

The Effects of Cloud Computing and Internet of Things on the Next Generation Internet

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ABSTRACT

Two separate yet crucial technologies that are influencing our lives more and more are cloud computing and IoT. It is anticipated that they will be widely adopted, making them essential elements of the Future Internet (FI). IoT improves our daily life by enabling connectivity and communication across several devices. However, flexible network access offered by cloud computing makes it possible to integrate dynamic data from several sources. Nonetheless, there are a number of difficulties in integrating IoT and cloud computing in the FI. Our goal in this research paper is to present and analyze the fundamental ideas behind cloud computing and the Internet of Thing.

Keywords- Cloud Computing, Internet of Things (IoT), Artificial Intelligence and Machine Learning (AI & ML), Big Data and Analytics, Smart Cities, Autonomous Driving.

1. INTRODUCTION

A broad range of cutting-edge applications have been offered by the Future Internet (FI), especially when it comes to improving living quality, linking physical assets for collaborative services, and supplying access to a variety of tools across numerous sectors. This idea is a result of developments in the next-generation data communication networks, notably the Internet of Things (IoT), which provides a single, worldwide IT platform for networking seamless connections and networked devices. In this imagined future, people are going to efficiently employ any service and network and be connected to anything, anyone, anytime, and anywhere. In order to manage massive data streams and calculations, cloud computing emerges as a crucial backend solution. It provides a virtual data center that is scalable, efficient, and adaptable for context-conscious computing and online services, that in turn supports the expansion of the Network of Things[1]. Advanced sensors are the backbone of the Internet of Things (IoT), gathering information from the environment and ecosystem and sending it to cloud services for insights that can be put to use. This paradigm links self-configuring, intelligent devices in a global network architecture, but it has limitation in terms of processing power and storage, and privacy, security, performance, and reliability difficulties need to be addressed. Cloud computing is a very sophisticated technology that solves a lot of Internet of Things difficulties by providing massive processing and storage capacities. IOT and cloud computing work together to create an ancillary IT strategy that allows for the use of both extant and upcoming Internet capabilities[2]. This comprehensive system, which consists of cloud and IoT components, is the foundation of our daily life. It provides reliable interaction protocols and self-configuring capabilities to support virtual and tangible assets. The notion

of the Internet of Things (IoT), first introduced by Kevin Ashton in 1999, for instance, expands the scope of

worldwide computer networking by encompassing any thing that is capable of communicating. This comprises a vast range of items that have the capacity to able to communicate and exchange data, from wearables and sensors in cars to smart structures and home security systems[3]. The Internet of Things has advanced quickly as a result connected improvements in wireless communication, advanced sensing, mobile computing, and control technologies. IoT establishes a network that consists of a variety of physical items, contrasting to the conventional Internet, which mostly links computers. Many different sectors, including mobile healthcare, management of energy, agriculture, smart homes and offices, and transportation, have adopted this idea. Big data technology is about to find a significant unexpected application in the age of the Internet of Items (IoT)[4]. This idea enabled a wide range of physical things searchable on the internet in addition to computers. Sensors could be integrated into everyday items like clothes, cars, and appliances to allow for smooth automation and integration. The Internet of Things has changed drastically over time as result of higher-tech devices and applications made possible by computing developments. IoT is currently transforming a number of fields, such as smart cities, manufacturing, healthcare, and agriculture. It is also radically altering the way we engage with technology and improves ease and efficiency in every day life. This paper attempts to give a thorough introduction to cloud computing and Internet of Things ideas, highlighting their numerous applications in an organized way[5].

2. CLOUD COMPUTING

Instead of relying on your own servers or personal computers, cloud computing refers to the use of remote servers over the internet for data processing, management, and storing[6]. The technique makes it possible to access computer resources in a scalable and flexible manner, with services provided over the internet on the basis of individual requests. Cloud computing provides a range of accessible online services, such as computation and data storage, and allows for dynamic data fusion from different places[7]. Essentially, cloud computing offers a distributed computing model that makes it practical to supply services via the internet and use resources productively. It is frequently described as a more modern computer-related model that offers businesses/organizations a new business paradigm in exchange for the acquisition of IT[8]. Conventional computing paradigms are being transformed by modern distributed computing systems, which use the internet to provide effective, application-driven computer resources. By offering flexible, streaming utilization of computing resources and services, this method is transforming the way people engage with technology." [9].

