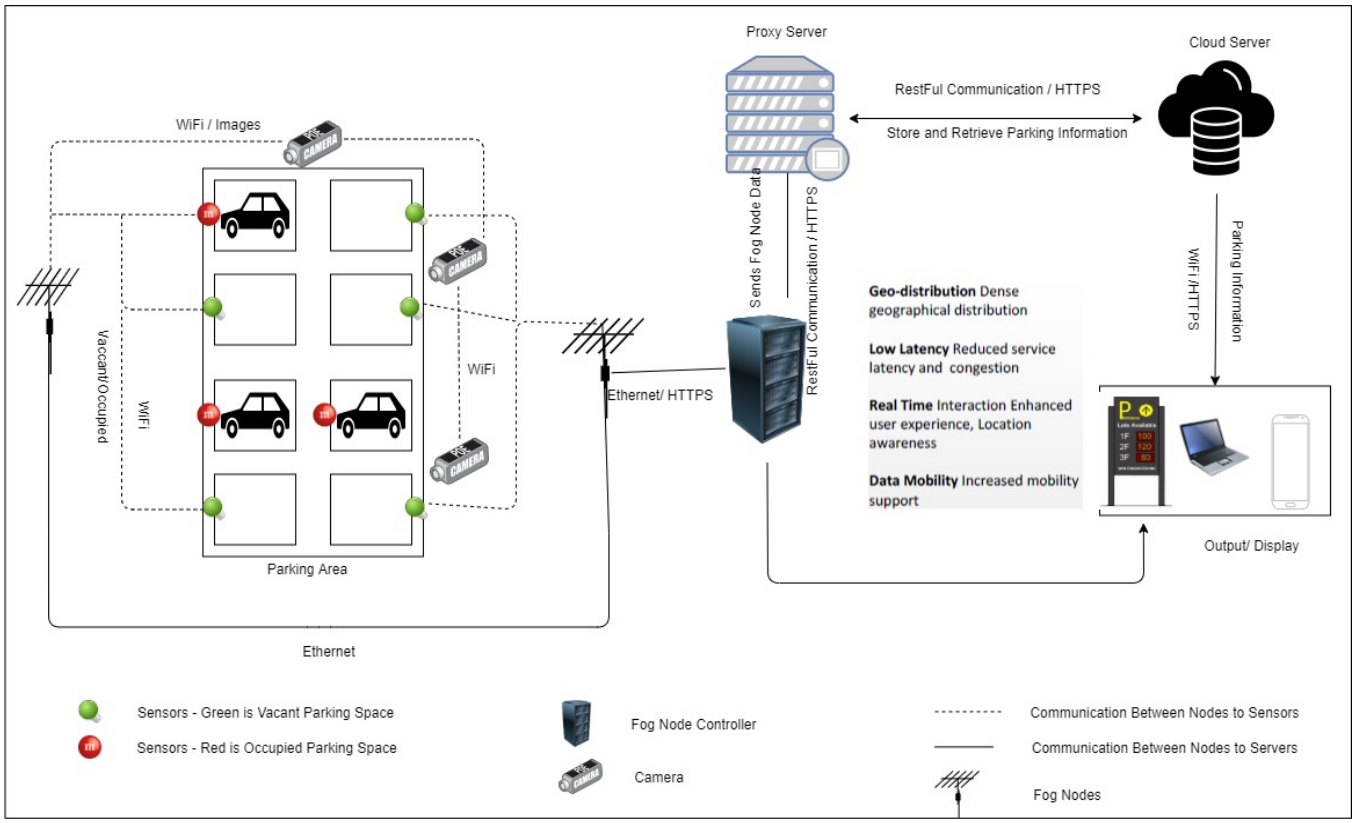

Figure 1: Framework for Smart Parking using Fog Computing

Domain knowledge were research with the guideless from the experts from the respective areas, a refine framework has been developed for validating the smart parking system which defines the working of the system with various communication mechanism, various computer hardware component and processes.

Figure 1 shown below is a diagram which shows the components of the system which collects the information from various sensors, cameras and transferred to fog nodes for quick and easy processing. All the information is sent to fog node through WIFI connections, Camera sends images to fog node to check whether the parking space is vacant or occupied. Sensors are placed directly above the parking space to measure the space if its vacant or occupied. Both the sensors are used to collect the data and send to fog node which combinedly use the data to provide valuable information. Red and green light denotes the occupied and vacant space respectively. Fog Node controller controls all the activities and provides the low latency and real time updates to the sensors and all the values are updated and displayed the information to be displayed in the parking space. All the information is then store and processed in cloud through a proxy server connected in between fog node controller and cloud server.

