A Review on Internet of Things based Cloud Architecture and Its Application

[1]D.Dakshayani Himabindu,[2]Keesara Sravanthi, [3]Raswitha Bandi,[4]Bharathi Panduri
[1,2,3]Assistant professor,Dept of IT,VNRVJIET,pragthinagar,Hyderabad-500090
[4]Assistant professor, Dept of IT, GRIET, Bachupally, Hyderabad-500090

[1]dakshayani.himabindu@gmail.com,[2]sravanthireddy.k8@gmail.com,[3]raswitha.29reddy@gmail.com,[4]bharathiraaz@gmail.com

Abstract

The recent expansion of the Internet of Things (IoT) and the rise in increased volume of data produced by smart devices have led to the outsourcing of data to specified data centers.It has been expect that different things we see around us are going to be internet world or interconnected. The services like smart homes, microwave Owens, refrigerator, self driving cars etc. Which we are enjoying are connections of various computing devices. Internet of Things (IoT) where all devices are having computing platforms run according to the instructions given by internet. Internet of Things which used for connecting various devices via internet. In order to store all this applications we need large storage capacity. It's also the data, the insights from the data, and the future. By future, I mean the potential for growth and innovation inherent in an IoT network. The more you know about the future, the better you can plan for it now. Cloud computing techniques provide large storage capacity, high processing speed. This chapter aims mainly on the Architecture and Applications of IoTCloud. In an effective IoT cloud architecture, data flows through different layers. Each layer makes the data more and more functional for analysis and insights. As IoT devices have limited capacity due its size and energy consumption, An IoT cloud became crucial to support the requirements of millions of IoT devices and provide various new and exciting IoT applications for the end-users. The main theme of this paper is that it explains about the Internet of Things and its applications and how these applications are stored in the cloud and explains about how IoT Cloud guarantee high performance. IoT Cloud point out a new type of distributed system consisting of a set of smart devices interconnected with a remote Cloud infrastructure, platform, or software through the Internet and able to provide IoT as a Service (IoTaaS).

Keywords: Internet of Things, Cloud Computing, IoTCloud, MQTT, Sigfox sensors

1. Introduction

Now-a-days emerging technologies are playing a key role in our daily activities. Some of them are Internet of Things, Block Chain, Artificial Intelligence, Robotics etc.More than 9 billion 'Things' (physical objects) are connected through Internet. In future, the number is likely to rise to a whopping 50 billion [1]. Internet of things consists of four main components. There are Low power embedded systems, Cloud computing, Big data availability, Connecting of Networks. In IOT Low power utilization, high performance is contrary factors which play important role in design of electronic systems. Cloud computing is used because IOT devices are huge and data collected through is massive to store the data we need storage server for this purpose cloud computing is used and plays a vital role. The data is trained to discover flaws like electrical or errors found within the system. Availability of big data where IOT depends on sensors and real time devices as the electric devices are

throughout all fields, usage of these devices cause a huge change in usage of big data. Networking connection is used to communicate and internet connection is necessary where every physical object will be represented by the IP address.IP naming is given to limited devices as growth in devices increased naming procedure is not applicable further. So researchers are proceeding for alternate naming system for signify physical object individually [1][2]. Here we are going to discuss about Internet of Things along with IOTCloud. Internet of Things makes Objects very Intelligent and increase their potential for active interaction ,we identify the objects and perceive the data around them in IOT.The objects interact with the server and store the information, if we want to access the data this can be done using internet .In order to store the information which is necessary for the objects we require large storage capacity that will become complicated for organisations to provide as it will become expensive to purchase more physical machines and provide space to store them to rectify this problem we use cloud architecture as cloud architecture provides large storage capacity .In order to Manage and Deploy the IOT applications we use the cloud computing techniques. Earlier before cloud IOT applications are used to run locally using the Fog Computing and Edge Computing as they are sufficient but when large amount of storage capacity is required then these computing techniques are no useful and cost spent will be more for storage, Hence to sort out this problem cloud computing techniques has come to existence to store IOT applications .Now, we discuss about the architecture and applications of IOTCloud which explains how the data flow happens between different layers and in each layer data is made more and more efficient for analysis and insights. There are various IOT applications which are using cloud architecture for examples like Smart appliances, Smart home hub, Smart locks, Self driving cars, Smart security systems [3].

