Cloud and IoT based Smart Car Parking System by using Mamdani Fuzzy Inference System (MFIS)☆

Tahir Alyas [1,*], Gulzar Ahmad [2], Yousaf Saeed [2], Muhammad Asif [2], Umer Farooq [1], and Asma Kanwal [2]

[1] *Department of Computer Science, LGU, Lahore Pakistan*
[2] *Department of Computer Science, National College of Business Administration & Economics, Lahore, Pakistan*

A R T I C L E   I N F O.

Abstract

Internet of Things (IoT) and cloud computing technologies have connected the infrastructure of the city to make the context-aware and more intelligent city for utility its major resources. These technologies have much potential to solve the challenges of urban areas around the globe to facilitate the citizens. A framework model that enables the integration of sensor's data and analysis of the data in the context of smart parking is proposed. These technologies use sensors and devices deployed around the city parking areas sending real time data through the edge computers to the main cloud servers. Mobil-Apps are developed that used real time data, set from servers of the parking facilities in the city. Fuzzification is shown to be a capable mathematical approach for modeling city parking issues. To solve the city parking problems in cities a detailed analysis of fuzzy logic proposed systems is developed. This paper presents the results achieved using Mamdani Fuzzy Inference System to model complex smart parking system. These results are verified using MATLAB simulation.

© 2019 ISC. All rights reserved.

1   Introduction

1.1   Internet of Things

Brilliant stopping is a noteworthy aspect of Internet of things where the sensor will converse with remote gadgets over the Internet. The gadget that you manufacture they fill in as use of Internet things. Those electronic gadgets that you manufacture can help the drivers in choosing a reasonable circumstance. Everywhere throughout the world traffic and vehicles are creating issues for the natives. These gadgets share data utilizing predefined correspondence conventions. Gadgets are interfacing with the Internet and give all data, which encourages individuals to comprehend their working reason. The electronic gadgets are helping to choose an appropriate zone, a spot for stopping. The data that gadgets and framework gather will be sent to the cloud and anybody over the globe. This is a simple method to get to information and dissect them. These days' organizations contribute a ton of cash on savvy stop-

ISeCure

ping since the stopping issues in creating and created nations are expanding. The savvy vehicle leaving is normally gotten data about an accessible parking spot in various shopping centers and leaving plots [1]. The International development of stopping issue is the principal purpose behind specialists to contribute their cash. Individuals stayed with this paper attempting to fathom the stopping issues that is excessively troublesome for the general population. [2]The new innovation changes the pattern of working and gathering information. Gather all the data on the cloud or you can say send it to the cloud for break down, as it is simple through innovations. Innovation refresh step by step and furthermore the most vital thing is it is enhanced which take care of your plenty of issues. The prominence of private engine vehicles and autos are getting traffic increasingly swarmed [3].

1.2 Clouds & IoT Revolution

The Internet of Things dependent on ordinary physical items, distinctive gadgets, all kind of vehicles, structures, inns, and eatery with implanted hardware. The product, sensors, and system network, enabling them to gather all data, send and get information. Distributed storage includes reserving information on equipment in a remote physical area, which can be fetch from any gadget through the Internet. Customers send documents to an information server kept up by a cloud supplier rather than putting away, all alone hard drives [4, 5]. The cloud is a very broad concept, and it covers just about every possible sort of online service, but when businesses refer to cloud procurement, there are usually three models of cloud service under consideration, Software as a Service, Platform as a Service, and Infrastructure as a Service [6]. SaaS is an item scattering showcase in which a pariah provider has applications and makes them open to customers over the Internet [7].

