National Conference on Engineering Innovations and Solutions (NCEIS – 2018)
International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 4 | Issue 6 | ISSN : 2456-3307

Big 'Internet-of-Things' Data Analytics: A Review

Noor Misbah[1], Shivashankara S[2], Pavithra D R[2], Muheebulla Khan N K[3]
[1]Software Tester, Digits-Mysore, Karnataka, India
[2]Assistant Professor, Dept. of CS & E, Govt. Engg. College, Krishnarajapete, Karnataka, India
[3]IT Administrator, Farooqia College of Dental &Pharmacy, Mysore, Karnataka, India

ABSTRACT

In recent era, 'Internet of Things' gained an inordinate attention from the researchers, since it becomes a significant technology that potentials a smart human being life, by letting a 2-way communications between the objects, machines and such other things. It signifies a system, which consists of things in the real world and sensors attached to or combined to these things, associated to the Internet via wired or wireless network structure. Internet of Things enables user to discover everything in the world uniquely, take control over identified things everywhere and guarantees various applications in society much easier, efficient, safe and smart. There are numerous applications such as smart cities, smart homes, transportation, energy and smart environment, smart agriculture, medical, industry and everywhere. The amount of data collected from sensors related to dissimilar events occurrences is huge (Big Data) and such data can be analyzed and turned into real life information. Numerous big data, Internet of Things, and analytics solutions have enabled people to obtain valuable insight into large data generated by Internet of Things devices. This paper highlights an overview on Internet of Things, its Applications, Architecture, Challenges, Technologies and Architecture for Big Internet of Things Data Analytics, and useful insights.
Keywords: Internet of Things, Applications, Technologies, Big Data, Big Internet of Things Data.

I. INTRODUCTION

Internet of Things (IoT), signifies a universal notion for the capability of network devices for sensing and collecting data around the globe, and shares that data across the Internet where it can be processed and used for a variety of fascinating intentions. An IoT is consisting of smart machines interacting with other machines, objects, environments and infrastructures. Now a day's everybody connected with every other by lots of communication way. The most popular communication way is internet thus in other word we can say internet which connect peoples[1]. The number of devices availing internet services is increasing every day and having all of them connected using wire or wireless will put a powerful source of info at our finger tips [2]. An IoT, as we can assume by its name, is the method of converging data achieved by dissimilar types of things for any virtual platform on available Internet infrastructure [3].

The notion of IoT dates back to 1982 when a customized coke machine was linked to the Internet that was able to report the drinks contained and that whether the drinks were cold. Later, in 1991, Mark Weiser [4] first provided a modern visualization of an IoT in the form of ubiquitous calculating. Conversely, in 1999, Bill Joy gave a clue about Device-to-Device communication in his categorization of internet [5]. In the same year, Kevin Ashton presented the term "Internet of Things" to portray a system of intersected devices [6].

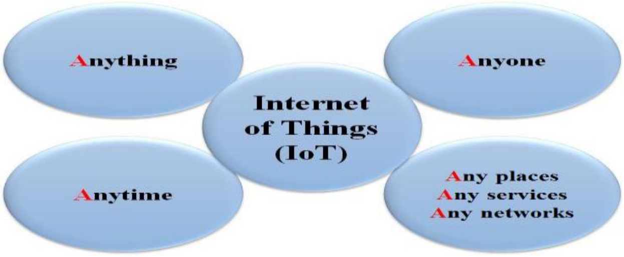

Figure 1: Concept of Internet of Things

Figure 1 appraises that with the IoT, anything's will able to communicate to the internet at any time from any place to offer any services by any network for anyone.

The remaining sections of this paper is organized as follows. Section 2 describes the generic architecture of the IoT; Section 3 discusses the technologies that IoT is composed of; Section 4 forecasts the applications of IoT; Section 5 thrash outs the security challenges posed by IoT; Section 6 confers role of big data analytics in IoT and finally section 7 concludes the paper.

II. ARCHITECTURE OF IOT

More than 25 Billion things are projected to be connected by 2020 [7]. Thus the available architecture of Internet with TCP/IP protocols, adopted in 1980 [8], cannot handle a network as big as IoT. These grounds a essential for a new open architecture that could address several security and Quality of Service (QoS) concerns as well as it could encourage the available network applications using open protocols. Without a specific privacy assurance, IoT is unlikely to be take on by many. Hence, protection of data and secrecy of users are crucial challenges for IoT [9].