2.1 Big Data and Analytics

In the field of cloud computing, analytical tools and big data are essential because they provide a strong way for determining conclusions, trends, and patterns from large and complicated datasets[10]. "Big Data is the term used to describe the vast volumes of data produced by various sources, including social media, sensors, and commercial activities. The sheer volume and complexity of this data make it difficult for traditional data processing tools to handle and evaluate efficiently. In contrast, analytics employs techniques from statistics and mathematical algorithms to examine data and extract useful information[11]. In the realm of cloud computing, analytics and big data are tightly related. Cloud platforms give enterprises the scalable infrastructure they need to handle and store massive amounts of data, allowing them to use cutting-edge analytics tools and methods to glean insightful results[12].

3. INTERNET OF THINGS (IoT)

The Internet of Things, or IoT, completely transformed connection, connecting individuals, companies, and groups like never before[13]. The Internet of Things (IoT) consists of tangible gadgets that have sensors, software, and communication components placed in them so they can trade and gather data. The boundaries between the real and virtual worlds are blurred by this unity, which improves daily living by facilitating easy communication of information and interaction[14].

When he originally offered the idea of the Internet of Things, Kevin Ashton emphasized how revolutionary it could be. IoT was formally recognized by the International Telecommunication Union (ITU) in 2005 [15]. Cost-effective application, data, and infrastructure deployment are made possible by the cloud-based IoT platform. Despite their differences, cloud computing and the Internet of Things work

well together to improve connection and efficiency among a range of companies [16].

3.1 Focus on Security

The Internet of Things (IoT) environment is heavily dependent on security, especially given the increasing number of linked devices[17]. Cyberattackers find Internet of Things (IoT) devices appealing because of their interconnectedness and tendency to gather and share sensitive data. Therefore, maintaining the integrity of systems, safeguarding data privacy, and preventing unwanted access all depend heavily on the security of IoT devices and networks[18].

The vast array of gadgets and technology that are engaged in IoT security presents a significant problem. IoT devices come in a variety of forms, from consumer electronics like smart home appliances to industrial gear and medical equipment, each with specific security needs[19]. It is difficult to apply uniform security measures across all devices as a result of this variability.

3.2 AI and Machine learning

Given that AI and ML allow machines to do tasks like speech and picture recognition that used to demand human intellect, these technologies are revolutionizing entire sectors. To gain insights, they examine huge databases, which is helpful for industries like marketing and healthcare[20]. AI and ML offer personalized experiences by tailoring recommendations based on user data. Even with their advantages, privacy and bias moral concerns still exist. In order to guarantee the future responsible usage of AI and ML, the aforementioned problems must be resolved.

4. IoT APPLICATIONS

Several well-known Internet of Things tools will be discussed in this part to demonstrate how the technology is affecting people's daily lives.

4.1 Smart Home

The opportunity of smart home technology to improve efficiency and convenience in our daily lives is what makes this device so appealing. Imagine being able to unlock doors and manage the lighting and air conditioning from anywhere in order to temporarily offer friends access[21]. These features not only make things quicker to do, but they also save time and effort.

Businesses are creating revolutionary options to optimize our living environments as the Internet of Things keeps growing. It is anticipated that smart home technology will become equally prevalent as Smartphones, providing homeowners with reducing expenses options and enhanced quality of life[22]. For human beings wishing to simplify and improve their living environments, these goods are a tempting option because they make the promise to save energy, money, and time[23].

4.2 Connected Cars

Vehicle internal function efficiency is the primary focus of attention for automotive digital technology. Rather, these ideas are evolving to enhance the enjoyment of driving[24]. When an automobile is internet-connected, it can use onboard sensors and internet connectivity in order to optimize not only customer and passenger pleasure and fulfillment but also maintenance and operation. The majority of major manufacturers as well as a few bold startups are creating and developing linked car technologies[25][26]. The main companies are focusing only on bringing about the next automotive revolution.