The Internet of Things has bit by bit changed the manner in which daily assignments are finished [8]. Incalculable business openings are in the fire hose of Internet of things, because of the associated items. However, what makes a difference behind the huge number of associated applications, gadgets, and locales are "clients". [9]. In this way, it is extremely essential to give clients the best understanding and it must be conceivable through IoT Cloud. It is the main stage where you put your IoT information and help you serve your clients better. Both Cloud processing and the IoT have a corresponding relationship [10]. Distributed computing is Fog registering, numerous IoT gadgets don't have their very own processing power. There will be overhauls in interchanges systems, including higher-speed cell frameworks that will match the pace of home systems [11, 12]. The Internet of

Things won't simply remain consigned to the 'keen ice chests' that initially ring a bell when anybody makes reference to this new flood of tech. In actuality, everything will, in the end, be a shrewd gadget, putting new requests on crude handling power [13]. Amazon commands the shopper cloud advertise. Microsoft is taking their Internet of Things cloud benefits genuinely. IBM is another IT monster attempting to set itself up as an Internet of Things stage specialist. They attempt to make their cloud benefits as open as conceivable to novices with simple applications and interfaces [14, 15].

1.3 Smart Car Parking

Car parking systems are already working since last few years, because of the traffic ratio increase day by day. But still they are not that's much moderate or you can say they are not updated according to all situations, technology, and population. Technology update the Internet of things perspective are automatically updated, people transfer data on the cloud, collect all information of cloud just because they easily access that whenever they want and use [16]. Web of things gives another pattern to smart traffic advancement. The exploration design is to utilize the Internet of things specialists and different advancements to enhance traffic conditions. That is fundamental since individuals need to soothe the traffic weight. Along these lines, there is a dire need to enhance traffic and everything on the board.

Building a canny traffic framework dependent on IoT has various advantages such enhancement of traffic conditions, decreasing the automobile overload and the executives' costs, high unwavering quality, traffic well-being and autonomy of climate conditions [17, 18]. Such traffic IoT must incorporate each component of traffic, for example, streets, spans, burrows, traffic signs, vehicles, and even drivers. Every one of these things will be associated with the web for helpful recognizable proof and the executives through sensor gadgets, for example, RFID gadgets, infrared sensors, worldwide situating frameworks, laser scanners, and so on. I gathered information on all streets and can be displayed to the clients and you can say all explorers. Examination of information particularly traffic stream is difficult to break down on the grounds that it is on the vast scale, it's not possible for anyone to gauge it effortlessly without a legitimate source. Savvy gadgets are the best source to discover the stream and measure the separation too [19]. Everybody needs to spare their time and cash and need to know the substitute arrangement of their issues. Brilliant gadgets and new advances give them all the answers for their issues.

ISeCure

The framework of streets cannot permit that much traffic on the streets too in shopping centers and parking's, in light of all foundation configuration as indicated by the explicit number of vehicles. Foundation has fundamentally developed because of the consistently rising number of vehicles everywhere throughout the world. Finding a parking spot has turned into a very difficult errand for every one of the general populations, particularly on pinnacle hours [20]. Searching for an empty parking area in a bustling city, at a pinnacle hour is a bad dream to drivers. They need to drive around searching for a free parking space, something that is accepted to build traffic blockage. The cycling around baffles drivers as well as expands the normal utilization of gas and consequently the air contamination stopping for a free. The majority of the general population who have ever been baffled driving far and wide, looking forward to stop have wanted for an answer that could rapidly lead the person in question to that subtle spot. In ongoing exploration, it has been discovered that a driver takes about 8 minutes to leave his vehicle since he invests more energy looking through the parking garage. Possibly they have restricted time to complete this that they spend to finding a space in stopping [21].

The first task is structure a framework that would give stopping inheritance estimation, stopping charge installment strategy, stopping license the executives and stopping investigation for the city specialists. The venture had three stages. The first and the second stages utilized subjective ways to deal with the approval of our theories about stopping weakness in the Helsinki territory and the enlistment of members to the pilot of the undertaking, individually. The third stage included the plan, usage, and establishment of the framework. The other target was to examine the difficulties a savvy stopping framework would look at changed phases of its life cycle [22]. The destinations of the undertaking were accomplished and the considered suspicion about the difficulties related with stopping in a bustling city was approved [23].

The Internet of Things infiltrates with the universe of ceasing to streamline frames that pass on astute halting plans, which widen and manage ceasing inventories. In this one of a kind of circumstances, (IoT) uses embedded remote sensor frameworks to interface physical parking space establishments with information and correspondence developments, where cloud-based wise the board organizations are given [24–26].

