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A review on edge computing with data analysis and IoT techniques

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Abstract

The Internet of Things (IoT) has permeated people's daily lives, giving critical measurement and data collection capabilities to inform everyone's choices. Edge computing has developed as a new paradigm for addressing IoT and localized computing requirements as a solution for mitigating resource congestion. These methods will produce huge volumes of important data at a network edge, necessitating not just immediate data processing but also smart data analysis to properly exploit the edge big data potential. Due to their limited calculation and high latency capability, both on-device computing and traditional cloud computing cannot adequately handle this issue. The purpose of this paper is to review recent efforts on machine learning and deep learning empowered edge computing applications and to provide insights into how to influence deep learning advances to ease edge applications from different domains, namely, smart city, smart industry, smart multimedia, and smart transportation. In a comparative analysis, cloud Machine Learning (ML) has the highest 98.04% accuracy and Convolutional Neural Network (CNN) ResNet-50 has 81.06% accuracy. Additionally, emphasize the critical research issues and promising research areas associated with them. This paper will inspire additional research and contributions to this promising area.

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Keywords: *Edge computing, IoT, Reliability, Security, Ecosystem.*

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1. Introduction

Edge computing refers to the techniques that empower platforms, IoT programs, and services to still process at the program's edge, both on transmit and receive data [1]. The significance of edge computing in IoT networks is underscored by data transiting, system inefficiency, and a centralized cloud computing infrastructure that cannot handle the huge amount of data created by IoT devices. Massive data collection could lead to serious security and privacy concerns. Data from IoT devices are stored and processed on edge nodes thereby removing the need for data handling at the centralised transportation as well as some specific privacy issues. There are still a lot of technical challenges that need to be solved, both intellectually and in business. Network infrastructures for collecting and disseminating data from millions of networked devices via what seems like endless numbers of scattered nodes. Many IoT applications will be able to deliver significantly more durable and precise network services to clients [2].

An increasing number of devices and sensors are connected to a massive quantity of data accessible to consumers through IoT approaches. IoT technologies are quickly becoming ingrained in everyday life [3] [4]. A typical application is made up of several Processing Elements (PEs), which are known as Cognitive Processing Elements (CPEs) for utilizing an Artificial intelligence (AI) model to create output. The result would be a flowchart of processing components with numerous branching, which would serve as the foundation for an application [5]. Smart facilities near industrial units have been enabled to connect important needs for example agile connectivity, analysis of data by edge nodes, extremely approachable services of cloud, and a confidentiality-plan strategy [6].

2. Edge Computing Architecture

The edge is many computer and networking assets that exist among data resources and cloud data centers [7] [8]. The edge computing architecture is a useful building block for distributing hardware and software. The IoT system's base consists of a significant quantity of data collected by IoT devices [9]. The edge computing system is placed near to the end-user or IoT devices to maximize network bandwidth and shorten reaction time to results. Edge computing is used to do the following tasks [10].

- Organizing IoT devices and collecting data.

- It provided excellent data protection from sensors to the gateway.
- Carry out hands-free instrument activation.
- Data is ingested, collected, stored, and analyzed.

There are both data consumers and data producers in the edge computing paradigm. Figure 1 depicts the two-way calculation streams of the edge computing paradigm below [11]:

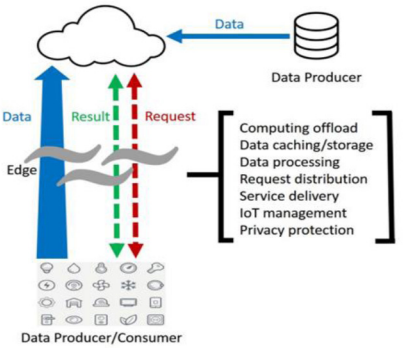


Figure 1

Edge computing paradigm [10]

3. Key Requirements of Edge Computing in IOT

A system is said to be user-friendly and feasible to fit the following needs [12].

A. *Latency*

IoT-based edge computing benefits from real-time communication because of the reduced latency [12].