(a). Advanced Safety Features

Advanced safety features found in connected automobiles include collision avoidance and detection systems, adaptive cruise control, and lane departure warnings. These innovations improve road safety by helping drivers and lowering the likelihood of collisions [27]. Because these technologies warn drivers of possible hazards and help prevent accidents, they have greatly improved road safety. In order to avoid crashes, collision detection systems can automatically apply the brakes and employ sensors to identify impediments. When a driver leaves their lane without indicating, they are alerted with lane departure warnings. Rear-end collisions are less likely when a car with adaptive cruise control maintains a proper distance from the one in front of it[28]. All of these elements integrate themselves to make driving safer, which lowers the risk of accidents and may even save lives.

(b). Autonomous Driving:

Even though completely automated driving was still a ways off, between 2020 and 2023, linked cars started to include more autonomous functions[29]. Among these technologies were automatic parking systems, which may park a car without the need for human intervention, and lane-keeping assist, which aids drivers in staying in their lanes. Even though they did not allow for completely autonomous driving, these qualities set the stage for later developments in the field. Through the integration of semi-autonomous functions, connected automobiles offered an insight into the direction of automotive technology, demonstrating how it might improve road safety and convenience[30].

4.3. Wearables:

Wearable technology has resulted in an exponential increase in market demand worldwide. Numerous businesses have made significant development expenditures for producing these goods. What exactly are wearable products, though? Wearable technology has the ability to gather information about users and their movements through built-in sensors and software[31]. In order to get crucial insights about users and consumers, this data is then pre-processed. These wearables provide for an extensive assortment of fitness, health, and entertainment needs. It is advised that wearable technology employ small, ultra-low power or very efficient

Internet of Things technologies. Longer battery life and a more comfortable user experience are guaranteed by doing this[32].

4.4. Smart Cities

The Internet of Things is being used powerfully in smart cities, which is drawing interest from people all around the world. Among the many other Internet of Things applications for smart cities are environmental monitoring, mechanized transportation, smart waste management, supply of water, smart energy utilization systems, smart surveillance, and automated transportation. Significant issues that city dwellers and citizens confront, The Internet of Things can be used to address issues like energy shortages, traffic congestion, and pollution.[33].

People can find open parking spaces throughout the city by installing sensors and making use of web applications. Furthermore, any problems with the electrical system can be found and fixed, general failures, and meter manipulation issues can be detected by the monitoring devices[34].

4.5. Industrial Internet

The newest and most cutting-edge innovation in the industrial sector is the Industrial Internet of Things (IIoT). By leveraging big data analytics, monitoring sensors, and management software, industrial engineering is developing to provide intelligent equipment and products[35]. One such lovely, intriguing, and investable asset is the Industrial Internet of Things. Intelligent equipment and systems that communicate through data are more precise and consistent than humans, according to the Industrial Internet of Things' guiding principle. Additionally, by using this data, businesses may increase inefficiencies and find quicker solutions to issues. Sustainable development, consistency, and quality assurance are three major benefits of the Industrial Internet of Things[36]. Applications that allow suppliers and merchants to communicate real-time data about inventories, manage goods, automate deliveries, and manage inventoryThe efficiency of The supply chain will be improved by applications that allow suppliers and merchants to share real-time information, track inventory, automate deliveries, and manage operations intelligently..

4.6. Smart Retail

The Internet of Things has enormous promise in the retail industry. The retail industry may improve the in-store experience by connecting and interacting with customers through the Internet of Things[37]. In fact, by utilizing cellphones, retailers can maintain With Beacon technology and smartphone engagements, retailers may build close ties with their customers outside of their physical store. Retailers' earnings can increase and customer service is improved by these technology.

By monitoring clients' movements in a store, they can also enhance the layout of the establishment and position sophisticated items in busy places[38].

4.7. IoT in agriculture

Furthermore to the ongoing global population growth, there is a very high demand for food supplies. Governments assist farmers in conducting research and implementing cutting-edge technology in order to increase food output[39]. One of the areas of the Internet of Things that is expanding the fastest is smart farming. Meaningful insights from the data are being used by the producers to deliver a higher return on investment. Among the various uses of the Internet of Things are controlling water usage for growing crops, sensing moisture and minerals in the soil, and creating individualized fertilizer[40].