In IOT standardization we use different techniques there are M2M, Contiki, LiteOS, RPMA, and Sigfor.Machine to Machine service layer is embedded both with hardware and software for example like Microwave Owen which is hardware embedded with the software.Contiki is an open source operating system used for the IOT Microcontrollers that require low power.LiteOS is also an open source software works similar like Linux operating system used for wireless sensor networks.RPMA takes the standard ownership to connect the Objects of Internet Of Things.Sigfor is an low power technology for both IOT and Machine to Machine communications. The IOT device we done various investigations on Wireless capability, function process, Interoperability, Security providence for storage, Fast boot capacity, Categorization of Devices, System Bandwidth, Control the Cryptograhic,Managing the power[4]. When we discuss about the IOT device architecture which use both the network and the cloud the architecture explained in the four stages where in the first stage we discuss about different networks like the actuators we use and the wireless sensor networks .stage two consists of the sensor data aggregation system and conversion of analog to digital data is processed. Third stage the system analytics and processing is done using Edge IT and final stage, stage four where the entire data is stored in the data centre and management of the data is done here cloud acts as the data centre.

1.1 Related work

There are some existing IOT applications which are using cloud architecture for storing the information. The IOT Cloud Architecture consists of IOT cloud applications; IOT integrated middleware, Databases, Security patches and other software algorithms and Analytic engine where the interface of secure communications is developed between the IOT device and the cloud is done by the MQTT, COAP, AMQP, WebSockets etc. We will connect the IOT device and monitor it continuously with the help of the IOT Cloud Applications. These will

also help the consumers with the issues they face and resolve them and this applications are loaded with API's and interface which will pull and push the information/data/commands to and from the applications and sensor nodes/devices. The above services are used in the IOTCloud Architecture. The usage of IOT Cloud has a great impact on performance of IOT applications. We have several IOTCloud applications which were discussed previously like Smart Buildings, Smart Farming, Smart Parking lot, Intelligent transportation, Smart Homes and soon. In (Saber Talari et al., 2017) on smart cities based on Internet of things proposed Smart Buildings use sensors for power management for continuous monitoring of the power; these results will give an idea on usage of electricity and water consumption where sensors are used to detect the usage of water, automatic turn on/off of the lights here the sensors which we use will gather data and analyze the data and maintain the record of the data these will help us in developing the smart cities. In (Chungsan Lee et al., 2016) projected smart parking using IOT where Ultrasonic sensors are used to find the parking space availability and also the location of the vehicle can be detected by using this sensor connecting to smart phone. In (Lu Hou et al., 2016) proposed about Intelligent transportation. Where GPS used for vehicle locating, sensors and cameras are used for knowing the traffic congestion of the vehicles the data collected and analyzed is stored in IOT cloud and for pedestrians also the traffic information will be available. In (Prem Prakash Jayaraman et al., 2016) proposed about Smart farming used phenonet which involved with variety of crop studies that are conducted by means of IOT technologies which include sensors,cameras,smartphones,data analytics.

In (Abdulsalam Yassine et al., 2018) projected about IOT Smart Homes they use sensors, metering services, different appliances to collect the data and analyze them and process the data for collection of data used big data analytics using Fog computing and Cloud computing. In (Alessio Botta et al., 2015) proposed about the cloud IOT applications explained that the data and applications are different drivers which are used for the purpose of communication and the cloud can improve the IOT applications performance.