For further development of IoT, the amount of multi-layered security architectures are presented. A 3 vital level architecture of IoT is defined in [10] and a 2 key level architecture is in [11]. In the similar way, a 6-layered architecture was also presented centered on the network hierarchical structure. The six layers as revealed in the Figure 2.

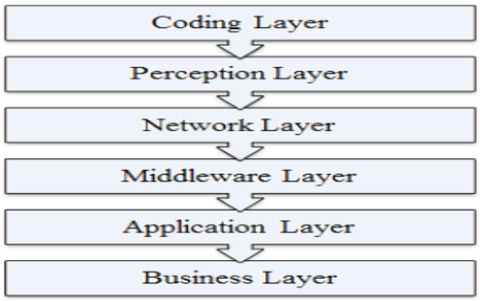

Figure 2: Six Layered Architecture of IoT

2.1 Coding Layer:

It is the groundwork of IoT that offers identification to the objects of interest. Here, each object is allocated an exclusive ID that builds it easy to differentiate the objects.

2.2 Perception Layer:

It is a device layer of IoT that provides a physical meaning to the entire objects. This contains data sensors in dissimilar forms like RFID tags, IR sensors or other sensor networks that can sense the objects' temperature, humidity, speed etc. This layer collects the beneficial info of the objects from the sensor devices linked and translated the information as digital signals that transported onto the Network Layer.

2.3 Network Layer:

This layer obtains the necessary info in the form of digital signals from the Perception Layer and transmit it to the processing systems in the Middleware Layer via the transmission mediums likeWiFi, Bluetooth, WiMaX, Zigbee, GSM, 3G etc with protocols like IPv4, IPv6, MQTT, DDS etc.

2.4 Middleware Layer:

This layer deals with the information obtained by the sensor devices [2]. This contains Cloud computing, Ubiquitous computing technologies and such technologies that makes a direct access to the database to store all the required information. With the use of few Intelligent Processing Equipment, the information is handled and a completely mechanized action is obtained centered on the processed outcomes of the information.

2.5 Application Layer:

Application layer realizes the applications of IoT for entire varieties of industry, centered on the processed data as applications promote the development of IoT. Therefore, this layer is supportive in the large-scale development of IoT network.

2.6 Business Layer:

The applications and services of IoT are managed by business layer. This layer is also liable for entire research relating to IoT. It produces diverse business models for effective business strategies [1].

III. TECHNOLOGIES

In this section, we discuss the relevant technologies that can help in the large-scale development of IoT [12].

3.1 Radio Frequency IDentification (RFID):

RFID is a system, which communicates the identity of an object or person wireless manner via using radio waves in the form of a serial number. This Technology acting a significant character in IoT for resolving identity matters of objects about us in a price in effect fashion. This system is self-possessed of readers and allied RFID tags that release the identification, location or any other particulars around the object, on activated by the compeers of any suitable signal. Figure 3 describes RFID scenario.

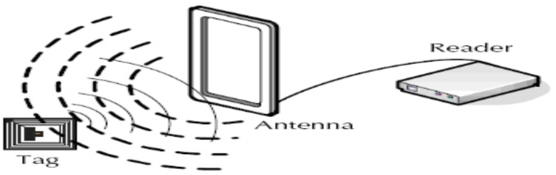

Figure 3: RFID Scenario

The RFID can work as an actuator to activate dissimilar actions and it has even alteration capabilities that Bar codes noticeably do not have.

3.2 Wireless Sensor Network (WSN):

WSN is a 2-way non-wired connected network of sensors in a multi-hop manner, constructed by numerous nodes distributed in a sensor field each connected to one or more sensors, that collects the object precise data i.e., temperature, humidity, speed etc and then sent to the processing device. WSN and RFID technology are pooled together opens up opportunities for even more smart devices, in such a way that amount of resolutions have been presented.

3.3 Cloud Computing:

It is an intelligent processing technology, where number of servers are congregated on single cloud platform to permit imparting of resources among each other that can access at any time and place. Cloud computing do the sensors and even offer good storage ability gain the much imperative part of IoT that not only congregates the servers but also processes on an increased processing power and analyses the beneficial info. Cloud computing interfaced with smart objects by possibly millions of sensors can be of enormous profits and can benefit IoT for a very large-scale expansion to researchers.

