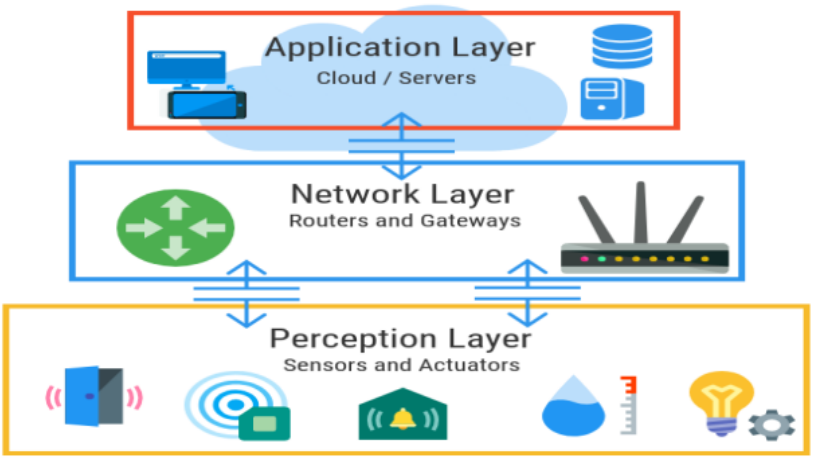
LITERATURE SURVEY OF IOT APPLICATIONS USING CLOUD COMPUTING

What is Internet of Things (IoT)?

It refers to a network of interconnected physical devices and the technology that helps to communicate between devices and the cloud, as well as between the devices themselves. The main aim of IoT is to communicate between devices and with the centralized system i.e., Cloud and to make some automated decisions and perform some tasks without human involvement.



CLOUD-IoT Architecture [3]

1. Task Scheduling for IoT applications in Cloud Computing.

Task Scheduling in IoT is a complex problem that depends on the particular use case of a user and the system.
It is necessary to schedule IoT applications to minimize the latency (delay), and this can be achieved through Fog computing because it brings the resources closer to the end user [2]. However, scheduling an IoT application task is difficult because it is heterogeneous as it is based on different network and hardware platforms [1]. The problem of scheduling the task is NP-hard originally which is non-deterministic polynomial-time hardness and is solved by implementing a genetic algorithm (GA) to schedule the IoT applications and thus minimizing the overall latency [1],[2]. Genetic Algorithm is the basic process of giving the best information after selection. Task scheduling generally uses various heuristic techniques that give optimal solutions [1]. These techniques can differ from user to user according to their problem.
There are various algorithms for task scheduling such as GAACO and heuristic techniques [1].

Load balancing is important when it comes to scheduling tasks. The Load balancer uniformly distributes the task among the processors so that task is done easily and parallelly.

2. Challenges in using IoT and Cloud Computing.

Cloud and IoT together gave outstanding results. However, there are many challenges faced when using the cloud and IoT together. Some of which are listed below [3]:

1. **Security:**

   In today's world, data is most important for a person, and when using cloud-IoT, the user does not even know the physical position of their data [3].

2. **Big Data Storage:**

   Data storage can be used to improve efficiency and provide a good advantage to IoT applications [4].

3. **Edge Computing:**

   Latency is one of the biggest challenges when using cloud computing, which is now solved by fog and edge computing, in which some auxiliary data centers are provided near the end-user's location [3].

4. **Maintenance:**

   Good techniques and plans are needed to manage the security and performance of the cloud because it serves over a billion people [3].

3. Resource Management in IoT with Fog-Cloud Computing.

Nowadays, most people use IoT applications in their daily lives, and this growth leads to a heavy workload on existing network resources. This problem is solved by integrating fog computing into cloud computing, which adds an extra layer of data center, helping to divide the usage of resources. Fog computing not only helps in resource management but also greatly helps in reducing latency by bringing the resources closer to the end-user. The efficient use of resources in network infrastructure is achieved by deploying some module applications in the Fog-Cloud infrastructure, and one such algorithm is the Module Mapping algorithm [5]. Module Mapping is a software-based process that maps the software to specific hardware to efficiently use the

resources. The result of the paper [5] is a general approach and can be used as a benchmark for studies related to IoT and Fog Computing and for knowing how good a service is.