4.8. IoT in Healthcare

One new use for the Internet of Things is connected healthcare, which has a lot of promise. This idea, which calls for linked healthcare systems and intelligent medical equipment, holds promise for improving public health as well as business outcomes. Studies indicate that the Internet of Things will become a major factor for health care in the years to come. The goal of the Internet of Things in healthcare is to enable individuals to lead better lives by wearing connected gadgets[41]. Using the information gathered, a personalized examination of a person's health can aid in the development of special illness-fighting tactics.

5. CLOUD COMPUTING APPLICATIONS

Numerous applications that can be used through the Internet are greatly impacted by cloud computing. Important uses, still will be described.

5.1 Platform as a service (PaaS) and infrastructure as a service (IaaS)

When it comes to infrastructure as a service, businesses these days are taking the obvious route and using pre-existing infrastructures under a pay-per-use model to decrease costs associated with acquiring, maintaining, implementing, and managing an IT infrastructure[42]. Nonetheless, enterprises occasionally employ PaaS in the same way, supplementing it to accelerate development on the platform of ready-to-deploy apps.

5.2 Test and Development

The ideal situation to use the cloud is in a research and development environment. This entails setting up your environment with time and material resources, as well as obtaining a substantial budget and workforce. When all of those factors are taken into account, finishing times often increase, requiring an extension of the milestone. There are readily available environments that are built to support cloud computing on demand in order to meet the needs and requirements. This automatically provides physical and virtual resources; it can combine both, but it's not restricted to that[43].

5.3 File Storage

The ability to store and retrieve files with ease is provided by the cloud. It offers users web service layouts that are straightforward and simple to manage, as well as file storage and retrieval via the internet. Systems that are hosted in the cloud provide speed, high availability, security, and scalability at any time and from any location[44]. Businesses don't have to worry about maintaining memory equipment; they are just charged for the storage space they utilize. Additionally, they can choose to store personal information off-premises or on-premises to comply with regulations [45]. Data storage is done in virtualized storage pools managed by a third party, based on customer specifications.

5.4 Big Data Analytics

Access to vast amounts of organized and unstructured data is one of the main benefits of employing cloud computing to generate corporate value. Retailers and suppliers frequently use data from promotions and advertising to target particular audience segments and comprehend consumer purchasing patterns[46]. Social networking sites are now essential for behavioral pattern analysis, as they provide organizations with insightful data.

5.5 Backup

Usually data backup has included the laborious and time-consuming process of physically gathering and sending disks or tapes to a backup center. Problems include running out of backup media, restoring operations taking an extended period to load, and being vulnerable to malfunctions and human error have been prevalent[47]. On the other hand, cloud-based backup has greatly enhanced this procedure. Although it isn't flawless, it enables data to be transmitted automatically via a cable, guaranteeing capacity, security, and availability. This development offers a more effective and dependable data backup option, which is a major improvement over conventional techniques[48].

5.6 Disaster Recovery

An affordable disaster recovery (DR) solution is provided by putting cloud-based technologies into practice. By using numerous physical locations with permanent assets, stringent protocols, and other resources—all at a far cheaper cost than standard DR sites—this solution guarantees a faster recovery. Table (1) illustrates the primary distinctions across cloud computing and the Internet of Things. Characteristics, Processing Capabilities, Storage Capabilities, Connectivity, and the amount of data collected are the comparison metrics[50].

Items	Cloud Computing	IoT
Characteristics	Cloud computing is ubiquitous (resources are available everywhere).	IoT is compelling because everything is connected. These are real-world things.
Processing Capabilities	infinite capacity for virtual computation.	Limited capacity for calculation .
Storage Capabilities	Unbounded storage capacities.	Bounded storage or no storage capacities.
Connectivity	In order to supply services, it uses the internet.	It makes advantage of the internet as a communication channel.
Big Data	It is a method for handling large amounts of data.	It is a massive data source..

Table 1: Difference between cloud computing and Iot.

Future Scope of IoT

In a brief period of time, the Internet of Things (IoT) has gained enormous popularity and grown to be a significant technology on a global scale. The automation of Internet of Things devices has been made possible by significant advancements in Artificial Intelligence (AI) and Machine Learning (ML). In essence, IoT devices are integrated with AI and ML algorithms to facilitate efficient automation. IoT has expanded its application breadth across numerous industries as a result. We will examine the uses and potential of IoT in healthcare, automotive, and agriculture in this part.