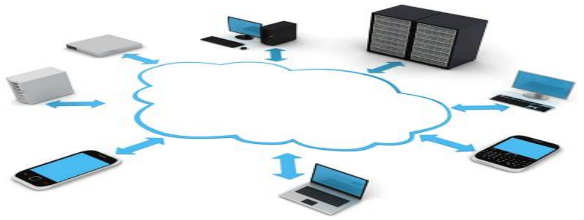

Figure 4: A typical Cloud computing Scenario

3.4 Networking Technologies:

We need a firm and an active network to manage large number of potential devices. For wide-range broadcast net, we use 3G, 4G etc. however as we know, mobile traffic is so much probable since it only has to execute the normal tasks like making call, sending message etc. Therefore as we step into this modern era of universal computing, will not be expectable anymore for a necessity of a super-fast, super-efficient 5^{th} generation wireless system that could deal a lot more bandwidth. Likewise, for a short-range communication network we use Bluetooth, WiFi, etc.

3.5 Nano Technologies:

This technology understands slighter and better form of things, which are interrelated and lessening the consumption of a system through allowing the expansion of devices in nano meters scale that can be used as a sensor and an actuator just like a usual device. Such a nano device is created from nano components and resultant network describes a new networking paradigm i.e., Internet of Nano-Things.

3.6 Micro-Electro-Mechanical Systems (MEMS):

MEMS are grouping of electric and mechanical components employed together to offer solicitations containing sensing and actuating that are at present being commercially used in numerous field in the form of transducers and accelerometers. MEMS are a economical resolution to improve the communication method of IoT and further benefits alike size lessening of sensors and actuators, incorporated ubiquitous computing devices and etc.

3.7 Optical Technologies:

Rapid expansions in an era of Optical technologies, Li-Fi, an important Visible Light Communication (VLC) technology. It offer a inordinate connectivity on a upper bandwidth to the objects interrelated on the concept of IoT. Likewise, Bi-Directional (BiDi) technology provides a 40G Ethernet for a big data by multifarious devices of IoT.

IV. APPLICATIONS

Many of the day-to-day lifecycle applications, which we usually see are at present smart but they are incompetent to connect with each other and empowering them to connect with each other and share beneficial info by each other can create a extensive variety of pioneering applications [13]. There are number of potential upcoming applications that can be of great benefit [14]. Here, we present some applications.

4.1 Smart Cities:

The IoT can advance the cities in numerous levels, by successful infrastructure, improving public transportation, decreasing traffic crowding, and keeping citizens safe, healthy and much involved in the society. Along with the support people by the internet in the entire place to access the database of airports, railways, transportation tracking operating under specified protocols, cities will converted as smarter by means of the IoT.

4.2 Domestic and Home Automation:

In home, by means of using IoT system remotely monitor and handle home appliances and cut down the monthly bills and resource usage. With home automation, we can remotely control the appliances according to our requirements. Suitable monitoring of utility meters, energy and water supply will aid saving resources and detecting unpredicted overloading, water leaks etc. some of the important benefits are:

- ✓ **Energy and Water Use:** Energy and water consumption monitoring to obtain advice on how to save cost and resources.
- ✓ **Control Appliances:** Switching on and off remotely appliances to avoid accidents and save energy.
- ✓ **Intrusion Detection Systems:** Detection of windows and doors openings and violations to avoid intruders.
- ✓ **Art and Goods Preservation:** Monitoring of conditions inside museums and art warehouses.

4.3 Medical Field:

A close attention that is essential to hospitalized patients, their physiological status would be monitored uninterruptedly can be persistently done by using IoT monitoring technologies. The great benefits are:

- **All Detection:** Support for elderly or disabled people living self-governing.
- **Fridges:** Monitoring and Control of conditions inside freezers storing medicines, vaccines, and organs.
- **Sportsmen Care:** Vital signs monitoring in high performance centres and fields

- **Patients Surveillance:** Monitoring of conditions of patients inside hospitals and in old people's home.
- **Ultraviolet Radiation:** Measurement of UV sun rays to warn people not to be exposed in certain hours.