The principle (IoT) challenges incorporate the combination of little Smart Objects having solid vitality and preparing imperatives, the substantial scale interconnection of hubs through adaptable and secure systems administration, and in addition customized

association with the physical world and joining inside the client made substance and applications. Existing arrangements coming from past mechanical and scholarly activities experience the ill effects of a few restrictions. Web of things offers its client with its propelled network of gadgets, frameworks, and highlights, which is past the current extent of the machine-to-machine correspondences.

The Smart Parking System utilizing the Internet of things is an improved innovation that utilizes any framework or convenient gadgets like cell phones to control fundamental usefulness. Its highlights consequently connected through the Internet are effectively Operable from anyplace you lounge the world over. System framework varies from another current framework by enabling the client to effortlessly work and screen their framework's working from anyplace on the planet through an Internet association [27]. Smart Parking System utilizing big-scale controllers that people utilize the incorporation of remote correspondence, to give the client the remote control of different [28].

The Internet of things is to begin with stage and there is no essential building exists till today. There are a lot of investigative papers available and moreover, executions are starting on all the likelihood of the ceasing zones. Thus there are no tenets or limits to describe the importance of the Internet of things. Along these lines, dependent upon the remarkable condition, application the Internet of things has particular definitions. Immediately it is portrayed as the things present in the physical world or in an area are added to sensors or with any embedded structures and made related with the framework by methods for wired or remote affiliations. These related contraptions are called splendid devices or keen things. Besides, it includes keen machines which pass on partner with various machines, condition, protests, etc [29].

The degree of my undertaking is to structure a component of the IoT set up together Parking System regarding an item system stopping structure, malls, and all ceasing spots adjoining you. A complete target is that the contemplations and orchestrating showed through this model structure would then have the capacity to be successfully climbed to a genuine halting office [30]. As the system is to be completed in considerable and involved with stopping structures, there are different execution subtleties that must be met to ensure the structure works successfully and beneficially. Most importantly, The Development of Smart Parking System interface must send and get the fitting information. Making use of some IoT supportable gear, for instance, raspberry pi, designs the Smart Parking System, experiment with sheets, etc [31]. By

and by, we are focusing on less power use and more execution contraption so raspberry pi is the sensible microcontroller for our use. Since when we execute all these, we have to keep up our money related arrangement, manage all of the things. The budgetary arrangement is an imperative thing that we have to recall [32].

On a very basic level, any building headway and advancement must consider space for stopping regions. In any case it just theory how we can apply all these yet when we talk about speculation, we should know the data and yield of the discussion.It is an important issue these days, people require authentic vehicle parks to be given to them inside or outside the building especially the building works at 24 hours. In case the ceasing zone isn't in the headway figured, the errand could be considered as a failure [33].

Many-valued logic in which the truth-value of variables are may be any real number between 0, 1. It's somehow the concept of partial truth, where condition satisfy on just if, else condition. It's some kind of truth, which means true or false. You can say 0 and 1. In the modern approach you can say its modern type of approach. The advanced first fuzzy logic introduced by Dr.Lotfi Zadeh in 1960 [34].

Fuzzy logic based smart car parking system discussed, but in beginning 1965 Zadeh presented the foundations of the fuzzy set theory. Then different people explain fuzzy logic in their own words and work [35]. Microprocessor is the first component in which Analog-digital converter, and wireless module. It can use for the global network infrastructure. It used to connect different devices. These devices save data send it to each other from networking and have an information-processing unit.

The other one is wireless communication; it is main technology for microprocessor through these devices. IoT is the wireless sensor networks (WSNs). WSNs collect data from devices located at different places [25].

