*Research Article*

# An IoT and fog computing enabled intelligent health care monitoring system to optimize the cloud storage

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**Abstract:** Health is on eof the main characteristic of quantity of life, hence the significance of having an appropriate healthcare monitoring system. The Internet of Things (IoT) is a state of the art technology that has found application in modern remote health monitoring systems. Fog computing is given to IoT by producing the local computing. Fog computing serves to overcome high latency and consumption of bandwidth in the cloud. Remote operation and connection is the heart of health monitoring application where real time information exchange is key. However, there is often delay due to the transfer of the information to the cloud and back to request which is intolerable. So a technique is heareby proposed to incoperate the fog computing techniques amongst cloud computing and the sensors to process information and to collect it efficiently. The sensor nodes are collected and detected by using the global monitoring capability to trace and detect the moving sensors which can be achieved by fog computing. With this design, there is minimal amount of data transfer between the sensor and node which increases the system efficiency. The task scheduling algorithm has the ability in which the main factor provide importance to perform the task exactly. Thus the algorithm is further augmented with a system called Task Classification and Virtual machines Categorization (TCVC) which applied a MAX-MIN concept to schedule the important tasks to optimize the cloud storage and reduce the latency and time on fog computing.

## 1. Introduction

The simple processing devices, consist of cheap and battery-powered wireless sensor networks (WSNs) called sensor nodes. The sensor nodes are used for identifying conditions such as humidity, monitoring physical phenomenon, etc., or temperature (Yaseen et al. 2016). People are using various strategies such as digital devices, wearable sensors, and smartphones to make their life more comfortable and living better. Smartphones contain sensors that can be used to monitor evidence about the human body, these sensors are used to gather a large number of patient's vital signs and also monitor patients in real-time. Social networking is increasingly used in the healthcare trade and is also used to identify various issues such as accrued stress and expressive status, which might be translated into the patient's health status (Ali et al. 2021).

Fog computing is a condition and developed by Cisco in 2012, where a huge amount of mixed dispersed strategies and omnipresent interconnects work including the system to accomplish the packing and jobs payment without the intrusion of assemblies (Kumar and Mahajan 2019). Fog computing architecture provides flexible communication and collaborative variable such as, storage services and computation (Mutlag et al. 2019). The cloud service in a straight line, provided where the data is produced at the edge and its often observed as a "descendent cloud". Having the fog network at the edge, maximizes the network efficiency and minimizes the latency. Which reduces the cloud complexity by minimizing the data exchange with the cloud, thus preserving the network bandwidth. Being at the fog network can also provide better security of data (Kharel, Reda, and Shin 2019).

Cloud computing makes a package complete with several benefits to the users, but it also has disadvantages. One of the advantages of the IoT is its high processing speed and big data computing that is managed efficiently and employed in various applications (Mani, Singh, and Nimmagadda, n.d.). The mechanisms of the cloud cannot be managed in real-time urgently, Health monitoring systems needs to be continually monitored promptly, and the state of affairs of patients are reported. Fog computing is one of the latest technology with potential application in healthcare monitoring system which requires a high response time and low latency (Moghadas, Rezazadeh, and Farahbakhsh 2020). These devices can be either fixed in the human body using a nanoscale or can be wired by the patients and that can pass through nearest access points such as fog gateways (Vora et al. 2017).

The main research of this study is improving the health of the patients through efficient remote monitoring system through a Tasks Classification and Virtual machines Categorization (TCVC) algorithm that sets task priority. For secheduling IoT healthcare task in fog computing that based on importance than executing and progressing them in an efficient manner in real-time. The algorithm of tasks scheduling is defined as a set of instructions and strategies that are used to allocate tasks to get possible maximum level of presentation and resource allocation (Aladwani 2019).

The remaining part of the research work is structure as follows. Part 2 represents the highlights of the previous work that has been done by the scholars in this domain. Part 3 offers the proposed methodology architecture model and its mechanisms. Part 4 present the scheduling method. We present the performance evaluation of the system and discussion in Part 5 and Part 6 achieves the work in conclusion.