2. IOT Cloud Architecture

IOT Cloud Applications consists of interfaces or API'S which are used to send or receive information between the IOT sensors and consumer apps, we use IOT integrated middleware like MTQQ cluster which is used to get data from sensors and transmit the data into cloud services to process it. The MTQQ used for communication among the IOT devices and the end users as it is a broker protocol used for subscribing transportation of messages and the packets will be published with the help of these broker. For the purpose of publication we will uniquely define a topic and the packets will be published using broker but for subscription we use MTQQ client by using these at a time multiple topics can subscribed and for server implementation we use open source in node that means we use MTQQ connections to improve the performance of MQTT servers. The IOTCloud use different types of NOSQL Databases like MongoDB, Cassandra, CouchDB, Hypertable, Redis, Riak, Neo4j, Hadoop HBASE which are used to store the data here the data is stored in rows and the columns same as RDBMS(Relational Databases) NOSQL Databases are used for managing the data based on the modern demands. Rest API ENDPOINTS are the points where URL of a service is included each endpoint is used to access resources for carrying the functions.API runs by sending the request to server and receiving the response from server. Analytic Engine consists of RDBMS, Artificial Intelligence Algorithms and Machine Learning Algorithms which are used to integrate IOT based applications or various business apps.There are different

types of IOT Cloud Application Services like Sensor Nodes of IOT and Interface of Cloud Development, user IOT application developments, Database Management, Analytics In Sensor Nodes of IOT and Interface of Cloud Development which provides secured communication between IOT devices and Cloud applications using MQTT and the continuous monitoring of IOT cloud application is done using IOT device and IOT device also alerts users issues and resolve them safe handshake mechanism is implemented for communicating or transferring the data between sensor nodes and services. User IOT applications development here user pays a key role where user access assigned IOT devices after login and end users will be given roles and responsibilities that are maintained by IOTCloud applications, IOT devices are managed and stored to cloud where it is mapped to users so that we can provide security by avoiding non permitted access and finally end users can also control, monitor and access parameters, processes which are stored inside IOTCloud.In Database Management secure design is maintained which ensure no loss in Data, optimisation is used to maintain scalability and managing device data for monitoring of devices which are deployed and the analytic phase is used for developing and integrating machine learning algorithms with IOTcloud for the growth of business. Historical data is processes when we enable IOTCloud which is used to predict behaviour of patterns and benefits us get from applications. In below architecture the process of the IOTCloud application is processed [4][5].

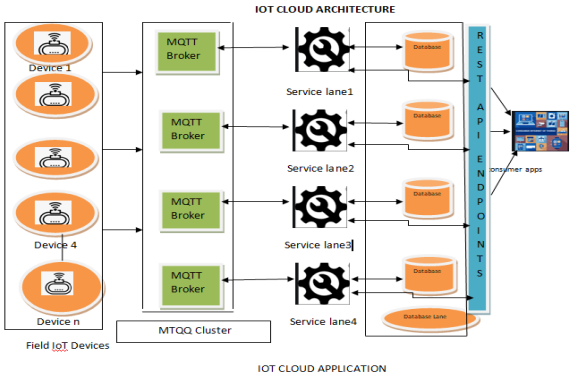

Fig 1:IOT CLOUD APPLICATION

3.IOTCloud Applications

Before going to discuss about various IOTCloud Applications we will go through the services of the IOTCloud as IOTCloud should fulfil the requirements of all IOT applications using the services that are provided by IOTCloud different applications will be offered by the end users, managers, programmers. We can access the services using the browsers and smart phones whenever we require from anywhere in the world. IOTCloud are classified into three categories[5]. Web applications where IOTCloud provides services by deploying WebPages using HTTP servers and these WebPages are developed with the help of Hyper text Markup Language and CSS is used to develop static pages and JavaScript is used to page where a page is taken to forward for next page[6] [7] .In IOTCloud Web applications are developed for managers in order to manage interface, monitor the data of the IOT devices like timing tasks and control IOT devices with owners permissions for debugging. Mobile apps as Smartphone play a crucial role for the communication purpose in our daily life as with the help of it people access the internet on their phone using different kinds of APPS and for the ease of users to use mobile applications this apps are developed in such a way that they can use both in Andriod and iOS platforms and we