2 System Model

Our proposed IoT enabled Smart Parking System (SPS) using Mamdani Fuzzy Inference System (MFIS) based Expert System (IoT-SPS-MFIS-ES) is explained in this section. The Figure 1 shows the flow of proposed IoT-SPS-MFIS Expert System methodology. The expert system take input from cloud and IoT devices. Relavant information is collected and irrealvant information is discarded. The information is mapped from crisp input to fuzzy input values by using the fuzzification process. Rules are crested with the help of expert. On the basis of these rules, fuzzy output is calculated which is further mapped to crisp
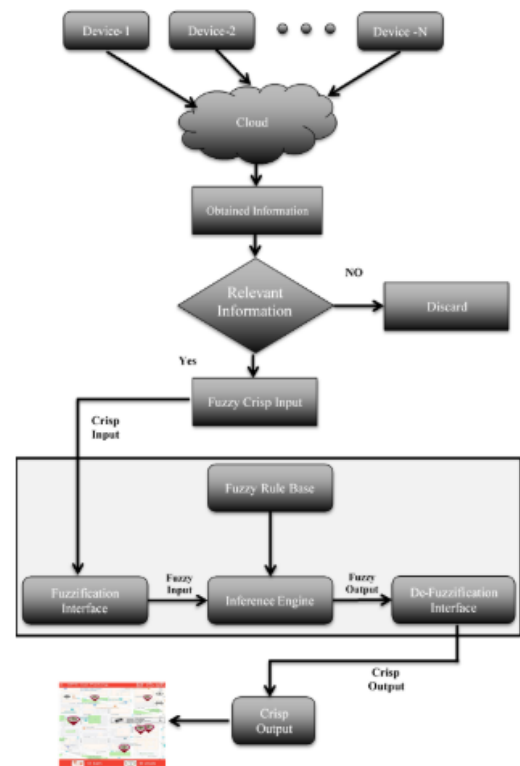

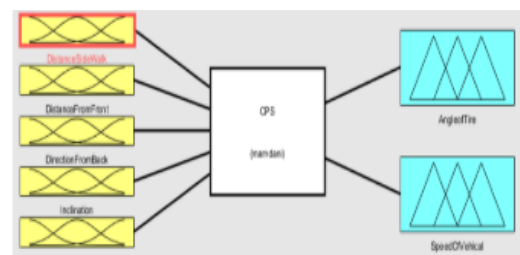**Figure 1**. Flow of proposed IoT-SPS-MFIS Expert System

Figure 2. Input and output of IoT-SPS-MFIS Expert System

output.

2.1 Inputs Fuzzy Sets

Fuzzy input variables are statistical values that are used to find the value of fuzzy crisp output. In this article, there are five different types of input variables are used. The details of these input variables with their ranges are shown in Table 1.

2.2 Output Fuzzy Sets

In this Article, there are two output variables used which are given with their semantic values are shown in Table 2.

2.3 Membership Functions

A membership function (MF) is a curve that defines how each point in the input space (also called universe

Table 1. Input variables

Sr#	Input Parameters	Semantic Sign
1	DFS	Near
		Medium
		Far
2	DFf	Near
		Medium
		Far
3	DFB	Near
		Medium
		Far
4	Inclination	Upper left
		Right
		Center
		Left
		Upper Right
3	Vehicle	Light
		Medium
		Heavy

Table 2. Output of Fuzzy Sets

Sr#	Input Parameters	Semantic Sign
1	Angle of Tire	Right
		Center
		Left
2	Speed of Vehicle	Reverse
		Halt
		Drive

of discourse) is mapped to a membership value (or degree of membership) between 0 and 1. Membership functions for proposed System.

2.4   D.Rule Based

I/O Rules play a critical role in any Fuzzy Inference System (FIS). The performance of any expert system depends upon these rules. In this research, I/O rules are developed using a shown in Figure 4