IV. Classification

The component table show below in Table 1 is taken from 15 research paper selected based on smart parking and internet of things keywords. All the paper is limited to last three years i.e. 2020 being latest and up to 2018 being all Q1 and Q2 ranking journals to maintain the quality of this paper. The papers are chosen based on the key factors i.e. smart parking, internet of things, fog computing and smart city. Table 1 show below summarizes the techniques, methods, model, algorithms, performance and output with their data as presented in line with their authors.

Considering the criteria from 30 journals to review, 15 best paper has been selected in table 2 to classify components. Each classification is discussed and summarize the solutions provided in those selected publications.

V. Evaluation

For considering the most efficient and real time parking system utilizing fog computing and internet of things, we identify the various components which should be add value to the system if it has any benefits. The component should be evaluated and verified to check whether it has some value to the desired framework or not. The validation and evaluation will be discussed in the following way the validation determines the matching with expected outcome with actual outcome i.e. accuracy and efficiency of the system by reducing latency and providing real time data for the users by system which indicates the fulfilment of the requirement of the project. Evaluation determines the use of the framework in the system which provides the functionality and the added value into the system.

By studying the paper, most of them describes some sort of validation, efficiency and evaluation of the system. Most of the paper states the performance and efficiency of the system such as low latency, cost of operation, quality of services and power consumptions [2]. Most of the paper also focused on

accuracy of the outcome of the system [2],[7],[11],[14]. Analysing few papers, resource pricing and computing resources of the system was validated [10]. The efficiency of the system was examined and validated by analysing the uses of energy and computational power, cost of operation, identifying the vacant space, leisure taxis or vehicles, communication latency and consumption of fuel which were all optimised and promotes the efficiency of the system [12].

VI. Verification

Evaluating the system is the most important task which to find the most used technique along with fog computing and internet of things in smart parking. The most used term was chosen in most of the papers. Literature review section which explains on the fog computing and internet of things approaches in smart parking. In this verification both qualitative and quantitative methods are considered.

The system with high quality sensors which detect and recognise the object and guide the user to take decision and make easier to park and alert user displaying important information from the data about the condition and occupancy of the parking spot in particular area with improved localization accuracy [9]. Sharif [14] proposes the mobile based application to enhance the experience of the smart city and describes the problems of not having seamless communication with IoT services. Basir [16] describes the industrial internet of things which satisfies the user growing demand with ultra-low latency and reliable with high speed data rate that is satisfied with fog computing.

In this Figure 2, the percentage of term which are used most frequently is chosen based on the components and the instances from the chosen best articles.

VII. Discussion

In this section, the component of smart parking with fog computing technology will be discussed from the 30 chosen publications. The instances are explained from the literature review and evaluation to present the value of fog computing and internet of things to enhance the experience of smart parking to eliminate the idle time or waiting time while parking the vehicle.

A. Data: Collected from sensors, fog nodes and cameras

Several papers have discussed data collection from sensors and cameras but not all the paper utilize the best use of those sensors. Naranjo [8] used fog node function which are deployed in virtualized network which optimizes deployment and improve latency from communicating with various sensors. Instead of sending all data to cloud edge devices performs the preliminary analysis and abstract are send to cloud whereas, [2] uses the probe vehicle equipped with all the sensors and collects the data and process them using machine learning and crowd sensing technique using dataset of 486 taxis. Both techniques utilize the sensors but [8] technique performs better in real time scenarios due to fog computing which reduce the latency and pushes the metadata to the cloud and processes is done within the fog nodes.

Some of the papers had mentioned the problems of distributing computational task among vehicles and take support of roadside units. Shah [5] used vFog is designed where vehicles act as edge devices reducing the load from backbone network which operates without the support from roadside unit. Similarly, [4] explains the fast offset xpath services which eliminates the problems of crowd sensing technique using cloudlet under fog computing for collecting data from roadside units. However, [9] uses the OpenStreetMap database as the source of data for vehicular fog computing approach where roadside unit are deployed which provides communicating and computational services in the mobile terminal. Similarly, [3] collects data from various sensors from sensing layer of parking lot which is transfer through network layer to middleware where micro cloud, web server and database transfers the information to clients into computing devices.

