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A survey on Integration of Internet of Things along with Cloud Computing and Artificial Intelligence for smart applications.

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Abstract : By leveraging the uses of RFID, wireless sensor nodes, and of course Internet, the concept of Internet of Things is the fastest emerging trend that has made the lives of common people easier by automation and smart sensing. Some commonly used concepts of IoT can be smart home applications, smart irrigation systems, various calamities detection, on-road traffic management, transportation systems management, etc. These concepts use the data transmission from the sensor node to the notification-enabled device using Internet. But the actual question is that where does the data of a sensor node is stored for transmission? The answer to this is: Integrating the IoT services with Cloud. The applications of the cloud computing integrated with the IoT concept has been further discussed in this paper. Furthermore, the applications of integrating Artificial Intelligence with these two concepts has been focused on.

IndexTerms **- RFID,IOT,Cloud**

I. INTRODUCTION

Day-by-day the technology has been demanding one level up of what is existing today. Initially, the applications of Internet of Things concept have been focused on sensing some physical or environmental parameter and based on the sensed data, the actuator performed the pre-defined action. For example, when a person enters room, based on motion sensor, the lights can be switched on or off. Later, these concepts were connected through internet. For instance, for a smart security system, if there is any type of vulnerability detected in the house when the owner is away, the message can be sent to him to alert him through any sort of smart phone application using internet. The use of Cloud computing concept has opened new doors for the sensor data storage. The integration of Internet of Things with Cloud can be depicted from the following architecture [1]:

Fig. 1: Integration of Cloud in Internet of Things

From the above figure, it can be depicted that the IoT applications are being run with different sensor nodes like Arduino, has been run on different computing devices like Laptops, Desktop PCs, and mobile devices. The data sensed by the sensor can be displayed in these devices but also can be stored online using Cloud services for future use and security of data purpose. IoT can benefit from the virtually unlimited capabilities and resources of Cloud to compensate its technological constraints (e.g., storage, processing, energy).[2]. The furthermore analysis of IoT with cloud is discussed further in this paper.

In spite of being integrated with Cloud, IoT applications like Smart Health Monitoring, Prediction of Some parameters, either physical or environmental, needs some sort analytical processes on previously stored bulks of data. For this analysis, algorithm to predict a parameter value needs to be defined. This can be done using the Artificial Intelligence with the concept of Internet of Things. The sub-field of Artificial Intelligence, Machine Learning, is being recommended for these types of predictions and classifications of data. The further discussion of IoT and Machine Learning is discussed further in this paper.

II. Internet of Things: Applications and Challenges:

The applications of IoT in industries and real life [3] can be described as follows:

1. In Health care service:

For instance, the monitoring of heart beat, pulse rate, blood pressure, cholesterol, etc. of a person wearing a smart IoT enabled device can be obtained through the smart wearable device that sends the data to the cloud through internet and we can obtain it using our electronic devices. This technique is also deployed to bridge the gap between the physician and the patient. As soon as some weak signal is detected, the doctor gets the alert about the patient. Hence, by this we can have much less time wasted in detecting the disease, approaching the doctor, etc.

2. In Transportation Services:

To track the position of the transport vehicle, to estimate the arrival time and the departure time based on the road traffic, etc. are the basic functionalities of the Smart transportation systems.

3. Smart Automation Systems:

Automation systems like home automations where the sensors can sense the human interactions through motion sensors, etc and perform some pre-defined actions like switch on and off electronic devices, etc. are developed. Also, using smart applications, the person who is away from home can switch on and off the devices at home.
The Automation systems are not limited only to smart homes. In agriculture, Smart irrigation systems are provided where the sensors can sense the humidity of the soil and based on that the motor can b switched on and water can be sprinkled in the farm. Again when the humidity goes to its threshold, the motor can be turned off.
So these were the basic applications of Internet of Things. But as it is said, every coin has two sides, now let us have a look on the challenges the concept of IoT faces and its probable solutions [3]:

1. Technical Challenges:

The technical challenges faced while implementing the above-mentioned applications are as follows:

a. Design of an appropriate Service Oriented Architecture for IoT as it might cost performance, high cost and scalability issues.

b. Increase in complications of IoT in heterogeneous environments, that can include the connection between various types of networks through various communication technologies.

2. Standardization issues:

Specific issues in IoT standardization include interoperability issue, radio access level issues, semantic interoperability, and security and privacy issues.

3. Information Security and Privacy Protection:

The acceptance and widespread of new IoT technologies and services will largely rely on the information security and data privacy protection, which are two difficult issues in IoT.

Probable solutions for these problems can be integrating the IoT concepts with Cloud Computing and Artificial Intelligence can lead to much improvement in the drawbacks of IoT.

III. Internet of Things and Cloud Computing:

The Cloud can offer an effective solution to implement IoT service management and composition as well as applications that exploit the things or the data produced by them. On the other hand, the Cloud can benefit from IoT by extending its scope to deal with real world things in a more distributed and dynamic manner, and for delivering new services in a large number of real life scenarios.

