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# Recent Technologies for the Applications of IoT

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**Abstract**— Recent technologies such as big data and cloud computing are very useful for IoT based applications. Each of these technologies has its own features. The convergence of big data, cloud computing and IoT is the revolution in the digital world. These technologies are interdependent with each other. Big data and cloud computing provide new opportunities and applications in all the fields. The Internet of Things is the extension of internet connectivity into physical devices and objects. IoT applications can be emerged from people to industry. Day by day, data is growing enormously in all the fields. Data management is a tedious process. But the emergence of big data and cloud storage overcomes the data management issues. These are helpful to create plenty of IoT applications.

Keywords- Big Data, Cloud Computing, Cloud Storage, IoT, Sensors, Intelligent IoT

## 1. INTRODUCTION

Big data, cloud computing and IoT are unique features. However, they are interdependent with each other. The concept of big data and IoT has been evolved many years ago, but its mainstream application recently started. The cloud computing has been evolved to many stages.

Demand for big data is the adoption of both IoT and cloud platforms. With IoT, the amount of big data will enormously increase. The combination of IoT and big data move towards cloud technology. According to IDC, "Within the next five years, more than 90 percent of all Internet of Things data will be hosted on service provider platforms as cloud computing reduces the complexity of supporting the Internet of Things 'data blending.""

The number of IoT devices is expected to grow to 20 billion by 2020. The big data industry is expected to have a worth of US\$66.8 billion by 2021. These are the fastest growing sectors in IT. Both are needed for any technological innovation for a society.

The convergence of these big data, cloud computing and IoT creates a massive shift towards the interdependence on interconnected devices. The result becomes information-based outcomes instead of product-based outcomes.

## 2. BIG DATA

Big Data defines as complex and large data sets that have to be processed and analyzed to uncover valuable information. It is useful for organizations as well as society. It refers to a huge amount of data which grows exponentially with time. It contains data mining, data storage, data analysis, data sharing, and data visualization. The term big data is a package which includes data, data frameworks, along with the tools and techniques used to process and analyze the data. IoT devices generate huge data. The conventional data storage has limitations. Thus, the demand occurs for innovative storage solutions to handle these barriers and update the infrastructure of an organization's big data storage.

#### A. Characteristics of Big Data

There are three important characteristics of Big data.

1. Variety

Variety of Big Data refers to structured, unstructured, and semistructured data that is gathered from multiple sources. While in the past, data could only be collected from spreadsheets and databases, today data comes in an array of forms such as emails, PDFs, photos, videos, audios, SM posts, and so much more.

2. Velocity

Velocity refers to the speed at which data is being created in real-time. It comprises the rate of change, linking of incoming data sets at varying speeds.

3. Volume

Big Data indicates huge 'volumes' of data that is being generated on a daily basis from various sources. Those resources are social media platforms, business processes, human-machine interactions, etc. The huge data can be stored in data warehouses.

#### A. Types of Big Data

Big data is classified into three types:

- 1. Structured data
- 2. Unstructured data
- 3. Semi-structured data

#### 1. Structured Data

The structured data can be processed, stored, and retrieved in a fixed format. It refers to finely organized information that can be stored and accessed from a database by simple search engine algorithms.

#### 2. Unstructured Data

Unstructured data refers to the data which does not follow any specific form or structure. This makes it very difficult and time-consuming to process and analyze unstructured data. Email is an example of unstructured data.

#### 3. Semi-structured Data

Semi-structured data pertains to the data which means structured and unstructured data. It refers to the data that although has not been classified under a particular International Journal of Research in Advent Technology, Vol.7, No.5S, May 2019 E-ISSN: 2321-9637 Available online at www.ijrat.org

repository. It contains vital information that segregate individual elements within the data.

#### B. Big Data Analytics

IoT big data analytics is useful for a variety of IoT data to:

- ✓ Examine
- $\checkmark$  Reveal trends
- Find unseen patterns
- Find hidden correlations
- ✓ Reveal new information

Hence, companies can be benefitted from analyzing plenty of IoT big data and managing them. It assists business and other organizations to achieve an improved understanding of data. An efficient and well informed decision can be made in business world. The application of big data technologies in IoT accelerates the research advancement and business models.

The relationship between IoT and big data is shown in figure 1. It can be divided into three steps to enable the management of IoT data. The first step comprises managing IoT data sources, where connected devices and their interactions. For example, the interaction of devices such as CCTV cameras, smart traffic lights, and smart home devices, generates large amounts of data sources with different formats. This data can be stored at the cloud. In the second step, the generated data are called "big data". These are based on their volume, velocity, and variety [1]. These data are stored in big data files in shared distributed fault-tolerant databases. The last step applies analytics tools such as MapReduce, Spark, Splunk, and Skytree that can analyze the stored big IoT data sets. The four levels of analytics start are training data, analytics tools, queries, and reports.