have other apps also which are developed using third party like facebook etc[8][9].To improve the applications and the services provided by internet of things we use software development kits(SDKS) here IOT uses two types of SDKS one is ANDROID and other is AZURE. We have many different types of IOT applications which are using cloud architecture here we are going to discuss about that applications in details how they are using the cloud architecture and the benefits they can get by using this architecture.Here I will explain about the various applications which uses IOT Cloud architecture there are

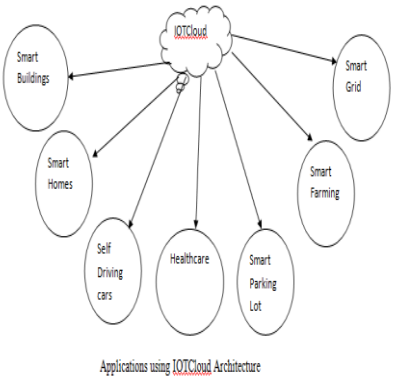

Fig 2:Application using IOTCloud Architecture

3.1 SMART BUILDINGS:

Smart Buildings will adjust to both the inside and outside environmental change to provide comfort to occupants where automation system infrastructure of a building is cheaper and simpler, autonomous and wireless, Sigfox sensors can be quickly installed all over the building for monitoring the systems like HVAC, boilers, light, power, fire, and security. These sensors allow us to control and monitor all the operational parameters such as indoor air quality, temperature, occupancy, humidity and door openings. The machinery like lifts and escalators which are heavy in size and weight can also be fitted using sensors to trigger and check the breakdowns and be proactive to do the require service to overcome the problem when a fault is detected. If water leakage is there it can also detected using IoT sensors. Advantage of using these sensors is that they can run on same battery by eliminating the hassle of manual maintenance and control. We will get fire alerts and smoke alerts via fire safety using internet equipment where time and man power is wasted by doing continuous checking's. Alerts will be triggered by smoke detectors which will not be heard by people or ignored by them. These detectors will be connected to the Sigfox network by which we can send real time alerts which keep status and battery level alive. By these alerts security providers will be alert and will respond quickly they will also set up back up alarms and provide protection which is powered by sigfox IoT network. Smart security solutions are used to hold accountable of security guards and increase the reliability of alarm system. Instead of competing with traditional systems, the smart devices are used to complement existing platforms and provide a cost-effective, so that they can increase the effectiveness of existing system services. By collecting the consumption data effortlessly we can put an end to time spent and money used on manual on-site meter readings and for processing data. Once activated, meters will transmit data immediately using the Sigfox public network, without pairing or configuring systems [10].You can monitor infrastructure by detecting leaks and by activating and deactivating the services.

Without wasting the time we can call refuse collection service and automatically sent the data to cloud to trigger refuse collection request[11]. A simple temperature sensor and fire alarm can be added and triggered as appropriate. This offers convenience and safety, and cuts down on collection requests refer table 1 for these information[12].

Scenario	**Use Cases**	**Device Type**	**People Population**	**Energy Consumption**	**Cost**	**Throughput**	**latency**	**Mobility**	**Reliability**	**Security**
Smart Buildings	Water metering	Sensors meters	Large	Low	Low	Low	High	Fixed	Medium	Low
	Residential Monitoring	Sensors	Few	Low	Low	Low	Low	Fixed	High	High
	Secure electrical panels	Sigfox	Few	Low	Low	Low	HIgh	Fixed	High	High
	Smoke and fire using Internet	Detectors	Large	Low	Low	Low	High	Fixed	Medium	Low

Table 1: Usage of IOTCloud By Smart Buildings

3.2 Smart parking lot:

.