Healthcare

We'll look at IoT's prospects in the healthcare industry in this section. With its ability to provide cutting-edge healthcare facilities for patients, physicians, and researchers, IoT has emerged as one of the most useful instruments for the healthcare sector. These services include patient management, wearable health tracking devices, smart diagnosis, and more. IoT devices have also lessened the needless burden on the healthcare system.

Agriculture

One of the three basic requirements of humans is food, which is produced through farming. But as the world's population grows, the agriculture industry is facing a number of difficulties. Agriculture is also significantly impacted by variations in climate and weather patterns. The food sector has embraced technology to increase efficiency in order to meet the growing demand for food. This includes using drones for agriculture, smart farming apps, and precision farming.

Automotive Industry

IoT is revolutionizing the automobile industry in the twenty-first century, especially with the advancement of self-driving vehicles. The purpose of these cars is to reduce human error and increase road safety. Companies that are setting the standard for self-driving car technology include Google, Tesla, Mercedes-Benz, Volvo, and Audi. These vehicles make use of IoT, Deep Learning, AI, and Data Science technology. IoT devices are essential to making self-driving car automation possible.

Jobs in IoT

India has a lot of IoT prospects because it is a developing country. With 117,114 job vacancies, Naukri.com predicts a strong demand for IoT developers in India in the future. On the other hand, the need for IoT developers has increased by more than 300 percent in the US.

CONCLUSION

Future generations' access to the internet will be revolutionized by cloud computing and the Internet of Things (IoT). A world that is more intelligent, connected, and efficient is promised by the Internet of Things' enormous network of interconnected gadgets and the scalability of cloud computing. The ability to collect and analyze enormous amounts of data produced by IoT devices is one of the main effects. This information can stimulate creativity, enhance judgment, and provide insightful information. IoT devices, for instance, can be used in the healthcare industry to continually track patient health parameters and send data for analysis to cloud-based systems, resulting in individualized treatment programs and the early identification of health problems. The connection is also making it possible for smart cities to grow, where Internet of Things (IoT) sensors collect data on energy consumption, traffic patterns, and other topics. This data can

then be evaluated in the cloud to optimize city operations and enhance quality of life. The combination of cloud computing with IoT has enormous potential to alter industries and create a more connected and efficient future, despite obstacles like privacy and interoperability.