**2. Related Work:**

To self-monitor blood glucose (SMBG) level in diabetes patients includes several drawbacks that were solved by using a device called Continuous glucose monitor (CGM)(Fernández-Caramés et al., 2019), that measures continuously without having to prick the patients. The design and implementation of the system that enhances the CGMs by adding the IoT capabilities that warn the patients in critical situations has been developed. These CGMs values are collected by the smartphones and send to the fog computing nodes or to the cloud, that includes the decentralized storage deployment that processes, receives and store the collected data. This method proposed the patients' data crowdsourcing and the novel mobile health development applications for monitoring, diagnosing, public health action which aid increase in the awareness of diabetes.

(Yu, Hu, and Chu, 2020) proposed the secure authentication identity and effective access control mechanism needed in IoT system. There is plenty of possible networks that attacks and threaten the security of the users and the cloud servers such as the DoS attack. To overcome this weakness, Yu and colleagues introduced an automated verification on security using BAN-logic verification and security analysis informal. This proposed scheme is secure and can prevent all known attacks on cloud computing technology.

(Nandyala and Kim 2016) proposed the architecture for IoT-based u-healthcare monitoring rewards of the cloud to fog (C2F). The u-healthcare monitoring system architectures has boundaries that are explained by Fog. The C2F computing deliver is more effective when compared with the cloud by quick dispensation with fewer delay or other cases of IoT with enhanced support and technologies combinations.

A novel framework is proposed by (Tuli et al. 2020) based on health fog, incorporating deep learning technology in edge computing devices. The system was implemented on real-life application for unconscious heart disease analysis. Health fog delivers healthcare as a fog service by using IoT devices and efficiently manages the heart patient's data, which arises to a request of users. Fog enabled the framework of cloud, fog bus is used to analyze the presentation and deployment of the future method in terms of network bandwidth, power, latency, accuracy, and finishing time.

The study of (Vijayakumar et al. 2019) implemented a design that could detect the mosquito-borne diseases at the initial stage. For this purpose, the IoT besides wearable sensors are used to fold the essential data, the fog is used to study, share and categorizes the medical data between the healthcare and service workers. The fuzzy k-nearest neighbor method was used to classify the user into their classes. Social network study is employes in understanding the epidemic of the diseases. The received disease is restrained by the computing prospect of disease outbreak (PDO) which is used to offer the location-based consciousness to stop the outbreak. This investigational performance was proposed with better organization accuracy on the fog-based health monitoring system.

**3. Proposed Methodology:**

In this section, we have discussed the general structure of cloud based Healthcare solution. An advanced structure of fog-based Healthcare solution is planned such that it is interoperable with the cloud-based solution to optimize the cloud storage.