4. Security Challenges for the IoT in Cloud Computing.

Privacy is important for everyone and, as we know, there are several people across the World who uses IoT. Therefore, IoT in cloud computing must ensure the security of every user. Some security challenges that IoT devices in cloud computing face are [6]:

1. **Hijacking:**
   Every device we use in our daily lives has a danger of getting accessed by some hackers. This leads to losing all the files and data of the user and the hacker can also demand money from the user for data that is highly confidential [6]. To ensure the high security of user data, the files are stored in a highly encrypted cloud environment that is inaccessible by a hacker [6].

2. **Insufficient testing and lack of updates:**
   Many IoT companies do not provide time-to-time security software updates, which leads to a loophole for some hackers to enter your device and access the information. Apart from security, there is also risk for when the machine stops working when an IoT device sends information to the cloud [6].

There are many other security challenges which need to be addressed, such as Remote Smart Vehicle or Remote Home Access etc. [6].
Lack of user knowledge about IoT security is also a challenge because every time it is not an IoT company or device which has the fault leading to security challenges, but it is also the user who is not taking proper measures to keep his/her data safe [6].

Some Strategies that might help users to keep their data safe are [6]:

1.Change passwords regularly.
2.Create a backup for your files.
3.Regularly update your IoT device.
4.Use some secondary networks.

5. Smart Agriculture: Agriculture using IoT.

IoT applications that are accessible, affordable, and interactive platforms for agriculture will provide farmers with techniques, tips, tools, and methods to increase their cultivation [7]. This will also address the problem of food waste by helping them know about the various diseases in crops with the help of an application, which will also increase the profitability of the farmers.

The application must provide multi-lingual support so that every farmer in every corner of the country can make use of the application easily [7].
The application must provide some extra small benefits, such as financial services, etc. The system must be robust, scalable, affordable, and sustainable [7] so that it can provide optimum solutions for problems that farmers face in agriculture.

Structure of IoT for agriculture [7] –

1.Information collection layer:
The main function of this layer is to collect real-time physical information via some sensors and then transform it into digital information for further processing.
2.Transport Layer:
The purpose of this layer is to summarize the digital information and then transmit it through various networks to the cloud.
3.Application layer:
This layer analyzes the collected information and then provides awareness to the farmers digitally with the help of an application.

With the help of IoT and Cloud Computing, single farmers can now directly deliver crops to customers in a wide area, and the Cloud Computing paradigm has also helped farmers in rural areas avail the necessary services at affordable prices [7].

6. Smart Cities: Role of IoT Applications in Smart Cities.

A smart city is an urban area that collects information using various devices to improve the lives of the people in the city. Cloud-based IoT applications help smart cities with information collected from citizens, devices, etc., and this information is used to manage resources and other opportunities in the city [8].

According to the authors of the paper [8], there exists a six-phase startup model for establishing a smart city:

Phase 1: A simple design of the city and a network of sensors and actuators; a Gateway for security of data transmission; and a large warehouse for storing records.

Phase 2: We need to track the activities of the person to collect and classify the data.

Phase 3: Analyzing the data for good resource management and other opportunities.

Phase 4: Smart control by sending commands to actuators through various ML algorithms.