B. Techniques and procedure

Fifteen of the chosen publication proposed different techniques and algorithms regarding smart parking. Shah [5] used vFog vehicle fog computing, task distribution algorithms to enhance the experience of driving which supports multi-hop communication enhancing task delivery ratio, [8] uses fog computing architecture network which reduces the latency and boost the efficiency by building fog computing architecture network which is multi-tier structure operating jointly interacting with each node and communicating to cloud. Kharel [6] uses the novel architecture for multimedia streaming utilization hierarchical fog computing to minimize the bad services experience by improving the by bringing the cloud services. Several papers discuss about the cloud computing but could not eliminate the drawback of cloud computing like latency and cost of operation. However, [8] shows the use of fog nodes with distributing of computing resources into small scale will increase the performance and the results can be displayed in real time without latency which eliminates the drawback of cloud computing.

Most of the paper uses global positioning system as tool for identifying and tracking the devices. Many papers have used the same tool but utilizing with various technique has a different result on overall performances. Bock [2] uses global positioning system as a tool and use probe vehicles, machine learning and crowd sensing to reduce the cost of static sensors and utilize the existing sensors on the probe vehicles. Similarly, [12],[17] also GPS as a tool to develop and improve the efficient collaboration of vehicles to minimize the traffic congestion. Among all these papers which uses GPS as a tool, [2],[18] utilizes the it best as compares to other paper which uses crowd sensing method with probe vehicles and all the data collected is processed with machine learning to detect empty parking slot, record information of latitude, longitude, timestamp etc provides the quality information about free parking space.

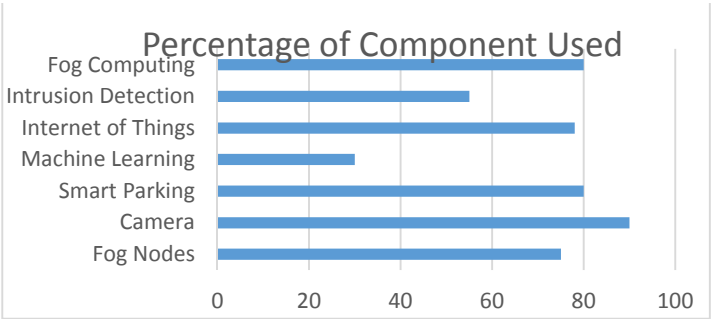

Figure 2. Percentage of component used by mentioned publication

TABLE 1. CLASSIFICATION TABLE

Author	Sensors	Datasets	Stimulation	Algorithms	Technique	Tools	Model	Performance and accuracy metrics	Primary output	Output visualization
[8]	Touch screen, Messenger, Fog Node	NA	NA	FOCAN	DPS, TDMA, WCN	FN tier, IoE tier	Smart City Model	MBFD, MDC	Communication cost in FOCAN and D2D	Simulation result
[2]	CPS	RSU	NA	Crowd Sensing, Probe Vehicle	ML, vFog	GPS	MCS	MHRM, PDR	Congest network results high packet drop.	ATD, vFog CPU utilization on vehicles density per km
[4]	ITS, V2V, WGD	RSU, Cloudlets	NA	FOXS	ITS	Self - Adaptive	FCP, GPS	CHIMERA	Speed, Position, Time spent, current route,	Transmission power, communication range
[3]	Node, RFID, WSN	Local datasets	APS	MOGWOLA	GWO	GPS, MOGWO	GWO, SP	RMSE	Computational efficiency, Minimize local errors, fast node positioning	AN, TR, MOGWOLA, DTBLA, GRNN, PSONL
[5]	OBU	RSU	DTR, FV	TD, VCC	vFog, VFC	OMNet++,, SUMO, VEINS	VAIS	MHRM, PDR, TD	NA	APDR
[6]	VANETs, MANETs	Cloud, RSU	WiMAX, OPNET.	MSUH	FC	OPNET, OBU, VANET	E2E DPD	E2ED, PDV PL VMOS	efficient bandwidth utilization, maximizing QoS	Average PDV
[7]	Neuron dendrites	TDM, VDM, ADM	NA	MP	IDT, ABIDT,LCC	Rasberries Pi	ANN	TF-IDF, ADFA-LD, ADFA-WD	Power, energy consumption	ADFA-LD/WD
[1]	FN	NA	FS	MCDA	TOPSIS,	MATLAB	VIKOR	sustainability and reliability of services	Rank the missing information	Closeness Coefficient, FP ideal solution
[9]	FN	OSM	NA	NA	PVA	FNC	AM	SRR, EPI, PFNC	WAR	High API,
[14]	Cameras,actuators, RTLS	NA	VNA	IT	CBSA	5G UWB	SPA	SRP, SCD	GHz,db	SPM, GM
[24]	Cameras, IoT devices	Historical Data,	PBF	PSA, ED	SPA	MATLAB	PBFP	PBFS, TP-C, WF-SPA, BF-SPA	DT, PG	RPSW,QoSW
[11]	Camera	CNR Park-Ext	NA	BSA	Bof	MATLAB	mAlexNet, AlexNet	VDS, RNTI	DS & NDS	Split and Original Accuracy
[17]	NA	PRCO, PSOFPO	CBAM	FOB, SMP	DSSM	MATLAB	MG	CMA, BODSM	TEBMG,BGFDSM	TLDPPPR, DEP , LP&RPD
[12]	WSN	ITS	NA	GPSME	MSM	MATLAB, GPS	MS	ETR		
[10]	RSU, FN	NA	CS	DRMA	VCR, RPBIS	VMBGM	GUCRA	OPSV	CP, time	DCR, CFCR