4.4 Security and Emergencies:

- ✓ **Perimeter Access Control:** Detection and control of people in unauthorized and restricted.
- ✓ **Liquid Presence:** Liquid detection, sensitive build & warehouses to avoid breakdowns & corrosion.
- ✓ **Radiation Levels:** Distributed measurement of radiation levels to generate leakage alerts.
- ✓ **Explosive and Hazardous Gases:** Detection of gas leakages and levels in industrial environments, surroundings of chemical factories and inside mines.

4.5 Smart Agriculture:

- ✓ **Wine Quality Enhancing:** Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.
- ✓ **Green Houses:** Control micro-climate conditions to maximizes production of fruits, vegetables & quality.
- ✓ **Golf Courses:** Selective irrigation in dry zones to reduce the water resources required in the green.
- ✓ **Meteorological Station Network:** Study of weather conditions in forecast ice formation, rain, drought, snow or wind changes.
- ✓ **Compost:** Control of humidity and temperature levels in alfalfa, hay, straw, etc., to prevent fungus and other microbial contaminants.

4.6 Industrial Control:

- **Machine-to-Machine Applications:** Machine auto-diagnosis the problem and control.
- **Indoor Air Quality:** Monitoring of oxygen levels and toxic gas inside chemical plants to ensure workers and goods safety.
- **Temperature Monitoring:** Monitor the temperature inside the industry.
- **Ozone Presence:** In food factories, monitoring of ozone levels during the drying meat process.
- **Vehicle Auto-diagnosis:** Information collection from the Bus to send real time alarms to emergencies or provide advice to drivers.

V. BIG 'IOT' DATA ANALATICS

An explosive development in the number of devices associated to the IoT leads to exponential upsurge in data shaped from these associated components echoes the growth of big data. The management of big data in an uninterruptedly growing network provides upswing to crucial issues concerning data collection, efficiency, data processing, analytics, and security. These Internet-connected objects, which contain PCs, smart phones, tablets, WiFi-enabled sensors, wearable devices, and household appliances, form the IoT, shown in Figure 5.

Figure 5: Big Data sources in IoT

However, such data are not beneficial devoid of analytic power. Plentiful big data, IoT, and analytics resolutions have permitted people to attain valued vision into huge data produced by IoT devices. Big data is classified depending on 3 aspects: (a) volume, (b) variety, (c) velocity [15]. These groupings were initially presented through Gartner to define the elements of big data challenges [16]. Immense chances are presented through an ability to analyse and use large amounts of IoT data, containing applications in smart cities, smart transport and grid systems, and remote patient healthcare monitoring devices.

5.1 Different Analytic Types for IoT Applications:

Following are the various analytic forms, used according to the necessities of IoT applications [17].

Real-time analytics is typically executed on data composed from sensors. In this condition, data change continually, and rapid data analytics methods are necessary to attain an analytical outcome within a short period. Accordingly, two current architectures have been presented for real-time analysis: parallel processing clusters via traditional relational databases and memory-based computing platforms. Greenplum and Hana are examples of real-time analytics architecture.

Off-line analytics is utilized when a rapid response is unnecessary. For example, several Internet initiatives use Hadoop-based off-line analytics architecture to decrease the price of data format translation. Such analytics advances data acquisition efficacy. SCRIBE, Kafka, Time-Tunnel, and Chukwa are examples of architectures that conduct off-line analytics.

Memory-level analytics is smeared when the mass of data is tinier than the memory of a cluster. To date, the memory of clusters has touched terabyte (TB) level. Memory-level analytics is appropriate to conduct real-time analysis. Mongo DB is an example of this architecture.

BI analytics is adopted when the mass of data is bigger than the memory level, but in this case, data may be imported to the BI analysis environment. BI analytic presently provisions TB-level data. Furthermore, BI can aid determine calculated business openings from the flood of data. Additionally, BI analytics permits easy interpretation of data volumes.

Massive analytics is applied when the mass of data is bigger than the whole capability of the BI analysis product and traditional databases. Enormous analytics utilizes the Hadoop disseminated file system for data storage and map/decrease for data analysis. Enormous analytics supports create the business foundation and increases market competitiveness by extracting meaningful values from data. Moreover, huge analytics gains correct data that leverage the hazards involved in building any business decision.