Fig. 1 IoT and Big Data Analytics

#### 3. CLOUD COMPUTING

Cloud computing is the delivery of computing services such as servers, storage, databases, networking, software, analytics, intelligence etc., over the Internet to offer flexible resources and economies of scale. The IaaS, PaaS and SaaS are provided in cloud computing [5]. Figure 2 shows the cloud computing services.



Fig. 2 Cloud Computing Services

#### A. IoT and Cloud

Cloud computing as well as IoT, go towards to increase the efficiency of everyday tasks. Both have a complementary relationship. IoT generates lots of data and cloud computing paves way for this data to travel. There are many cloud providers who provide a pay-as-you-use model where customers pay for the specific resources. Also, cloud hosting adds value to IoT startups by reducing their overall cost structure.

Cloud computing also enables better collaboration for developers. The cloud will allow developers to implement projects without delay. IoT companies can access a huge amount of Big Data.

#### B. Reason for Cloud Computing

Cloud computing is useful for better IoT applications. IoT applications can be built on the principle of mobility and networking.

1. Provides remote processing power

Cloud empowers IoT to move beyond regular appliances such as air conditioners, refrigerators etc. This is because the cloud has such a vast storage. It takes away dependencies on on-premise infrastructure. With the help of 4G to higher internet speeds, the cloud will allow developers to offload fast computing processes.

2. Provides security and privacy

Cloud makes IoT more secure with preventive and corrective controls. It has enabled users with security measures by providing authentication and encryption protocols. With the help of biometrics, the identity of users is possible for IoT products.

#### 3. Facilitates inter-device communication

Cloud acts as a bridge in the form of a mediator when it comes to IoT. The APIs like Cloudflare, CloudCache and Dropstr are enabled by cloud

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communications. These can be allowed easy linking to smartphones.

## 4. IOT APPLICATIONS

IoT has many applications. The big data and cloud computing are combined with IoT to implement many applications for the society.

## A. Smart Home

In smart home, the devices have the capability to communicate with each other as well as to their intangible environment. A smart home gives the owner who has the capability to customize and control home environment for increased security and efficient energy management. There are numerous technologies available for monitoring smart homes.

Consumer product manufacturers like Belkin, Philips, Amazon and Haier are established themselves as prominent companies in this market.

## **B.** Wearables

Wearables are experienced high demand in markets all over the world. Companies like Google, Samsung have invested heavily to build such devices. Wearable devices are installed with sensors and softwares which collect lots of data and information about the users. Then the data is later pre-processed to extract essential insights about user. These devices are used to cover fitness, health and entertainment requirements [2].

## C. Connected Cars

The automotive digital technology focuses on optimizing vehicle's internal functions. But nowadays, this attention is growing towards enhancing the in-car experience.

A connected car is a vehicle which optimizes its own operations, maintenance as well as comfort of passengers using onboard sensors and internet connectivity. Major brands like Tesla, BMW, Apple, Google bring the next revolution in automobiles.

## D. Smart City

Smart city is a powerful application of IoT generating curiosity among world's population. Smart surveillance, automated transportation, smarter energy management systems, water distribution, urban security and environmental monitoring are examples of internet of things applications for smart cities. IoT solves major problems faced by the people living in cities like pollution, traffic congestion and energy supplies issues etc. The parking slots across the city are available for citizens.

## E. IoT in Agriculture

The demand for food supply is extremely raised in this era. Government helps for the farmers to use advanced techniques and research to increase food production. Smart farming is the fastest growing field in IoT. Farmers will have the meaningful insights from the data to yield better return on investment. Sensing for soil moisture and nutrients, controlling water usage for plant growth and custom fertilizer determination are some simple uses of IoT.

## F. IoT in Healthcare

The big data and cloud computing technologies produce revolution in the applications of IoT. The concept of connected healthcare system and smart medical devices has lot of potential for the patient's care[3]. IoT in healthcare aims at empowering people to live healthier life by wearing connected devices. The collected data will help for personalized analysis of an individual's health and provide tailor made strategies to combat illness.

## 5. CONCLUSION

Internet of Things is the next stage of the information revolution. Integration with the Internet implies that devices will use an IP address as a unique identifier. IoT generates big data from lots of interconnected devices and all are stored in cloud. Cloud service providers are used to provide IaaS, PaaS and SaaS for the users. The convergence of big data and cloud computing are useful to generate lots of applications.

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