3.1 Cloud Computing:

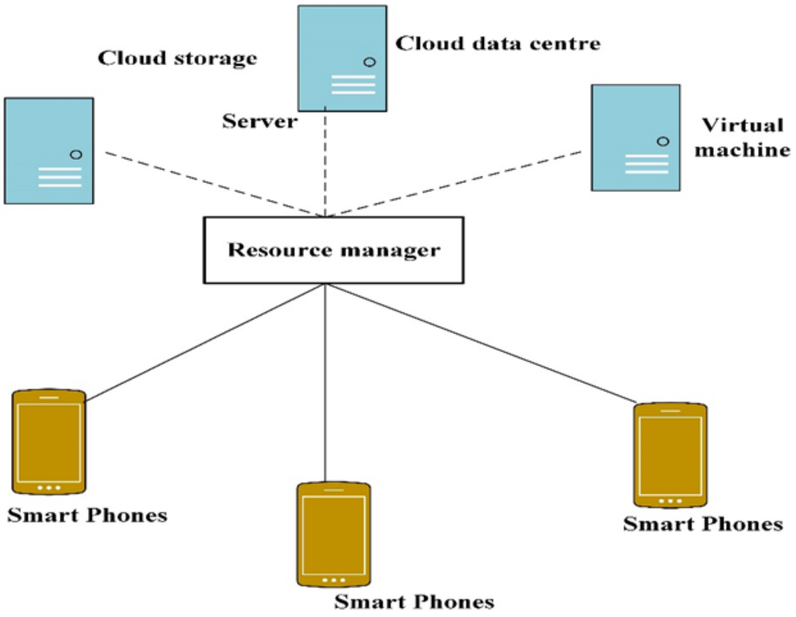


Fig.1. cloud-based system architecture for healthcare

Every single cloud-based IoT-healthcare solutions follows a common architecture and model of the application. They only differ in terms of the application functionality (Zeng et al. 2009). The architecture of the system based on cloud healthcare concept is comprised of several entities; In the Healthcare monitoring solution, body are connected with IoT sensors which recorde or monitores the health of patients. These devices can attach themselves with additional apparatus like Bluetooth, Infrared Transmission, Zigbee etc.

Cloud Datacenter:

The Best Stage for IoT on healthcare explanations is a cloud datacenter. The large-scale computation, that enables packing, service value with scalability then reliability. Cloud resources can be organized structurally and are virtualized (Mahmud, Koch, and Buyya 2018). The mechanisms within a datacenter or cloud support in healthcare keys can be listed:

- Resource manager:

This is accountable for organizing the cloud resources while dealing with IoT enabled Healthcare information. It can be dismissed, scaled, then Schedule the resources according to the weight, demand, and situation. It also confirms an advanced level of access control to the properties. Resource manager that expresses dependencies between the resources so they can be executed then run incorrect demand.

- Servers:

The cloud datacenters is made up of server that can either be homogeneous or heterogeneous in admiration of configuration hardware. In this desigh, there are two types of servers: application and database server. In the application server, the web facilities and the backend requests are hosted. In database only switches the associate operation then the data source.

- Virtual Machines (VMs):

Each Virtual Machine (VMs) has to access the resources of the hardware are provided by the host server. They compress some metadata regarding the processor, accessible memory, and size of storage. Web services and applications relevant to medical application are run on this server.

Smart Phones:

In many healthcare solutions, smartphones are used. The IoT devices are having lack processing capabilities and networking, Smartphones are assisting them in sending the generated data towards the cloud data centre and providing applications. The frequency of getting data on smartphones can be adaptable through the application. The smartphones have embedded sensors like global positioning system, accelerometer, etc., that observes related information.

Edge computing:

Edge computing is the process of improving the cloud computing systems by performing the data processing at the edge network, near the data basis (Hossain, Rahman, and Roy 2019). This reduces the bandwidth of communications between the central data center and the sensors by performance of analytics and development of knowledge near the source of information. In this area, several research works has been done and still going on the challenges regarding edge computing. (Abbas et al, 2017) in his study discussed different issues and surveys carried out on edge computing systems.

3.2 Fog Computing:

Fog Computing is evaluated as a rearrangement of the cloud which is a virtualized phase of sources that offers for storing, designing, and interacting features to end all users. where a huge amount of mixed omnipresent and discrete strategies communicates and probably cooperate among them with the system to perform loading and jobs allowance without the intrusion of assemblies. The fog architecture consists of a wireless sensor network, a local gateway for data stored both quickly and locally (Debauche et al. 2019).