TABLE 2. ANALYSIS TABLE

Author	Sensor Used	Source of Data				Sample of Vehicles used for testing	Medium of Communications	Efficiency / Outcome	Evaluation	
		Sensors	Datasets	Stimulation	RSU				Validation	Result
[8]	3	✓				NA	3G/4G-cellular , WiFi,ZigBee, Giga Ethernet	Low Power Consumptions	Communication per APC	FOCAN – 45.41 D2D – 60.40
[2]	1	✓	✓		✓	486 taxis	WiFi, GPS	Better position information	Kalman Filter	Input = 300 taxi Error = 10% Accuracy = 90%
[4]	3	✓	✓		✓	14	4G	Low CO2 emission	CO2 emission	FOXS = -28.25% DSP=20.37% Base = 0%
[3]	3	✓	✓	✓		10	RFID	Less CPU usage and network bandwidth by RMSLE	Average Localisation error	MOGWOLA reduced by 26% to 20% to 17%
[5]	1	✓	✓	✓	✓	500 - 900	WiFi, VPN	Less Bandwidth Consumption	Multi-hop Task Delivery	0 Hop = 40.5% 1 Hop = 10% 2 Hop = 16.3% 3 Hop = 8.8% 4 Hop = 10.2%
[6]	2	✓	✓	✓	✓	40	WiMax, LTE, Cellular, DSRC	Minimum loss of packets	% Packet Loss	PF2V =3 -6 % V2V = 10 -22% SF2B = 18 - 33% C2V = 30 – 50%
[7]	1	✓	✓			750	Bluetooth, WiFi	High Accuracy with Small no, of nodes	Accuracy	Accuracy = 94%, Recall = 95% F1-Measure in ADFA-LD = 92% F1-Measure in ADFA-WD = 74%

[1]	1	✓		✓		NA	4G	Reduce Latency and power consumption of IoT devices	Fuzzy Ideal Solution	**FPIS** A1=.90, A2 = .86, A3= .857, A4 = .853 **FNIS** A1=.80, A2 = .833, A3= .837, A4 = .832
[9]	1	✓	✓			20	VANET	Less Fuel Consumption due to quick reservation	Successful reservation ratio	No of Vehicle = 450 Single FNC=12000 Multiple FNC = 16000
[14]	2	✓	✓	✓		100 - 900	WiFi	QoS on weekdays	SPA based on Driver Behaviour	No. of Parking Grid = 100 Reservation increased to 25% from 5%.
[24]	3	✓		✓		NA	GPS	Improve localisation accuracy	Accuracy	NA
[11]	1	✓	✓			200	WiFi	Efficient for identifying vacant space	Accuracy with Fusion CNRPark	SURF = 88.44 RAW Color = 90.89 VDS= 500.
[17]	NA		✓	✓		100	4G	Reduce cost of operation	Benefit from DSM	Primary Match = 10% more than other models Cost Benefit of MicroGrid = 6.8% More than other Models
[12]	1	✓	✓			2191	GPS	Reduce leisure taxis	MS model	10.51% Less leisure Taxi, Reduced 5 overriving Taxis Optimisation = 33.73%
[10]	2	✓		✓	✓	100	VCS	Reduce energy utilized	Resource pricing and computing resource	Change by 0,0.2,0.5 is 2000,3000,3600 Gflops