5.2 Association between IoT and Big Data:

One of the the majority outstanding features of IoT is its study of info concerning associated things. Big data analytics in IoT necessitates processing a huge amount of data on the fly and storing the data in a variety of storage technologies. In general, the use of IoT enhances the amount of data in quantity and category; Therefore providing the chance for an application and improvement of big data analytics. Furthermore, the application of big data technologies in IoT accelerates the research progresses and business models of IoT. The association between IoT and big data [18] that is shown in 3 stages in Figure 7. The 1st stage comprises handling IoT data sources, where connected sensors devices utilize applications for interacting through one another. For example, the communication of devices such as CCTV cameras, smart traffic lights, and smart home devices, produces huge amount of data resources through dissimilar formats. This data can be stored in inexpensive commodity storage on the cloud. In the 2nd stage, the produced data are known 'bigdata', which are depending on their volume, velocity, and variety. These vast amount of data are stored in big data files in communal dispersed fault tolerant databases. The final stage pertains analytics tools such as MapReduce, Spark, Splunk, and Skytree, which can analyse the stored big IoT data sets.

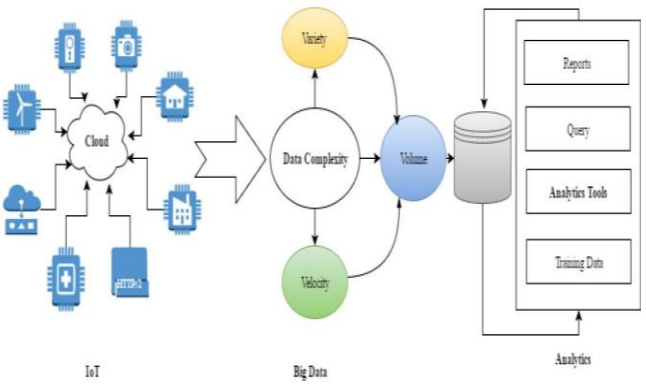

Figure 7: Relationship between IoT and Big Data

5.3 Big Data Analytics Methods

Big data analytics aspire to instantly take out the knowledgeable information that facilitates in making predictions, discovers recent trends, searching hidden information, and eventually, make decisions [18]. We can present big data analytics techniques under categorization, clustering, association rule mining, and prediction categories. Figure 8 illustrates and recapitulates entire categories. Each category is a data mining function and entails numerous techniques and algorithms for fulfilling the information extraction and analysis necessities.

Classification is a supervised learning method, which utilizes prior knowledge as training data to categorize the data objects into groups. A predefined category is allocated to an object, and hence, an objective of the predicting a group or class for an object is accomplished. Searching unknown or hidden patterns is much difficult for big IoT data.

Clustering is another data mining method utilized as a big data analytics technique. Contrary to classification, clustering utilizes an unsupervised learning method and builds groups for specified objects depending on their distinct meaningful features. The well-known techniques utilized for clustering are hierarchical clustering and partitioning. The hierarchical clustering technique remains unite small clusters of data objects to form a hierarchical tree and build agglomerative clusters. Disruptive clusters are formed in an opposed style by separating a single cluster, which includes entire data objects into smaller suitable clusters.

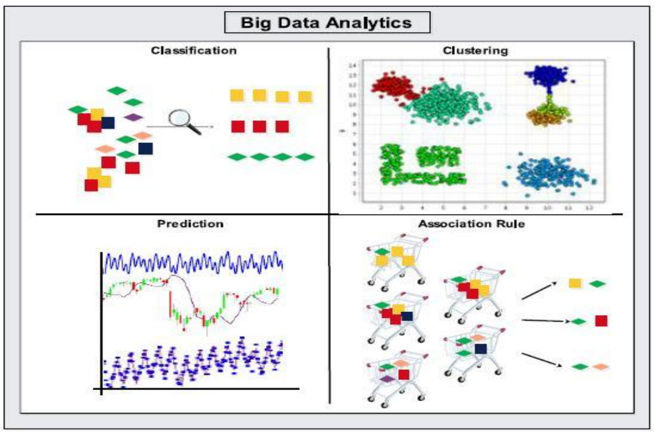

Figure 8: Overview of Big Data Analytics Methods.

Association rule mining entails recognizing appealing relationships between dissimilar objects, events, or further things for analyzing market trends, consumer buying behaviour, and product demand predictions. Here, Data processing is performed in 2 types. 1st, in order data processing utilizes priori-based algorithms, like MSPS and LAPINSPAM, to recognize interaction associations. 2nd, temporal sequence analysis that utilizes algorithms for analyzing event patterns in uninterrupted data.

