EXPLORING THE POWER OF CLOUD COMPUTING TO BOOST IOT APPLICATION CAPABILITIES

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Abstract

Cloud computing is a methodological approach that facilitates the interconnection of diverse networks for the purpose of exchanging large volumes of data.With the help of cloud computing, regular people can store their important data online. Both free and paid cloud services are currently accessible for use. Cloud computing has emerged as a prominent and widely adopted technology in contemporary times. Internet of Things (IoT) technology is another recent development. The IoT technology pertains to the transmission of data and information among intelligent objects or devices. The Internet of Things (IoT) is increasingly being incorporated into various aspects of society and has gained notable importance in sectors including healthcare, agriculture, smart homes, smart cities, and other domains. The integration of Cloud Computing into the IoT has resulted in the cloud playing a crucial role in connecting applications and smart objects. Specifically, it serves as a storage platform for the data and records that are generated as a result of the interactions among these objects. Both technologies are currently popular and exhibit certain similarities, as they mutually enhance each other's capabilities. The convergence of cloud computing and the IoT has the potential to yield significant benefits to society. The proliferation of automation on a large scale will give rise to a scenario in which a substantial amount of data will be generated through device communication, particularly in the industrial sector. There have been a multitude of cloud computing applications that have been developed to offer services to IoT applications. This paper presents a comprehensive review of applications of IoT focusing on the integration of cloud computing and the IoT.

Keywords: Internet of Things (IoT); Cloud, Integration, Applications, Role.

I. Introduction

The concept of the Internet of Things (IoT), initially coined by Kevin Ashton in 1998, represent a paradigm that encompasses the integration of the internet and pervasive computing (Wu et. al., 2012). The current technological revolution signifies the forthcoming era of enhanced connectivity and accessibility. In the context of IoT, the term "things" encompasses all entities present on the Earth's surface, regardless of their nature as either communicating devices or non-communicating objects lacking intelligence. The objects are transformed into communicating nodes via data communication methods, predominantly utilizing Radio Frequency Identification (RFID) tags. The IoTencompasses the integration of smart objects. This is the reason why the Internet of Things (IoT) encompasses not only softwareand hardwarecomponents, but also incorporates social dimensions and interaction (Kortuemet al., 2009). The concept of the IoT involves the interconnection of various devices, commonly referred to as "things," and their virtual representation that can be accessed and communicated with through standard protocols. The presence of diverse characteristics among various entities poses a challenge in achieving interoperability, thereby hindering the widespread implementation of standardized solutions. Moreover, the proliferation of IoT devices has introduced significant challenges to current information services due to the sheer volume, high velocity, and volatile nature of the data generated. In recent years, there has been an increasing desire to expand the current internet infrastructure by incorporating interconnected physical devices and their corresponding virtual representations. This will facilitate the development of a diverse range of services across various sectors, including smart homes, e-health, transportation, logistics, and environmental initiatives (Zhang et al., 2010; Ma, & Zhang, 2012; Jadeja, & Modi, 2012).

Cloud computing technology is a contemporary phenomenon that offers adaptable computing and storage services to facilitate the handling of extensive data processing requirements. Hence, the examination of data generated by sensors and Internet of Things (IoT) devices can be utilized in the context of cloud computing. In order to fully exploit the future market potential, it is imperative to

address critical challenges such as data interchange formats, communication bottlenecks, interoperability and protection by implementing platform-neutral technologies (Vincentet al., 2019).
Cloud computing is a broad term that encompasses various technical services provided through the internet. Cloud computing provides on-demand and compliantnetwork access for various computing tools, including networks, systems, software, and facilities (Chen et al., 2014).
Currently, there exists a substantial and widespread demand for intelligent network Internet of Things (IoT) applications across various sectors, including agriculture, healthcare, education, smart cities, and retail, among others. The Internet of Things (IoT) is employed in the agricultural sector to optimize crop harvesting processes. This application aims to reduce transportation expenses and enhance price predictability through the utilization of historical data analytics (Shenoy & Pingle, 2016). The utilization of Internet of Things (IoT) is frequently employed in the context of electricity conservation to notify consumers about the need for conserving electricity (Pingle et al., 2017).
Numerous research endeavors are currently underway in the field of healthcare IoT, encompassing diverse models and methodologies for predicting various diseases. The utilization of IoT and cloud computing in the healthcare sector proves to be highly advantageous in facilitating real-time monitoring of patient health. This is achieved through the implementation of sensor technology, which enables the collection and transmission of raw data to the cloud for subsequent analysis. Consequently, alerts are promptly dispatched to both the attending physician and caretaker, allowing them to interpret and predict potential illnesses or conditions at an early stage. Various data mining techniques and machine learning algorithms are employed for the purpose of analysis and prediction (Banka et al., 2018).