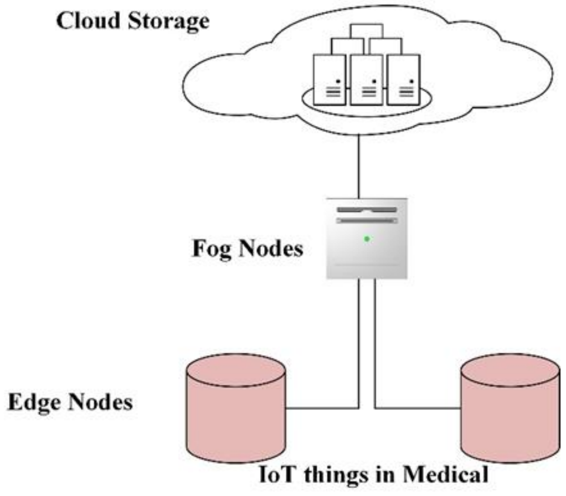


Fig.2. (Kumar and Mahajan 2019) Fog computing architecture in health care.

In the atmosphere of fog that contains an ancient-style mechanism of networking, that can be positioned at the earlier understanding of the IoT strategies. The devices are distributed with diverse of schmoozing, loading, calculating; capabilities and facility requests can be implemented. Fog computing covering transports an additional area precise for IoT schemes facilities.

- Data Management:

This has an Important portion in fog computing techniques by which the numbers of sensual is nearby preserved to eliminate the evocative information for announcements and operative response besides with system plan amendments. The more vital jobs in healthcare conditions meanwhile indecision and dormancy in decision making might that causes the everlasting indemnities for the paitients.

- Data Filtering:

The data dispensation is the first sector component to designed a scrubbing approaches after receiving the numbers form device network. The sitation of medical patients is gathered from the numerous of bio-signals such as EEG, EMG, ECG etc., are composed using the applicable process.

- Data Compression

  For decreasing the volume of conveyed information over a communication network, information can be compressed by using Lossy or lossless density approach. In IoT applications for healthcare, compression using lossless approach is used in most of the conditions since lost data can cause inappropriate analysis of sickness.

**4. Scheduling Method:**

The healthcare for IoT tasks is scheduled in a fog computing by exploitation of the tasks classification and virtual machines categorization (TCVC). This novel method is proposed to improve the performance of fog computing and overcome existing algorithm tasks scheduling divide through Virtual Machines (VMs) into groups and that using the organization techniques on tasks and that giving importance for tasks based on their position.

A suitable task development algorithm performance was implemented by using a technique called TCVC that is based on the task status. Tasks established by IoT are confidential based on their priority. To portion of the performance accomplished by these methods, that will be functional to the MAX-MIN scheduling process. The emulator cloud has been used to determine their impact on complex algorithm, accessibility of resources, Total waiting time (TWT), Total Finish Time (TFT), and Total Execution Time (TET).

The cloud computing exposure, wireless sensor networks and Internet of things applications has brought a major concern in mobile wireless sensor network, such as forwarding attacks in selective. Detecting the selective forwarding attacks in MWSNs is hard due to continuous sensor mobility(Yaseen et al. 2016). The approaches that are used to detect the sensor on the user by the fog computing to get the information by using the global monitoring system. Healthcare can benefits greatly from a targeted application of the cloud computing paradigm (Stantchev et al. 2015). To evaluate the performance attained by this method, that will be verified on the MAX-MIN scheduling process, the performance will be implemented in terms of ET (Execution Time), WT (Waiting time), and FT (Finish Time) of the responsibilities. These tasks can be differentiated by the algorithm then it can be gotten by the Fog computing.

| | Low position | | | | Medium Position | | | | High Position | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tasks | T2 | T12 | T11 | T4 | T10 | T7 | T6 | T5 | T1 | T8 | T9 | T3 |
| Lengths | 70000 | 20000 | 2000 | 1000 | 90000 | 10000 | 4000 | 3000 | 100000 | 80000 | 25000 | 5000 |
| VMs | VM1 | VM2 | VM2 | VM2 | VM4 | VM3 | VM3 | VM3 | VM5 | VM6 | VM6 | Vm6 |
| WT | 0 | 0 | 40 | 48 | 0 | 0 | 6.67 | 9.33 | 0 | 0 | 50 | 56 |
| ET | 140 | 40 | 4 | 2 | 60 | 6.67 | 2.67 | 9.33 | 40 | 32 | 10 | 2 |
| FT | 140 | 40 | 48 | 52 | 60 | 6.67 | 9.33 | 11.55 | 40 | 40 | 72 | 58 |