C. Performance Evaluation

Out of all the paper selected, almost all the paper used fog computing as the technique to get the benefit of cloud computing without inheriting drawbacks of cloud computing. Most of the paper did not discuss about the fog computing in detail which only used edge computing for a specific task as to collect data only. Most of the paper offloaded the computational resources to small fog nodes which can perform specific task on their own and push the metadata into the clouds which boost the processing speed and performance of overall system providing real time output and low latency. Kharel [6],[19],[20] uses fog computing technology along with vehicular ad-hoc network where novel architecture for multimedia streaming utilizing hierarchical fog computing for efficient bandwidth utilization and minimal involvement of the cloud services whereas, [5],[21],[22] uses OMNet++ as a tool for vehicular fog computing to support multi-hop communication enhancing task delivery ratio enabling the platform to support delay-sensitive applications and minimize the load in the network. Similarly, [9],[23] also uses vFog as fog computing with parked vehicles assistance technique with OpenStreetMap and fog node controller for higher demand of application where roadside unit can be deployed with fog computing services.

Few of the paper discussed about the algorithm for allocating the parking space. Lin [24] uses the smart parking algorithm to utilize the maximum space available by analysing the parking behaviour and vehicle selection and allocating whereas [11] uses the smart parking management system with vacant parking space detection to guide the drivers with available parking space location. Similarly, [10],[25] uses the vehicular computing resource to locate the vacant parking space and promote quick service by removing the network congestion and delay on cloud computing by introducing resources available onboard and devices of internet of vehicles capable of computing resources.

VIII. Future work and Conclusion

The paper illustrates the fog computing is one of the emerging technologies in the world of smart city. From the study of all the paper, there is lots of possibility that fog computing architecture can be extended to coverage of 5G management for number of applications streaming also real time data processing solutions under mobile edge computing technique which delivers robust framework. Furthermore, the accuracy and performance can be increased in various fog nodes by rigours testing which helps in safety of machine and users. European or Asian cities having different parking dynamics where parking pattern differs, an advanced investigation on error behind crowd sensing should be done. In the current context, smart parking enables drivers to locate the parking location effortlessly. Fog computing and use of fog nodes reduce the delay and latency over the network and the computing is done relevantly quick compare to use of cloud computing. Automating parking system promotes the ease for parking the vehicle which eliminates the time for searching for parking which saves lots of time for drivers to find the vacant spot and reduces the extra omission of pollution from the vehicle from searching the vacant space. Selecting the best of cloud services which can be remotely access and compute all the required process from anywhere on the top of the fog computing which eliminates the latency and issue with real time output facilities the selection of services in fog to cloud platform. Real time data can be better displayed and processed if 5G technology are used as a communication medium if those became affordable.

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IX. APPENDIX

1. FOCAN – Fog Computing and Network
2. WCN - Wireless communication network
3. DPS - Data Packet Scheduling
4. TDMA - Time Division Multiple Access
5. FN - Fog Network
6. IoE - Internet of everything
7. MBFD - Modified Best Fit Decreasing
8. MDC - Maximum Density Consolidation
9. D2D - Device to Device
10. RSU - Road Side Unit
11. GPS - Global Positioning System
12. ML - Machine Learning
13. MHRM – Multi-hop relay mechanism
14. PDR – Packet Delivery Ratio
15. FCP – Fog Computing Paradigm
16. FOXS – Fast offset xpath service
17. ITS - Intelligent Transport System
18. WGD – Wide geographical distribution
19. VFC – Vehicular fog computing
20. VCC – Vehicular cloud computing
21. VAIS – Vehicle as an infrastructure as service
22. OBU – On Board Unit
23. ANN – Artificial Neural Network
24. TDM – Training Data Master
25. VDM – Validation Data Master
26. ADM – Attack Data Master
27. LCC – Linear Correlation coefficient
28. MCDA- Multiple Criteria Decision Analysis
29. TOPSIS – Technique for Order of Preference bySimilarity to Ideal Solution
30. FS – Fuzzy Similarity
31. APDR - Average packet delivery ratio
32. FNC – Fog Node Controller
33. AM – Auction Model
34. ATD - Average transmission delay
35. VNA – Vector Network Analyzer
36. ED – Event Driven
37. PBFS - Parking Behavior Forecast Scheme
38. DT – Daily Traffic
39. PG – Parking Grid
40. RPSW – Reserved Parking Grid on Weekends
41. QoSW – Quality of Service on Weekends
42. PES – Parking Energy System
43. MG – MicroGrid
44. CBAM – Cost Benefit Analysis of MicroGrid
45. SMP – Successful matching pair
46. NA – Not available
47. FRB – Failing offering bids