Parking is considered as the major problem in the cities where the population is high compared to towns and villages so we should provide extra services to solve this problem so that which will be useful for parkers and also for administrators .so we are offering survey on the relevant technologies and IoT with parking in smart city[13]. From past decade the cars which are manufactured have some advanced features which include radio, automatic door locks, movie player, navigating systems and so on, now using IoT we can link up them with smart phone apps and find the parking spaces which will find the availability of parking, reservations of parking[14], and online payment mode[15]. We can secure our information about the parking lots using emerging technology like Blockchain. We use the techniques like sensor network, positioning system, and image detection. Table 2 explains what are the types of sensors used in parking lots in different countries like underground sensors, RFID.etc. [16].

Smart parking application	Country	Sensors/Technology used
Park.ME	Austria, Germany	Underground Sensors
SmartParking	New Zealand	Underground Sensors, RFID
ParkMe	Japan, US, UK, Germany, Brazil	Underground Sensors
ParkAssist	US	M4 Smart sensors, LPR
SpotHero	US	Underground Sensors
EasyPark	Canada	Underground Sensors
PaybyPhone	France	Underground Sensors
ParkMobile	US	Underground Sensors
AppyParking	UK	Magnetometer
EasyPark Group	Sweden, Denmark, etc.	Transactional data and crowdsourcing
Parker	US	Underground Sensors, Machine vision
ParkiFi	US	Magnetometer
Best Parking	US	Underground Sensors
Parkopedia	US, Germany, Sweden, etc.	Predictive analytics, Underground sensors
SFPark	US	Underground Sensors
Open Spot	US	Crowdsourcing

Table2: Smart parking applications and technologies used for it in various areas.

3.3 Smart Farming:

Now a day's lots of services are providing by various technologies some of them are used for farming which will increase the growth in farming and usage of less man power also and increases the quality of product for that IoT, Artificial intelligence and other technologies are used, IoT plays a key role for product growth and provides better measures comparing to regular farming and the technologies offered are sensors, software solutions used for the purpose of connecting IoT platforms, connectivity's used and mobile devices along with gps locations using robotic tractors along with different processing facilities and we can also use data streaming for other solutions. By using all these a farmer can always monitor the field condition and can act according to it and can follow using the steps like first observe the problem then diagnosis the damage which will cause by it take a decision and take the action for that problem we use two types of framings one is precision farming and other is livestock farming .In precision farming the changes in the field are measured and will act according to it and in livestock farming we use various smart farming techniques which will make easy cultivation easy for the farmer[17].

We use different ways to use IoT in farming for making agriculture more efficient the ways IoT is used to improve by collecting the data using sensors like quality of soil, the growth of the crop, health of the cattle and information of climate conditions will be monitored and stored for better efficiency. It will control the risk which are faced during production by predicting future problems which will be faced which cultivating the crop. We can also reduce the cost as there will decrease in the usage of man power and predicting the loses by harvesting the crop by knowing the weather conditions [18]. Increase the quality of the crop by monitoring the climatic conditions which are faced during harvesting the crop, by following all these we can increase the growth quality of the crop.

The monitoring of the weather conditions are done by using some IoT devices like Smart Elements, allmeteo, Greenhouse automation is done by using the Farmapp,GreenIQ which are used to find the humidity, lighting and soil conditions of the crops. The management of the crops is done by the devices like Arable and Seminos, Monitoring the cattle is done by using the sensors by placing them to the cattle we can monitor the health condition of the cattle we will use sensors like Cowlar, cropx is used to find the soil condition also and finally agriculture drones are used to monitor and also perform operations like spraying pests. Table 3. is used to define the sensors used in smart farming technologies[19].