Table.1. MAX-MIN with the proposed methodology

It can be seen form Table.1. that the AWT (Average Waiting Time), AET (Average Execution Time), and AFT (Average Finish Time) are decreases due to the problem solving of tasks are large that can exploiting the VMs to a small, medium and long time tasks that have been waiting until the executing finish on large tasks. Thus they spread on development of IoT healthcare responsibilities based on their position with MAX-MIN, will improve the stability between ET, WT, and FT for all responsibilities. It also indicates that reductions due to the complexity of large tasks that manipulats VMs to a minor and elongated time and the average responsibilities have been waiting until the accomplishment of the great task is finished.

**5. Result and Discussion:**

In this section, we have discussed the proposed algorithm to optimize cloud storage by using fog computing to store the data information. The data can be selected by using the scheduling algorithm and the fog computing detecting the sensor by using the global monitoring based on the patient's importance. The scheduling algorithm is used along with the fog computing to select the nearer optimal solution to get minimized latency to cloud computing. The proposed methodology, TCVC is applied to the MAX-MIN algorithm. This proposed design is compared with the existing method such as First come First Serve (FCFS), Shortest Job First (SJF) and MAX-MIN algorithms. From Fig.3, it can be deduced that MAX-MIN with TCTC has the highest performance based on task position in second and other tasks in terms of AWT in scheduling algorithm. Hence MAX-MIN with TCTV is better than MAX-MIN without it.

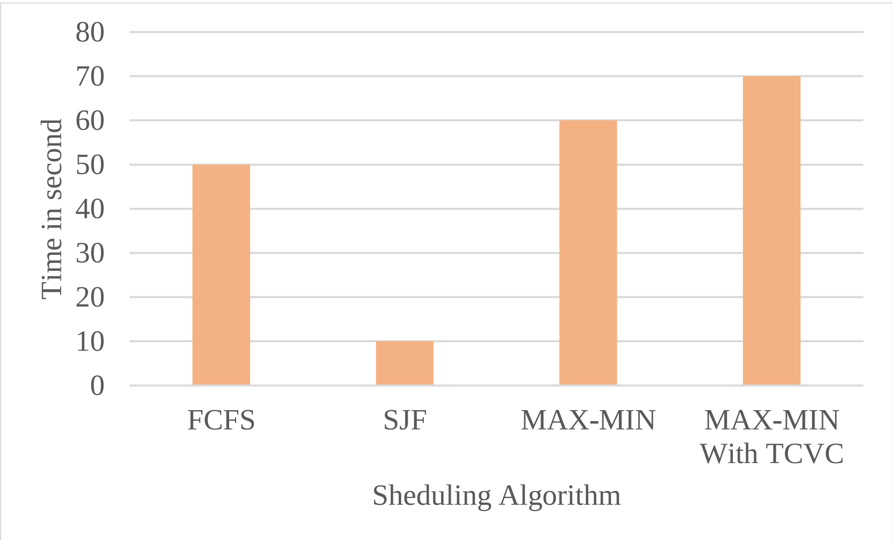


Fig.3. MAX-MIN tasks scheduling algorithm.

**6. Conclusion:**

In this research paper, a Task computing and Virtual machine computing (TCVC) scheduling algorithm is proposed in healthcare monitoring. Based on IoT we implement fog computing between the users, the fog computing detects the sensor of the patients by using the global monitoring system and by using a scheduling algorithm. Based on tasks important or priority of the patient conditioning, the immediate response from the fog computing reduce and optimize the cloud storage, time and reduce latency. This method is one of the best optimal scheduling techniques for real-time isolated healthcare monitoring. Thus, the results have exposed that the planned scheduling process is attained better between the AET, AFT, and AWT, when it is related with another task scheduling algorithm.

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