2.5   De- Fuzzifier

De-fuzzifier is one of the critical components of an Expert system. There are different types of defuzzifier. In this research centroid type of De- Fuzzifier is used. The Figure 5 and Figure 6 shows the De-Fuzzifier graphical representation of IoT-SPS-MFIS Expert
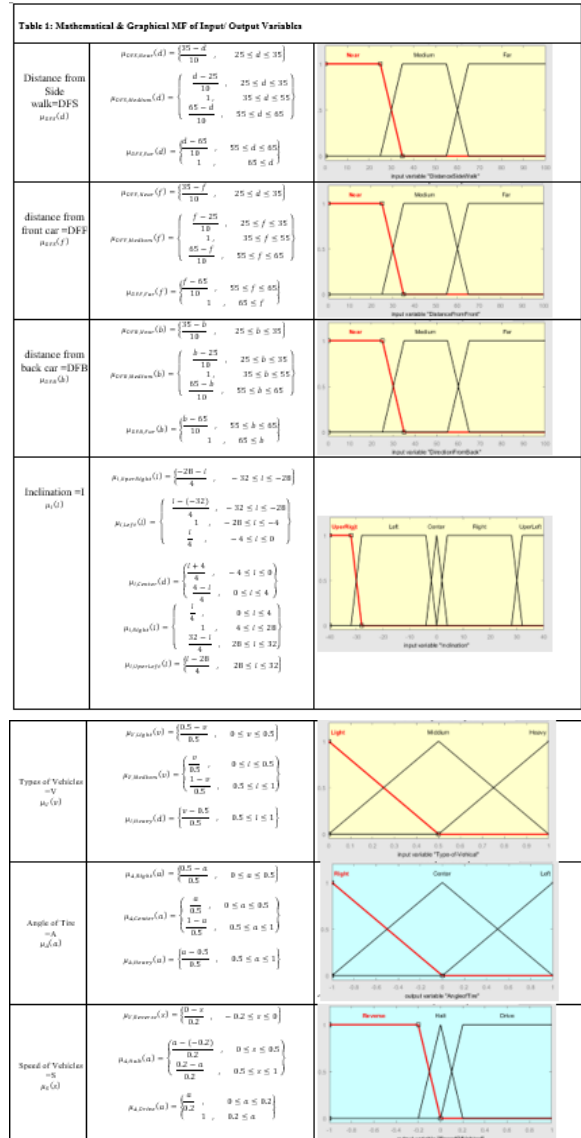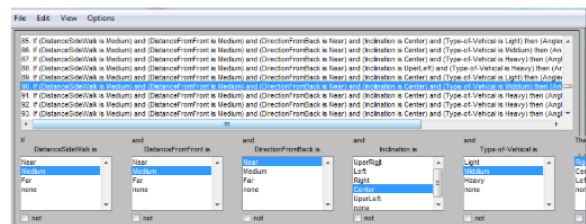

Figure 3. Input variables

Figure 4. I/O rules for proposed IoTSPS-MFIS Expert System

System. The rule surface shows different colors, the Bluish color shows the reverse speed of vehicle on the basis of Types of Vehicle and Inclination. The Greenish color represent the halt condition of Vehicle on the basis of Types of Vehicle and Inclination and the yellowish color represent the drive condition of Vehicle on the basis of Types of Vehicle and Inclination. In figure.5 the Bluish color represents the right Angle of tire of vehicle on the basis of Distance from
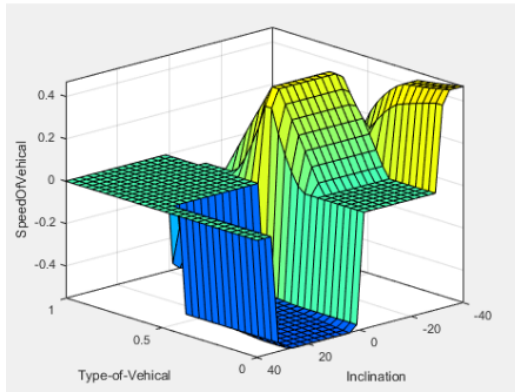
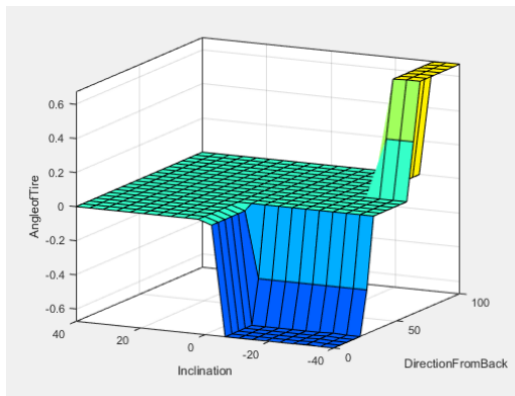**Figure 5**. Rules surface for Types of Vehicle and Angle of Inclination