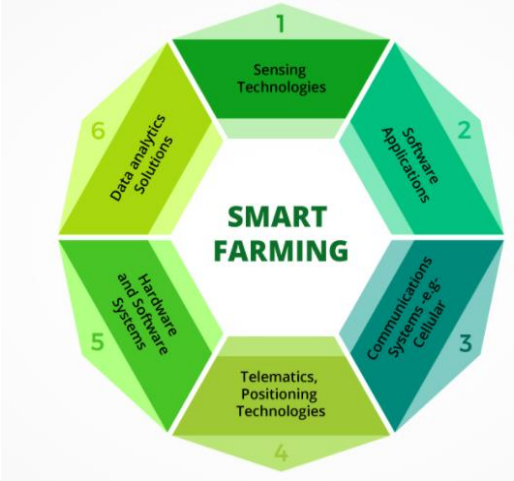

Fig3: SmartfarmingTechnologies

Sensor/ System	Target/Placed				Considered Purpose/Parameters							
	Plant	Equipment	Soil	Weather	Yield	Temp	Moisture	Location/Tracking	Wind	Pollution /Co2	Water	Fruit/ Stem Size
Loup 8000i [138]		✓			✓		✓					
XH-M214 [139]			✓				✓					
Ag Premium Weather [140]		✓		✓		✓		✓	✓			
FI-MM [141]	✓											✓
PYCNO [142]			✓	✓		✓	✓				✓	
MP406 [143]			✓			✓	✓					
DEERE 2630 [144]		✓			✓		✓					
Sol Chip Com (SCC) [145]				✓						✓	✓	
SenseH2TM [146]	✓								✓	✓		
DEX70 [147]	✓											✓
Piccolo ATX [148]		✓						✓				
CI-340 [149]	✓						✓			✓		
Wind Sentry 03002 [150]				✓					✓			
AQM-65 [151]				✓						✓		
POGO Portable [152]			✓			✓	✓				✓	

Table 3: Sensors used in IoT based Agriculture

4. Conclusion:

In these review paper I addressed some of IoT applications that are using cloud architecture these applications are very useful to the end users. It is a new technology enabling various experiments was conducted with an objective to evaluate the performance of the application servers in the proposed IoT cloud. for example in smart agriculture we have smarter and efficient farming methods which will increase the growth of the crop all this aspects are mentioned in this paper briefly and cloud computing implementation is explained thoroughly specified other applications also where IoT based architecture is used in all these applications based on the following data I can conclude that IoT applications will become efficient to use by using cloud architecture. More research is being conducted to solve challenges which are faced while using IoTCloud.

References:

1. L. Hou et al., "Internet of Things Cloud: Architecture and Implementation," in IEEE Communications Magazine, vol. 54, no. 12, pp. 32-39, December 2016, doi: 10.1109/MCOM.2016.1600398CM.
2. C. Lee, Y. Han, S. Jeon, D. Seo and I. Jung, "Smart parking system for Internet of Things," *2016 IEEE International Conference on Consumer Electronics (ICCE)*, Las Vegas, NV, USA, 2016, pp. 263-264, doi: 10.1109/ICCE.2016.7430607.
3. Jayaraman PP, Yavari A, Georgakopoulos D, Morshed A, Zaslavsky A. Internet of Things Platform for Smart Farming: Experiences and Lessons Learnt. Sensors (Basel). 2016 Nov 9;16(11):1884. doi: 10.3390/s16111884. PMID: 27834862; PMCID: PMC5134543.
4. M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour and E. M. Aggoune, "Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk," in IEEE Access, vol. 7, pp. 129551-129583, 2019, doi: 10.1109/ACCESS.2019.2932609.
5. Ademir F. da Silva, Ricardo L. Ohta, Marcelo N. dos Santos, Alecio P.D. Binotto, A Cloud-based Architecture for the Internet of Things targeting Industrial Devices Remote Monitoring and Control,IFAC-PapersOnLine,Volume 49, Issue 30,2016, Pages 108-113. doi:org/10.1016/j.ifacol.2016.11.137.
6. A. Chowdhury, G. Karmakar, J. Kamruzzaman, A. Jolfaei and R. Das, "Attacks on Self-Driving Cars and Their Countermeasures: A Survey," in IEEE Access, vol. 8, pp. 207308-207342, 2020, doi: 10.1109/ACCESS.2020.3037705.
7. Z. Zhou, H. Yu and H. Shi, "Human Activity Recognition Based on Improved Bayesian Convolution Network to Analyze Health Care Data Using Wearable IoT Device," in IEEE Access, vol. 8, pp. 86411-86418, 2020, doi: 10.1109/ACCESS.2020.2992584.
8. L. Liu, Y. Liu, L. Wang, A. Zomaya and S. Hu, "Economical and Balanced Energy Usage in the Smart Home Infrastructure: A Tutorial and New Results," in IEEE Transactions on Emerging Topics in Computing, vol. 3, no. 4, pp. 556-570, Dec. 2015, doi: 10.1109/TETC.2015.2484839.
9. Luigi Atzori, Antonio Iera, Giacomo Morabito, The Internet of Things:survey,Computer Networks,Volume 54, Issue 15,2010,Pages 2787-2805,ISSN 1389-1286, doi.org/10.1016/j.comnet.2010.05.010.