B. *Reliability*

Any peripheral computing system must be consistent for the system to be relevant for real-world Wireless integration of digital networking [12].

C. *Mobility Support*

Mobility techniques are being utilized in a variety of cloud, edge architectures, and becoming increasingly frequent in hybrid applications.

Controlling mobile device mobility is always a difficulty in infrastructures containing mobile devices [12].

D. *Real-Time Interactions*

Real-time application is becoming more important in modern communications. Certain edge applications are demands on the real-time interaction in IoT. The batch processing is accessible which is suitable for many existing IoT applications that rely on edge computing [13].

E. *Security*

Security for edge computing must be expressly established and implemented. Data security is enhanced because aggregated client data is kept close to the end user's location [12].

F. *Interoperability*

Edge computing applications and services are interoperable to be compatible with other apps and hardware elements. Some of the following needs are emphasized in the context of the IoT. This listing of prerequisites is not expected to be a comprehensive and exhaustive list [12].

4. IOT Edge Ecosystem

The rise of the edge-IoT ecosystem has naturally constrained the capabilities and resources of other computing paradigms, including cloud, grid, and fog computing [14]. Edge devices are called IoT which have the storage and processing power to make low latency choices and process data in milliseconds. Exchange to exchange (E2E) provides all the backend services necessary to build viable business applications in today's IoT period [15].

A. *ETSI Multi-access Edge Computing*

The European Telecommunications Standards Institute (ETSI), Industry Specification Group, is running a course on Multi-access Edge Computing (MEC). Any legitimate operator can operate the Radio Access Network at the edge where MEC is deployed [15].

B. *Cloud Foundry Foundation*

It comprises Google, Pivotal Cisco, Microsoft, International Business Machines (IBM), Systems Applications Products (SAP). Additionally, this

framework also handles container-specific services as well as multi-cloud multi-services [16].

C. *Living Edge Lab*

The lab's should be broad public testbeds for researchers on how they would use edge computing in their work. This technology's key objectives are to reduce data movement while improving user experience. [15].

D. *Linaro IoT and Embedded (LITE) Group*

The LITE implementation might be utilized to create complex bootloaders as well as Trust Zone services. Linaro edge is a cutting-edge networking solution that is specifically built to handle Time-Sensitive Networking (TSN) [17].

E. *Object Management Group*

The organization is leading in developing standards and protocols for Industrial Internet of things (IIoT). Nowadays, several IoT solutions at the edge are being created to leverage on built-in Business Process Modelling (BPM) [15].

F. *Open Fog Consortium*

It involves collaborating activities aimed at supporting and coordinating specification enhancement tasks about fog computing and related computing concepts. The objective of providing an open-source fog computing architecture is towards operational technology models and deployable testbeds [18].

5. Literature Survey

The subsequent research built upon the cloud computing or data analysis that was done before with the IoT. The following is a list of the several researchers who explain their discoveries:

Islam et al. [19] demonstrated the utilization of a blockchain-based modular Intelligent Vehicular Edge Computing (IVEC's) architecture to optimize resource management transparency and to use peripheral clients (such as automobiles) with data processing validation possibilities.

Menon et al. [20] proposed a system that integrates a plethora of in-car sensors to monitor a wide range of variables, including but not limited to: distance traveled, speed, and the operation of various safety equipment

including seatbelts, airbags, door locks, and handbrakes. The cloud stores data in real-time, or the vehicle may react to different situations using data from the past.

Sittón-Candanedo, Inés, et al. [21] shown the benefits of incorporating the Global Edge Computing Architecture (GECA) design concepts and features into the framework, especially in instances where IoT and social computing technologies are employed to improve energy efficiency. This novel approach has been utilized to improve an existing energy efficiency system, reducing data traffic entering the cloud and the amount of information broadcast from ZigBee beacons to the cloud-based locating engine.