Figure 6. Rules surface for Distance from back and Angle of Inclination

Figure 7. Lookup diagram of angle of tire and speed for proposed IoT-SPS-MFIS Expert System

back and angle of Inclination. The Greenish color represent the angle zero condition of Vehicle on the basis of Distance from the back and Inclination and the yellowish color represent the left angle of tire of the vehicle on the basis of distance from the back of Vehicle and Inclination.

3   Simulation Results

For simulation results, MATLAB R2017a tool is used. MATLAB is also used for modelling, simulation, algorithm development, prototyping and many other fields. MATLAB is an efficient tool for programming, data analysis, visualization and computing. For simulation results, five inputs and two output variables are used. Figure 7 shows the straight angle of tire (Zero Degree) and Slow speed of vehicle on the basis of Medium distance from the walk, medium distance from the front and normal distance from the back and the vehicle type is light weight. Figure 8 shows
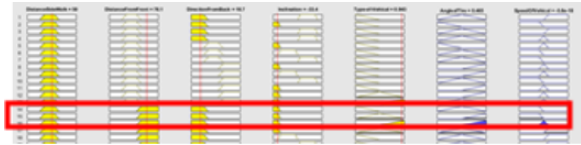

Figure 8. Lookup diagram of angle of tire and speed for proposed IoT-SPS-MFIS Expert System

Figure 9. Lookup diagram of angle of tire and speed for proposed IoT-SPS-MFIS Expert System

the right-side angle of tire and normal speed of vehicle on the basis of Medium distance from the walk, Maximum distance from the front and minimum distance from the back and the vehicle type is heavy weight. Figure 9 shows the right-side angle of tire (Zero Degree) and reverse of speed of vehicle on the basis of Medium distance from the walk, medium distance from the front and minimum distance from the back and the vehicle type is light weight.

4   Conclusion

The main objective of this research is to design an expert system to create the automated car parking system on the basis the IoT enabled device and cloud computing. The simulation results are obtained from the MATLAB system. The efficiency of the proposed system can be improved using other soft computing approaches like Neural network, Neuro-Fuzzy etc.

References

[1] Feng Xia, Laurence T Yang, Lizhe Wang, and Alexey Vinel. Internet of things. *International Journal of Communication Systems*, 25(9):1101, 2012.

[2] Mohamed Ali Feki, Fahim Kawsar, Mathieu Boussard, and Lieven Trappeniers. The internet of things: the next technological revolution. *Computer*, (2):24–25, 2013.

[3] Andrea Zanella, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi. Internet of things for smart cities. *IEEE Internet of Things journal*, 1(1):22–32, 2014.

[4] John A Stankovic. Research directions for the internet of things. *IEEE Internet of Things Journal*, 1(1):3–9, 2014.

[5] BB Prahlada Rao, Paval Saluia, Neetu Sharma, Ankit Mittal, and Shivay Veer Sharma. Cloud computing for internet of things & sensing based applications. In *2012 Sixth International Conference on Sensing Technology (ICST)*, pages 374–380. IEEE, 2012.

[6] Flavio Bonomi, Rodolfo Milito, Jiang Zhu, and Sateesh Addepalli. Fog computing and its role in

the internet of things. In *Proceedings of the first edition of the MCC workshop on Mobile cloud computing*, pages 13–16. ACM, 2012.

[7] Partha Pratim Ray. Creating values out of internet of things. *Journal of Computer Networks and Communications*, 2016:1, 2016.

[8] Stefan Walraven, Eddy Truyen, and Wouter Joosen. Comparing paas offerings in light of saas development. *Computing*, 96(8):669–724, 2014.