II. Cloud Computing to Boost IoT Application

Healthcare

As prevalent healthcare applications produce a substantial volume of sensor data that necessitates appropriate management for subsequent analysis and processing (Doukas& Maglogiannis, 2012). The implementation of Cloud technology in this context results in the simplification of technical intricacies, removing the necessity for specialized knowledge or direct oversight of the technological infrastructure (Alagöz et al., 2010). Additionally, it offers a potentially advantageous approach to efficiently managing sensor data from healthcare (Doukas& Maglogiannis, 2012). Mobile devices are well-suited for the delivery, access, and communication of health information, even while on the move. This capability enhances the security, availability, and redundancy of medical data (Alagöz et al., 2010).
In the domain of IoT and cloud platforms, the utilization of a range of sensors is a crucial element that assumes a central role in the surveillance and facilitation of a wide array of functions. These sensors have a broad range of applications, particularly in the field of healthcare. One notable illustration is the temperature sensor, which is utilized for the purpose of measuring body temperature, a critical component in health evaluations. Force sensors are employed in kidneys dialysis machines to guarantee accuracy in the administration of treatment. Airflow sensors play a substantial role in enhancing anesthesia delivery systems, thereby optimizing the quality of patient care. Pressure sensors play a crucial role in the functionality of infusion pumps and sleep apnea devices, as they are responsible for maintain the precision of medication administration and sleep therapy. Implantable pacemakers employ sensors in order to sustain optimal cardiac rhythms, administering synchronized electrical impulses to the heart. Oximeters are utilized to measure the level of oxygen saturation in haemoglobin, whereas Glucometers aid in approximating the concentrations of blood glucose. Electrocardiogram sensors are utilized to quantify the electrical activity of heart, while heart rate sensors are employed to monitor the rhythmic contractions of the heart. Electroencephalogram sensors are utilized to measure brain activity, while respiration rate sensors are employed to monitor the frequency of chest movements per minute. Proximity sensors are capable of detecting the presence of objects without physical contact, whereas Infrared sensors play a crucial role on the detection of objects. Ultrasonic sensors are utilized for the measurement of distances and velocities, whereas piezoelectric sensors are employed for the quantification of

changes in friction, acceleration and temperature. These sensors collectively serve as the fundamental components of IoT and cloud platforms, facilitating the acquisition and analysis of data to improve decision- making and healthcare applications. (RF Wireless Vendors and Resources, n.d.; electronics hub (n.d.); Piezoelectric sensor, 2023).

Smart City

The term "Smart City" is used to describe a metropolitan area that employs data-driven solutions and cutting-edge technologies to better the lives of its citizens and the city as a whole. the establishment of a smart city necessitates the collection of data from various dissimilar sensing infrastructures, as well as the utilization of diverse geo-location and Internet of Things (IoT) technologies. These technologies may include, for example, the use of RFID sensors and geo-tagging to generate 3D representations. Furthermore, it is essential to present this information in a standardized manner. Frameworks typically comprise of a sensor platform that includes application programming interfaces for both actuatingand sensing. Additionally, there is a Cloud platform that facilitates the automated analysis,control of extensive data derived from real-world devicesand management on a large scale (Suciu et al., 2013).

Smart Court System

The implementation of Internet of Things (IoT) technology has facilitated the development of a Smart Court system. This system incorporates advanced analytics, improved access to factual information, and streamlined procedures within court systems. These enhancements aim to optimize strategies, eliminate unnecessary procedures, address issues of corruption, reduce costs, and enhance overall satisfaction (Dawood et al., 2018).

Smart Home and Smart Metering

The Internet of Things (IoT) exhibits significant potential in residential settings, as diverse embedded devices facilitate the automation of routine household tasks. In this particular context, the utilization of the Cloud emerges as the most suitable option for constructing adaptable applications with minimal lines of code, thereby rendering home automation an effortless undertaking. To enable a diverse range of autonomous single-family smart homes to access reusable services via the Internet, it is imperative that the resulting solution meets three essential requirements (Ye & Huang, 2011). The key features of a smart home include internal network interconnection, intelligent remote control, and automation. The term "internal network interconnection" is used to describe the capacity of all digital devices in a smart home to communicate with one another. Any gadget, no matter where it is, may intelligently operate the smart home's appliances and services. To automate a home, appliances must be networked together so that they can carry out their duties by tapping into the services offered by a Cloud infrastructure designed specifically for use in smart dwellings.

Smart Entertainment and Media

Smart Entertainment and Media involves the utilization of cloud-based technology to facilitate the transfer of data from one location to another. The Internet of Things (IoT) plays a crucial role in enabling seamless connectivity among individuals, allowing for the efficient transfer of media content between them (Reddy, 2017).

The Implementation of Visual Monitoring Systems

Intelligent video/visual surveillance has emerged as a highly significant tool for various security-related applications. Complex video analytics necessitate the utilization of Cloud-based solutions, such as Video Surveillance as a Service (VSaaS), as a substitute for in-house, self-contained management systems. This is essential in order to effectively meet the storage requirements, ensuring that stored media is fault-tolerant, scalable, accessible at high-speedand securely centralized. Additionally, Cloud-based solutions are crucial for processing tasks, such as computer vision algorithms, pattern recognition modulesand video processing, which are employed to extract valuable insights from the recorded scenes (Prati et al., 2013).