Predictive analytics use historical data that are called as training data, for determining the outcomes as tendency or behaviour in data. SVM and fuzzy logic algorithms are utilized for recognizing relationships among non-dependent and dependent variables and for achieving regression curves for predictions such as for natural disasters. In addition, customer buying predictions and social media tendency are analysed by predictive analytics.

VI. CONCLUSION

IoT has been gradually bringing a sea of technological changes in our daily lives, which in turn helps in making our life simpler and more comfortable, though various technologies and applications. This emerging paradigm of networking will influence every part of our lives ranging from the automated houses to smart health and environment monitoring by embedding intelligence into the objects around us. The key observations in the literature are that (1) There is no standard definition in worldwide (2) Universal standardizations are required in architectural level (3) Technologies are varying from vendor-vendor, so needs to be interoperable (4) For better global governance, we need to build standard protocols. Let us hope future better IoT. IoT is one of the biggest sources of big data, which are rendered useless without analytics power. IoT interacts with big data when voluminous amounts of data is needed to be processed, transformed, and analysed in high frequency. Finally, the existing big IoT data analytics solutions remained in their early stages of development. In the future, real-time analytics solution that can provide quick insights will be required. The deployment of IoT requires strenuous efforts to tackle and present solutions for its security and privacy threats.

VII. REFERENCES

1. Rafiullah Khan, Sarmad Ullah Khan, Rifaqat Zaheer and Shahid Khan, "Future Internet: The Internet of Things Architecture,Possible Applications and Key Challenges", Proceedings of Frontiers of Information Technology (FIT), pp. 257-260, 2012.
2. Guicheng Shen and Bingwu Liu, "The visions, technologies, applications and security issues of Internet of Things," International Conference of E-Business and E –Government, pp.1-4, 2011.
3. Ling-yuan Zeng, "A Security Framework for Internet of Things Based on 4G Communication," International Conference of Computer Science and Network Technology, pp. 1715-1718, 2012.
4. M Weiser, "The computer for the 21st century", Scientific American., pp.66 -755, 1991.
5. Jason Pontin, "Bill Joy's Six Webs," MIT Technology Review, 2005.
6. Kevin Ashton, "That 'Internet of Things' Thing", RFID Journal, 2009
7. HD Ma, "Internet of things: Objectives and scientific challenge," Journal of Computer Science and Technology, 2011, pp. 919-924
8. Nich Heath, "What the Internet of Things means for you", European Tecnology, 2012
9. De-Li Yang, Feng Liu and Yi-Duo Liang, "A Survey of the Internet of Things", International Conference on E-Business Intelligence (ICEBI), 2010
10. Bob Violino, "Top IT Vendors reveal their IOT strategies". Network World, 2014.
11. Harald Sundmaeker, Patrick Guillemin, Peter Friess, Sylvie Woelffl, "Vision and challenges for realising the Internet of Things," , Publications Office of the European Union, 2010
12. MU Farooq, Muhammad Waseem, "A Review on Internet of Things(IoT)", International Journal of Computer Applications(0975 8887), Volume 113-No. 1, 2015.
13. Vandana Sharma,Ravi Tiwari, "A review paper on "IoT" & its Smart Applications", International Journal of science, Engineering and Technology Research(IJSETR), volume 5, issue 2, pp.472,474-476,2016.
14. P Tiainen "New opportunities in electrical engineering as a result of the emergence of the Internet of Things", Tech. Rep., AaltoDoc, Aalto Univ.,2016.
15. M Beyer, "Gartner says solving `Big Data' challenge involves more than just managing volumes of data," Tech. Rep., AaltoDoc, Aalto Univ.,2011.
16. C L. P. Chen and C.-Y. Zhang, "Data-intensive applications, challenges, techniques and technologies: A survey on big data," Inf. Sci., vol. 275, pp. 314-347, 2014.
17. M Marjani et al.: "Big IoT Data Analytics: Architecture, Opportunities and open Research Challenges", IEEE Access, volume 5, pp. 5247, 5249-5252, 2017
18. CW. Tsai, "Big data analytics: A survey", J. Big Data, vol. 2, no. 1,pp. 1_32, 2015.