Sarker, Victor K. et al. [22] examined a variety of Long Range (LoRa)-related research issues, with an emphasis on potential improvements and problems. These have created a proof-of-concept for an edge-assisted IoT architecture based on LoRa. Experiment findings revealed that the proposed architecture overcomes some of the shortcomings of existing LoRa-based IoT applications via data reduction and encryption.

Naveen, Soumyalatha et al. [23] utilized edge computational architecture to assist the rapid interchange of information, administration, storage, and analysis of the produced data. Data made by IoT tools were being studied for cloud storage, processing, and analysis. Edge computing offered the ability to reduce bandwidth usage, protect data privacy, and improve service response times with well-suited applications that must complete tasks in a short period.

Alrowaily, Mohammed et al. [24] stated that the big data analytics [25] and IoT architectures are growing at a pace unprecedented in network system design. The limitations and potential of edge computing are examined in further depth. It is two real-world examples, smart parking and content delivery networks (CDNs), to understand how IoT systems are utilized in the real world. Finally, it is look at two potential uses for the CDN and smart parking systems.

Chen, Baotong, et al. [26] stated that edge computing may improve IoT applications. It is being investigated the application of edge computing in IoT-based businesses. Edge computing's self-organizing task scheduling mechanism beats traditional solutions in terms of business responsiveness and bandwidth optimization. Industrial IoT-based manufacturing is benefiting from enhanced service quality even the limited computer resources positioned at the network edge with the cloud's lack of response latency and network security.

Calo, Seraphin B., et al. [27] examined how generative policy models were utilized to require the necessary support for cooperative and autonomous systems. Managed systems set the rules in this fashion, but they are bound by the bigger system's aims. The effectiveness, methodologies, and data structures necessary to implement such a paradigm are being investigated.

6. Comparative Analysis

The paper's comparative study of several deep learning algorithms applied to cloud computing is found in this part. It is the most popular method for Cloud Computing. There are used many techniques such as CNN ResNet-50, CNN Simple, Deep Neural Network (DNN), and Cloud Machine Learning (ML). Cloud ML has the highest 98.04% accuracy. Second, CNN ResNet-50 has 81.06% accuracy. Table 1 shows the comparison based on accuracy. Figure 2 shows the comparison graph based on accuracy below:

Table 1

Comparison based on Accuracy

Technique	Accuracy (%)
CNN ResNet-50 [28]	81.06
CNN Simple [28]	78.99
DNN [28]	75.26
Cloud ML [29]	98.04

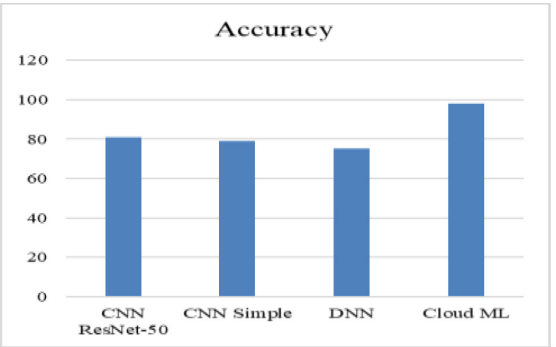


Figure 2

Comparison graph based on Accuracy

7. Conclusion and Future Scope

Edge computing is a novel computer concept that enables the combination of essential functions such as network, processing, and storing capacity closer to the peripheral devices. The implementation of edge computing in IIoT fulfills the needs of real-time for lightweight intelligent manufacture, boosts the flexibility and reliability of the network. It provides increased response latency or network security, limited computing resources implemented at the network edge is help enhance service quality for industrial usage in IoT-based business. It gave rise to current knowledge of edge computing with the notion that computation should take place close to data sources. Most of the effort has gone into resolving difficulties highlighted by the IoT-based smart grids, such as rapid user response, intelligent scheduling, intelligent maintenance, intelligent customer response, and quick market responses in the development of IoT-based smart grids. It has the potential to be highly successful in decreasing latency, minimizing data transit, and maintaining community data privacy. In the future, it will integrate edge computing into power grids to enable real-world applications. Furthermore, the commercial benefit of edge computing utilized in power systems will be the useful practicality of the approach.

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