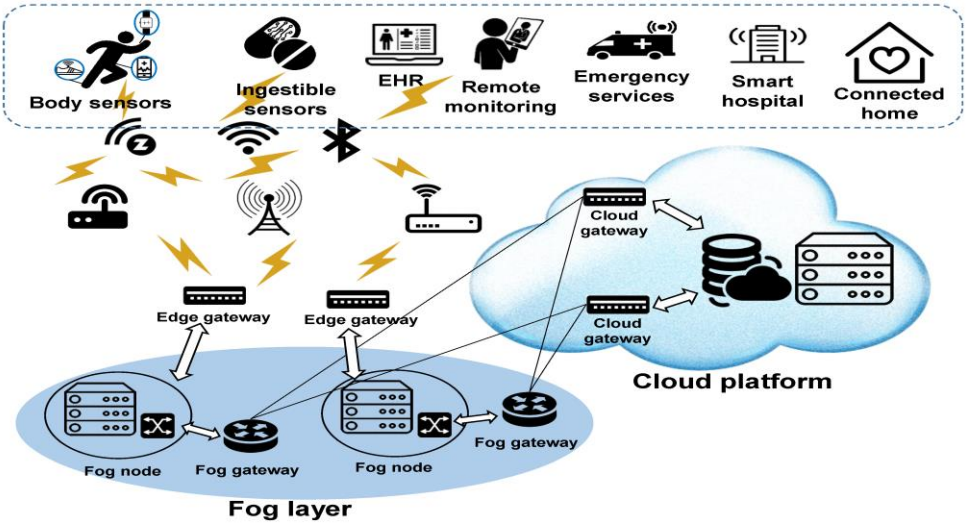
Phase 5: Automatic Traffic Control in case of any emergency, and this also helps the consumer re-route their way in case of a traffic jam.
Phase 6: The number of features must be increased in order to have a Smart City.

This application of IoT with Cloud Computing has increased the people's lifestyles.

7. Healthcare: IoT and Cloud Computing for Healthcare.

IoT with cloud computing is used in healthcare with the help of body sensors that take the information from the person and then store it in the cloud. The extensive use of IoT in healthcare produces a vast amount of data that needs to be stored and managed for processing and future usage. There exists a proposed system architecture that collects and manages sensor data on the cloud [9],[10]. This architecture mainly collects the data from wearable sensors and then further processes the data for evaluation or stores the data in the cloud.

The authors of the paper [9] have also used a Case-based implementation for evaluation. Cloud computing, through its characteristics of elasticity and storage, helps in storing a large amount of healthcare data. The authors of the paper [9] used IoT functionality to directly communicate between sensor devices and the cloud.



IoT and Cloud based Healthcare System [10]

REFERENCES:

1. Basu S, Karuppiah M, Selvakumar K, Li KC, Islam SH, Hassan MM, Bhuiyan MZ. An intelligent/cognitive model of task scheduling for IoT applications in a cloud computing environment. Future Generation Computer Systems. 2018 Nov 1; 88:254-61.

2. Narman HS, Hossain MS, Atiquzzaman M, Shen H. Scheduling Internet of things applications in cloud computing. Annals of Telecommunications. 2017 Feb; 72:79-93.

3. Sadeeq MM, Abdulkareem NM, Zeebaree SR, Ahmed DM, Sami AS, Zebari RR. IoT and Cloud computing issues, challenges and opportunities: A review. Qubahan Academic Journal. 2021 Mar 15;1(2):1-7.

4. Cai H, Xu B, Jiang L, Vasilakos AV. IoT-based big data storage systems in cloud computing: perspectives and challenges. IEEE Internet of Things Journal. 2016 Oct 19;4(1):75-87.

5. Taneja M, Davy A. Resource aware placement of IoT application modules in Fog-Cloud Computing Paradigm. In2017 IFIP/IEEE Symposium on Integrated Network and Service Management (IM) 2017 May 8 (pp. 1222-1228). IEEE.

6. Surya L. Security challenges and strategies for the IoT in cloud computing. International Journal of Innovations in Engineering Research and Technology ISSN. 2016 Sep 8:2394-3696.

7. Patil VC, Al-Gaadi KA, Biradar DP, Rangaswamy M. Internet of things (IoT) and cloud computing for agriculture: An overview. Proceedings of agro-informatics and precision agriculture (AIPA 2012), India. 2012 Aug 1; 292:296.

8. Alam T. Cloud-based IoT applications and their roles in smart cities. Smart Cities. 2021 Sep 17;4(3):1196-219.

9. Doukas C, Maglogiannis I. Bringing IoT and cloud computing towards pervasive healthcare. In2012 Sixth International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing 2012 Jul 4 (pp. 922-926). IEEE.

10. Dang LM, Piran MJ, Han D, Min K, Moon H. A survey on Internet of things and cloud computing for healthcare. Electronics. 2019 Jul 9;8(7):768.