[9] Thiago AL Genez, Luiz F Bittencourt, and Edmundo RM Madeira. Workflow scheduling for saas/paas cloud providers considering two sla levels. In *2012 IEEE Network Operations and Management Symposium*, pages 906–912. IEEE, 2012.

[10] Anthony D JoSEP, RAnDy KAtz, AnDy KonWinSKi, LEE Gunho, DAViD PAttERSon, and ARiEL RABKin. A view of cloud computing. *Communications of the ACM*, 53(4), 2010.

[11] Flavio Bonomi, Rodolfo Milito, Jiang Zhu, and Sateesh Addepalli. Fog computing and its role in the internet of things. In *Proceedings of the first edition of the MCC workshop on Mobile cloud computing*, pages 13–16. ACM, 2012.

[12] Mohammad Aazam, Sherali Zeadally, and Khaled A Harras. Deploying fog computing in industrial internet of things and industry 4.0. *IEEE Transactions on Industrial Informatics*, 14(10):4674–4682, 2018.

[13] Mung Chiang and Tao Zhang. Fog and iot: An overview of research opportunities. *IEEE Internet of Things Journal*, 3(6):854–864, 2016.

[14] Mung Chiang and Tao Zhang. Fog and iot: An overview of research opportunities. *IEEE Internet of Things Journal*, 3(6):854–864, 2016.

[15] Syed Hassan Ahmed and Shalli Rani. A hybrid approach, smart street use case and future aspects for internet of things in smart cities. *Future Generation Computer Systems*, 79:941–951, 2018.

[16] Ray Y Zhong, Xun Xu, Eberhard Klotz, and Stephen T Newman. Intelligent manufacturing in the context of industry 4.0: a review. *Engineering*, 3(5):616–630, 2017.

[17] Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, and Marimuthu Palaniswami. Internet of things (iot): A vision, architectural elements, and future directions. *Future generation computer systems*, 29(7):1645–1660, 2013.

[18] Bhagya Nathali Silva, Murad Khan, and Kijun Han. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society*, 38:697–713, 2018.

[19] Mohammad Aazam, Imran Khan, Aymen Abdullah Alsaffar, and Eui-Nam Huh. Cloud of things: Integrating internet of things and cloud computing and the issues involved. In *Proceedings of 2014 11th International Bhurban Conference on Applied Sciences & Technology (IBCAST) Islamabad, Pakistan, 14th-18th January, 2014*, pages 414–419. IEEE, 2014.

[20] Flavio Bonomi, Rodolfo Milito, Jiang Zhu, and Sateesh Addepalli. Fog computing and its role in the internet of things. In *Proceedings of the first edition of the MCC workshop on Mobile cloud computing*, pages 13–16. ACM, 2012.

[21] Flavio Bonomi, Rodolfo Milito, Jiang Zhu, and Sateesh Addepalli. Fog computing and its role in the internet of things. In *Proceedings of the first edition of the MCC workshop on Mobile cloud computing*, pages 13–16. ACM, 2012.

[22] Weisong Shi, Jie Cao, Quan Zhang, Youhuizi Li, and Lanyu Xu. Edge computing: Vision and challenges. *IEEE Internet of Things Journal*, 3(5):637–646, 2016.

[23] Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, and Marimuthu Palaniswami. Internet of things (iot): A vision, architectural elements, and future directions. *Future generation computer systems*, 29(7):1645–1660, 2013.

[24] Brandon P Wong and Branko Kerkez. Real-time environmental sensor data: An application to water quality using web services. *Environmental Modelling & Software*, 84:505–517, 2016.

[25] Subir Biswas, Raymond Tatchikou, and Francois Dion. Vehicle-to-vehicle wireless communication protocols for enhancing highway traffic safety. *IEEE communications magazine*, 44(1):74–82, 2006.

[26] Y Raghavender Rao. Automatic smart parking system using internet of things (iot). *Int J Eng Technol Sci Res*, 4(5), 2017.

[27] M Mazhar Rathore, Awais Ahmad, Anand Paul, and Seungmin Rho. Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks*, 101:63–80, 2016.