10. Goel, S.S., Goel, A., Kumar, M. *et al.* A review of Internet of Things: qualifying technologies and boundless horizon. *J Reliable Intell Environ* **7,** 23–33 (2021). https://doi.org/10.1007/s40860-020-00127-w.
11. https://www.embitel.com/iot-cloud-application-development
12. Butpheng, C.; Yeh, K.-H.; Xiong, H. Security and Privacy in IoT-Cloud-Based e-Health Systems—A Comprehensive Review. *Symmetry* **2020**, *12*, 1191. https://doi.org/10.3390/sym12071191
13. A. Alsaidi and F. Kausar, "Security Attacks and Countermeasures on Cloud Assisted IoT Applications," *2018 IEEE International Conference on Smart Cloud (SmartCloud)*, New York, NY, USA, 2018, pp. 213-217, doi: 10.1109/SmartCloud.2018.00043.
14. A. Hameed and A. Alomary, "Security Issues in IoT: A Survey," 2019 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT), Sakhier, Bahrain, 2019, pp. 1-5, doi: 10.1109/3ICT.2019.8910320.
15. R. K. Dwivedi, S. Singh and R. Kumar, "Integration of Wireless Sensor Networks with Cloud: A Review," 2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India, 2019, pp. 114-119, doi: 10.1109/CONFLUENCE.2019.8776968.
16. Keesara.Sravanthi, Burugari.Vijay Kumar, Prabha Selvaraj, P.Kanmani, Amit Kumar Tyagi, "Preserving Privacy Techniques for Autonomous Vehicles", International Journal of Emerging Trends in Engineering Research, vol. 8, no. 9, pp. 5180-5190, Sep 2019,https://doi.org/10.30534/ijeter/2020/48892020.
17. P. Eugster, S. Kumar, S. Savvides and J. J. Stephen, "Ensuring Confidentiality in the Cloud of Things," in IEEE Pervasive Computing, vol. 18, no. 1, pp. 10-18, Jan.-March 2019, doi: 10.1109/MPRV.2018.2877286.
18. Y. Chen, "Challenges and opportunities of internet of things," 17th Asia and South Pacific Design Automation Conference, Sydney, NSW, Australia, 2012, pp. 383-388, doi: 10.1109/ASPDAC.2012.6164978.
19. Keesara. Sravanthireddy, "Blockchain-Enabled Decentralization Service for Automated Parking Systems," Opportunities and Challenges for Blockchain Technology in Autonomous Vehicles, edited by Amit Kumar Tyagi, et al., IGI Global, 2021, pp. 51-63. http://doi:10.4018/978-1-7998-3295-9.ch004