REFERENCE

- [1] Ghadiyaram, Anil Kumar. "A compendium on edge computing where Ai can meet." *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 12.10 (2021): 4118-4126.
- [2] Sharma, Bhisham, and Mohammad S. Obaidat. "Comparative analysis of IoT based products, technology and integration of IoT with cloud computing." *IET Networks* 9.2 (2020): 43-47.
- [3] Shafiqul Abidin et al , "Cloud Computing Encryption Image Retrieval Strategy in Cloud Computing Using a Hybrid Optimization Algorithm", *Journal of Intelligent & Fuzzy Systems*, ISSN: 1875-8967, March 2024.
- [4] Reddy, K. Sravanthi, Kavita Agarwal, and Amit Kumar Tyagi. "Beyond things: A systematic study of internet of everything." *Innovations in Bio-Inspired Computing and Applications: Proceedings of the 10th International Conference on Innovations in Bio-Inspired Computing and Applications (IBICA 2019) held in Gunupur, Odisha, India during December 16-18, 2019*. Springer International Publishing, 2021.
- [5] Hwang, Kai, Jack Dongarra, and Geoffrey C. Fox. *Distributed and cloud computing: from parallel processing to the internet of things*. Morgan kaufmann, 2013.
- [6] Sunyaev, Ali, and Ali Sunyaev. "Cloud computing." *Internet Computing: Principles of Distributed Systems and Emerging Internet-Based Technologies* (2020): 195-236.
- [7] Sarker, V. K., Gia, T. N., Ben Dhaou, I., & Westerlund, T. (2020). Smart parking system with dynamic pricing, edge-cloud computing and lora. *Sensors*, 20(17), 4669.
- [8] Sarkar, G. and Shukla, S.K., 2023. Behavioral analysis of cybercrime: Paving the way for effective policing strategies. *Journal of Economic Criminology*, p.100034.
- [9] Sedaghat, Shahrzad. "New approach in the applications and forensics of the networks of the internet of things based on the fog infrastructure using SDN." *International Journal of Information and Computer Security* 15.2-3 (2021): 272-298.
- [10] Ansar Isak Sheikh, M I Thariq Hussan, Shafiqul Abidin et al , "Revolutionizing Collaborative Auditing : A Dynamic Blockchain-Based Cloud Storage Framework for Data Updates and Assurance", *Journal of Intelligent & Fuzzy Systems*, ISSN: 1875-8967, March 2024.
- [11] Awad, Mariette, and Rahul Khanna. *Efficient learning machines: theories, concepts, and applications for engineers and system designers*. Springer nature, 2015.
- [12] Arankalle, Chinmay, et al. *The Artificial Intelligence Infrastructure Workshop: Build your own highly scalable and robust data storage systems that can support a variety of cutting-edge AI applications*. Packt Publishing Ltd, 2020.
- [13] Stephenson, W. David. *The Future is Smart: How Your Company Can Capitalize on the Internet of Things--and Win in a Connected Economy*. Amacom, 2018.
- [14] Barrera, Kevin Giang, and Denish Shah. "Marketing in the Metaverse: Conceptual understanding, framework, and research agenda." *Journal of Business Research* 155 (2023): 113420.
- [15] Trautman, L.J., Hussein, M.T., Ngamassi, L. and Molesky, M.J., 2020. Governance of the Internet of Things (IOT). *Jurimetrics*, 60(3), pp.315-352.
- [16] Dizdarević, Jasenka, et al. "A survey of communication protocols for internet of things and related challenges of fog and cloud computing integration." *ACM Computing Surveys (CSUR)* 51.6 (2019): 1-29.
- [17] Alaba, Fadele Ayotunde, et al. "Internet of Things security: A survey." *Journal of Network and Computer Applications* 88 (2017): 10-28.
- [18] Sharma, Vishal, et al. "Security, privacy and trust for smart mobile-Internet of Things (M-IoT): A survey." *IEEE access* 8 (2020): 167123-167163.
- [19] Tayyaba, Shahzadi, Salman Ayub Khan, Muhammad Waseem Ashraf, and Valentina E. Balas. "Home automation using iot." *Recent trends and advances in artificial intelligence and internet of things* (2020): 343-388.
- [20] Dash, Sabyasachi, et al. "Big data in healthcare: management, analysis and future prospects." *Journal of big data* 6.1 (2019): 1-25.
- [21] Vadi, VR. , Abidin, Shafiqul., Khan, Azimuddin., Izhar, Mohd. August, 2022. Enhanced Elman spike neural network fostered blockchain framework espoused intrusion detection for securing Internet of Things network: *Transactions on Emerging Telecommunications Technologies*.
- [22] Sovacool, Benjamin K., and Dylan D. Furszyfer Del Rio. "Smart home technologies in Europe: A critical review of concepts, benefits, risks and policies." *Renewable and sustainable energy reviews* 120 (2020): 109663.
- [23] Glaeser, Edward L., et al. "Big data and big cities: The promises and limitations of improved measures of urban life." *Economic Inquiry* 56.1 (2018): 114-137.
- [24] Chatterjee, Anjan. *The aesthetic brain: How we evolved to desire beauty and enjoy art*. Oxford University Press, USA, 2014.
- [25] Reynolds, Elisabeth B. "Innovation and production: Advanced manufacturing technologies, trends and implications for US cities and regions." *Built Environment* 43.1 (2017): 25-43.
- [26] Cohen, Boyd, José Ernesto Amorós, and Lawrence Lundy. "The generative potential of emerging technology to support startups and new ecosystems." *Business Horizons* 60.6 (2017): 741-745.
- [27] P. S. Ramesh , P. Srivani , Miroslav Mahdal , Lingala Sivaranjani , Shafiqul Abidin et al", "Contextual Cluster-Based Glow-Worm Swarm Optimization (GSO)