[28] Thanh Nam Pham, Ming-Fong Tsai, Duc Binh Nguyen, Chyi-Ren Dow, and Der-Jiunn Deng. A cloud-based smart-parking system based on internet-of-things technologies. *IEEE Access*, 3:1581–1591, 2015.

[29] Dipti Srinivasan, Min Chee Choy, and Ruey Long Cheu. Neural networks for real-time traffic signal control. *IEEE Transactions on intelligent transportation systems*, 7(3):261–272, 2006.

[30] M Mazhar Rathore, Awais Ahmad, Anand Paul, and Seungmin Rho. Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks*, 101:63–80, 2016.

ISeCure

[31] Sylvain Kubler, Jérémy Robert, Ahmed Hefnawy, Chantal Cherifi, Abdelaziz Bouras, and Kary Främling. Iot-based smart parking system for sporting event management. In *Proceedings of the 13th International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services*, pages 104–114. ACM, 2016.

[32] Vaibhav Hans, Parminder Singh Sethi, and Jatin Kinra. An approach to iot based car parking and reservation system on cloud. In *2015 International Conference on Green Computing and Internet of Things (ICGCIoT)*, pages 352–354. IEEE, 2015.

[33] Giancarlo Fortino and Paolo Trunfio. *Internet of things based on smart objects: Technology, middleware and applications.* Springer, 2014.

[34] Mark C Childs. *Parking spaces: a design, implementation, and use manual for architects, planners, and engineers.* 1999.

[35] Richard Bishop. *Intelligent vehicle technology and trends.* 2005.

Tahir Alyas is currently working as an Assistant Professor at the Department of Computer Science, Lahore Garrison University, Lahore, Pakistan. He completed his PhD from School of Computer Science, NCBA&E, Lahore, Pakistan. He completed his Master of Computer Sciences from the Department of Computer Science NCBA&E, Lahore, Pakistan. Tahir's research interests primarily include Cloud Computing, IoT, Intelligent Agents and Cognitive machines with various publications in International journals and conferences

Gulzar Ahmad is currently working as a Lecturer at the Department of Computer Science, NCBA&E, Lahore, Pakistan. He completed his Master of Computer Sciences from the Department of Computer Science NCBA&E, Lahore, Pakistan. Gulzar Ahmad's research interests primarily include Fuzzy System, Cloud Computing, IoT and Smart City with various publications in conferences of international repute.

Yousaf Saeed received his Ph.D. degree in Cognitive VANETs from NCBA&E, Lahore, Pakistan, and M.S. degree in Broadband and High-Speed Communication Networks from the University of Westminster, London, U.K., where he achieved distinction in Research Thesis on IPv6. He is currently working as Assistant Professor with the Department of Information Technology, University of Haripur, Pakistan. He acquired seven Research Projects from National Grassroots ICT Research Initiative (NGIRI) Program from the Ministry of Information Technology & Telecom, Government of Pakistan. His patent is under review regarding emergency vehicles-based traffic lights control system.

Muhammad Asif is currently working as a Lecturer at the Department of Computer Science, NCBA&E, Lahore, Pakistan. He completed his Master of Computer Sciences from the Department of Computer Science NCBA&E, Lahore, Pakistan. Asif's research interests primarily include Fuzzy System, Cloud Computing, IoT and Smart City with various publications in conferences of international repute.

Umer Farooq is currently working as a Lecturer at the Department of Computer Science, Lahore Garrison University, Lahore, Pakistan. He is doing PhD from School of Computer Science, NCBA&E, Lahore, Pakistan. He completed his Master of Computer Sciences from the Department of Computer Science NCBA&E, Lahore, Pakistan. Umer's research interests primarily include Cloud Computing, IoT, Intelligent Agents, Image Processing and Cognitive machines with various publications in International journals and conferences.

Asma Kanwal is a PhD Research Student in the Department of Computer Science at the NCBA&E, Lahore. Her area of research is Artificial Intelligence and Machine Consciousness. Her current focus of research is on the design and development of conceptual cognitive model for attention generation in cognitive systems.