Smart Industrial Control

Smart Industrial Control refers to the implementation of automated diagnostic capabilities and system control in various industrial settings. This includes the monitoring of oxygen and toxic gas levels within chemical plants, with the aim of ensuring the safety of both employees and products.

Additionally, temperature monitoring plays a crucial role in maintaining optimal conditions within industrial environments. (Sharma & Tiwari, 2016)

Transportation and Smart Mobility

The incorporation of Cloud technologies into Wireless Sensor Networks (WSNs), satellite networks, Radio Frequency Identification, and other intelligent transportation technologies presents a potential opportunity to address the primary challenges currently faced (He et al., 2014). A potential avenue for enhancing business operations is the development and implementation of novel IoT-driven vehicular data Clouds. These Clouds have the potential to yield numerous advantages, including but not limited to enhancing road safety, mitigating road congestion, facilitating traffic management, and providing recommendations for vehicle maintenance or repairs (He et al., 2014).

Intelligent Power and Infrastructure

The integration of IoT and Cloud technologies has the potential to aid in the coordination of power supply and use across a wide range of geographical settings. In the initial scenario, luminescence could be strategically implemented by utilizing data gathered from various nodes (He et al., 2014), thereby ensuring lighting is only utilized in specific locations and times when it is essential. These nodes possess capabilities for sensing, processing, and networking, albeit with restricted resources. Therefore, it is imperative to appropriately distribute computing tasks among multiple entities or delegate them to the Cloud, where more intricate and all-encompassing decisions can be executed. The issue pertaining to energy alternatives and their compatible usage can be effectively addressed through the integration of system data in the Cloud. This integration should encompass features such as mutual operation, self-healing, and user participation, as well as the provision ofdistributed generation, demand response andoptimal electricity quality(Han & Lim, 2010).

III. Advantages of convergence of IoT and cloud computing

The convergence of Io T and cloud computing presents numerous benefits that augment diverse facets of data management and utilization. This technology allows for the examination of extensive quantities of unstructured sensor data through the process of collecting and consolidating data on a cloud-based platform. This, in turn, facilitates thorough exploration of knowledge in a comprehensive manner. Scalability is a significant advantage that enables organizations to easily augment their resources by leveraging supplementary cloud merchant services as required, thereby ensuring the scalability of sensor networks. The sensor's cloud infrastructure offers a flexible platform for visualization data, enabling the gathering and retrieval of sensor data from various sources. In addition, sensor clouds facilitate collaboration among diverse entities, facilitating the sharing of sensor data and integrating physical sensor networks. Furthermore, the integration of these components enhances the capabilities of data storage and processing, thereby facilitating the efficient management of substantial volumes of data. The utilization of dynamic service processing enables users of sensor cloud technology to conveniently access their data from any location and at any time, thereby ensuring a high degree of flexibility and adaptability. In addition, the integration of wireless sensor networks and cloud computing yields rapid response times, rendering it suitable for real-time applications. Automation plays a pivotal role in enhancing the efficiency of sensor data transmission and facilitating the necessary modifications. The concept of multitenancy involves the allocation of services to multiple users, facilitating the sharing of cloud resources for sensors and guaranteeing universal accessibility to sensor data. The integration describes provides a comprehensive framework for leveraging the capabilities of the IoT and cloud computing to facilitate innovation and enhance efficiency across multiple domains (Ari et al., 2012).

Conclusion

The field of IoT technology has experienced rapid growth and is considered a ground-breaking area within computer science. It has played a pivotal role in establishing connections between ordinary objects and the internet, thereby creating an extensive network of interconnected devices. The proliferation of Internet of Things (IoT) devices has been facilitated by the progress made in wireless networking technologies and the growing need for enhanced automation and productivity in various sectors. The application of this technology is being observed in diverse sectors, and its implementation is anticipated to further proliferate. The IoT is increasingly being incorporated into various aspects of society and has gained notable importance in sectors including healthcare, agriculture, smart homes, smart cities, and other domains. Due to its central role in facilitating the interconnection of apps and smart things, the cloud has become an integral part of the IoT since its incorporation into cloud computing. More specifically, it acts as a repository for the information and records produced as a result of the connections between various things. Both technologies are gaining traction at the moment, and they complement one another well. The combination of cloud computing with the Internet of Things could have far-reaching positive effects on human civilization. The ongoing development of networking and technological advancements is facilitating the expansion of the IoT, leading to a broader range of applications and greater integration within our society. This study has investigated the emergence of IoT devices, explored their prevalent applications in the domains of Power, Industry, smart courts, entertainmenthealthcare, and smart cities, and delved into the prospective advancements of this promising field.

In summary, the amalgamation of Internet of Things (IoT) and cloud computing is significantly transforming the digital environment, effectively tackling prevailing obstacles faced by businesses, and unveiling novel opportunities across diverse industries. The potential of cloud computing and the IoT is continuously expanding due to ongoing advancements and the development of innovative applications. This holds great promise for the future.

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