Applications of Cloud Computing on IoT platform:

1. Healthcare:

Healthcare can be cost effective, efficient, timely, and high-quality ubiquitous medical services Pervasive healthcare applications generate a vast amount of sensor data that have to be managed properly for further analysis and processing The adoption of Cloud in this scenario leads to the abstraction of technical details, eliminating the need for expertise in, or control over, the technology infrastructure , and it represents a promising solution for managing healthcare sensor data efficiently. It further makes mobile devices

suited for health information delivery, access and communication, also on the go , enhancing medical data security, availability, and redundancy .

2. Smart City:

A number of recently proposed solutions suggest to use Cloud architectures to enable the discovery, connection, and integration of sensors and actuators, thus creating platforms able to provision and support ubiquitous connectivity and real-time applications for smart cities. Frameworks can consist of a sensor platform (with APIs for sensing and actuating) and a Cloud platform for the automatic management, analysis, and control of big data from large-scale, real world devices. This type of advanced service model hides the complexity of the underlying Cloud infrastructure, whilst at the same time meeting complex public sector requirements for Cloud, such as security, heterogeneity, interoperability, scalability, extensibility, high reactivity, and configurability. Moreover, Cloud based platforms help to make it easier for third parties to develop and provide IoT plugins enabling any device to be connected to the Cloud. While cities share common concerns – such as the need to effectively share information within and between cities and the desire for enhanced cross border protocols – they lack a common infrastructure and methodology for collaborating , which may result from the application of a holistic approach . Common issues are related to security, resilience, and real-time interactions.

3. Video Surveillance:

Intelligent video surveillance has become a tool of the greatest importance for several security-related applications. As an alternative to in-house, self-contained management systems, complex video analytics require Cloud-based solutions to properly satisfy the requirements of storage (e.g., stored media is centrally secured, fault-tolerant, on-demand, scalable, and accessible at high-speed) and processing (e.g., video processing, computer vision algorithms and pattern recognition modules to extract knowledge from scenes). Proposed solutions intelligently store and manage video content originating from (IP and analog) cameras, and efficiently deliver it to multiple user devices through the Internet, by distributing the processing tasks over the physical server resources on-demand, in a load-balanced and fault tolerant fashion.

4. Smart Energy and Smart Grid:

IoT and Cloud can be effectively merged to provide intelligent management of energy distribution and consumption in both local and wide area heterogeneous environments. In the first case, for instance, lighting could be provided where and when strictly necessary by exploiting the information collected by different types of nodes. Such nodes have sensing, processing, and networking capabilities, but limited resources. Hence, computing tasks should be properly distributed among them or demanded to the Cloud, where more complex and comprehensive decisions can be made. In the second case, the problem on energy alternative and compatible use can be solved by integrating system data in the Cloud, while providing self-healing, mutual operation and participation of the users, optimal electricity quality, distributed generation, and demand response.

IV. Challenges for Integrating Cloud Computing with IoT: [4]

1. Protocol Support:

For different things to be connected to the Internet, different protocols will be there in use. Even if there are homogenous entities, for example a sensor IoT, then there is a possibility sensor may be working on different protocols, like: Wireless HART, ZigBee, IEEE 1451, and 6LOWPAN. [4].

2. Energy Efficiency:

With sensor networks everywhere and connectivity with the cloud will lead to a lot of data communication, which consumes a lot of powerlift is not going be suitable to have a temporary power supply, like batteries and have to replace them every now and then. With billions of sensors and low power devices, it is beyond possibility. Having efficient usage of energy and rather permanent power supply would be required.

3. Resource allocation:

Depending upon the sensor and the purpose for which sensor is being used, the type, amount, and frequency of data generation, resource allocation has to be mapped. Sending a sample packet from the newly added node can also be useful.

4. Identity management

Communicating nodes over the Internet are identified uniquely. When objects are becoming part of Internet (IoT), they also need a unique identification. Also, in case of mobile devices, like mobile sensor nodes on vehicles and other objects, need to have identity mapping in the new network they have just entered.

5. Location of data storage

Location also matters for critical and latency or jitter sensitive data. Time sensitive data, like video, should be stored in the closest possible physical location to the user, so that minimum possible time should be involved in accessing big data. For multimedia data, nearest possible virtual storage server must be allocated.

These were the issues and applications when we integrate IoT with Cloud Computing.

Now Let us have a glance on the applications and issues of integration of IoT with Machine Learning in Artificial Intelligence.

4.1 Applications of IoT with Machine Learning:[5]

1. Energy saving approaches:

By analysis of power usage through machine learning algorithms, we can switch on or off various machines through smart sensing.

2. Traffic Routing Systems:

Using online navigations along with, the pattern of the traffic found on the road can be analyzed and based on the the traffic can be routed.

3. Smart Home applications:

As discussed earlier, we can have dataset containing frequent patterns for smart lock, iris recognition, etc

4. Healthcare:

Remote Expert doctor Consultation, chronic disease management, elderly care, etc can be provided.

The challenges faced by integration of IoT with Artificial Intelligence are almost the same as those faced before in cloud computing.

V. Conclusion

So hereby, we conclude that instead of a standalone IoT system, if we integrate it with newly emerging technologies like Cloud Computing and Artificial Intelligence, we can have wide variety of applications in this area and also we can move towards a brighter and automated future.

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