- Coupled Wireless Sensor Networks for Smart Cities”, Sensors, MDPI, pp 1- 26 , July 2023
- [28] Nekovee, Maziar, and Jing Bie. "Rear-end collision: Causes and avoidance techniques." *Wireless Vehicular Networks for Car Collision Avoidance*. New York, NY: Springer New York, 2013. 99-119.
- [29] Ahmed, Hafiz Usman, et al. "Technology developments and impacts of connected and autonomous vehicles: An overview." *Smart Cities* 5.1 (2022): 382-404.
- [30] Butt, Faran Awais, et al. "On the integration of enabling wireless technologies and sensor fusion for next-generation connected and autonomous vehicles." *IEEE Access* 10 (2022): 14643-14668.
- [31] Vijayan, Vini, et al. "Review of wearable devices and data collection considerations for connected health." *Sensors* 21.16 (2021): 5589.
- [32] Calautit, Katrina, Diana SNM Nasir, and Ben Richard Hughes. "Low power energy harvesting systems: State of the art and future challenges." *Renewable and Sustainable Energy Reviews* 147 (2021): 111230.
- [33] Nižetić, Sandro, et al. "Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future." *Journal of cleaner production* 274 (2020): 122877.
- [34] Di Lorenzo, Gianfranco, et al. "Review of O&M practices in PV plants: Failures, solutions, remote control, and monitoring tools." *IEEE Journal of Photovoltaics* 10.4 (2020): 914-926.
- [35] Ansar Isak Sheikh, M I Thariq Hussan, Shafiqul Abidin et al , "Revolutionizing Collaborative Auditing : A Dynamic Blockchain-Based Cloud Storage Framework for Data Updates and Assurance", *Journal of Intelligent & Fuzzy Systems*, March 2024
- [36] Pasi, Bhaveshkumar N., Subhash K. Mahajan, and Santosh B. Rane. "Smart supply chain management: a perspective of industry 4.0." *Supply Chain Management* 29.5 (2020): 3016-3030.
- [37] Hossain, MdShakawat, et al. "Role of Internet of Things (IoT) in retail business and enabling smart retailing experiences." *Asian Business Review* 11.2 (2021): 75-80.
- [38] Kolodziej, Krzysztof W., and Johan Hjelm. *Local positioning systems: LBS applications and services*. CRC press, 2017.
- [39] National Academies of Sciences, Engineering, and Medicine. *Science breakthroughs to advance food and agricultural research by 2030*. National Academies Press, 2019.
- [40] Boursianis, Achilles D., et al. "Internet of things (IoT) and agricultural unmanned aerial vehicles (UAVs) in smart farming: A comprehensive review." *Internet of Things* 18 (2022): 100187.
- [41] Nandalal, V., and V. Anand Kumar. "Internet of Things (IoT) and Real Time Applications." *Artificial Intelligence for COVID-19* (2021): 195-214.
- [42] Leitner, Philipp, et al. "A mixed-method empirical study of Function-as-a-Service software development in industrial practice." *Journal of Systems and Software* 149 (2019): 340-359.
- [43] Calheiros, Rodrigo N., et al. "CloudSim: a toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms." *Software: Practice and experience* 41.1 (2011): 23-50.
- [44] Gulabani, Sunil. *Amazon Web Services Bootcamp: Develop a scalable, reliable, and highly available cloud environment with AWS*. Packt Publishing Ltd, 2018.
- [45] Sharma, Pradeep Kumar, et al. "Issues and challenges of data security in a cloud computing environment." *2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference (UEMCON)*. IEEE, 2017.
- [46] Familmaleki, Mahsa, AlirezaAghighi, and KambizHamidi. "Analyzing the influence of sales promotion on customer purchasing behavior." *International Journal of Economics & management sciences* 4.4 (2015): 1-6.
- [47] Wallace, Michael, and Lawrence Webber. *The disaster recovery handbook: A step-by-step plan to ensure business continuity and protect vital operations, facilities, and assets*. Amacom, 2017.
- [48] Zahraee, S. M., M. KhalajiAssadi, and R. Saidur. "Application of artificial intelligence methods for hybrid energy system optimization." *Renewable and sustainable energy reviews* 66 (2016): 617-630.
- [49] Wallace, Michael, and Lawrence Webber. *The disaster recovery handbook: A step-by-step plan to ensure business continuity and protect vital operations, facilities, and assets*. Amacom, 2017.
- [50] Pierleoni, Paola, et al. "Amazon, Google and Microsoft solutions for IoT: Architectures and a performance comparison." *IEEE access* 8 (2019): 5455-5470.