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Cloud-based Integrated Sensor Network with Low Energy Consumption

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Abstract

Wireless sensor network applications are useful in a wide range of fields, including human healthcare monitoring, defence monitoring, environmental monitoring, infrastructure monitoring, and so on. In a wireless sensor network, there are several concerns and obstacles such as security, scalability, storage, network longevity, and so on. Sensor Cloud (SC) has become an important component of today's research period in order to solve concerns and obstacles. Sensor clouds are the synthesis of two distinct technologies. As a result of the fantastic data collection capabilities of wireless sensor networks, as well as the strong data storage and processing capabilities of cloud computing, Sensor Cloud integration is currently gaining more attention from both academic and industrial sources. Virtualization is a crucial Sensor Cloud idea in which several applications run on each sensor device at the same time. Sensor Cloud provides us with an open, adaptable, and changeable platform for monitoring and controlling a variety of applications. Here, we will focus on an essential topic about Sensor Cloud Architecture, which will provide us with Sensor Cloud Design, Applications, Issues, and Challenges. In our suggested study, we will explore Social Sensor Cloud, in which we will create an algorithm for both parameter energy efficiency and security through virtualization. Our work will assist academics as well as industry professionals in the design and development of sensor clouds.

Keywords: *Virtualization, Sensor Cloud, Wireless Sensor Network, Cloud Computing, Physical Sensor, Research, Virtual Sensor*

INTRODUCTION

A. Wireless Sensor Networks

A wireless sensor network is a type of dispersed collection of sensors that includes a large number of sensors with restricted capabilities such as temperature, soil, sound, vibration, pressure, motion, and so on. Wireless sensor networks are becoming increasingly essential in fields such as area monitoring, industry, civilian, military, and environmental or earth sensing, which may alter the general and routine course of human interaction with the physical world. Scalability, security, and programmability are all significant aspects of sensor nodes.

B. Cloud Computing

Because of the tremendous potential of data gathering capacity and data processing capacity, cloud computing has become a big pioneering computing invention for appropriate, on-demand network access to a collective pool of adjustable and adaptable computing resources. On the recent decade, the relevance of cloud computing has had a tremendous impact in the fields of communication and technology. Amazon, for example, serves better because of its cost-effective, powerful, and secure cloud platform. On communication, there are three types of Cloud computing functions that are based on infrastructure, platform, and software. The infrastructure that enables functionality based on storage and networks in general. Platforms that provide functionality based on operating systems. The software that typically delivers application-based capabilities.

C. Sensor -Cloud

Sensor Cloud is the form of a fusion of two high-potential technologies. The first is a wireless sensor network, while the second is cloud computing. SensorCloud for real-time applications that require precise, cost-effective, and efficient infrastructure. Sensor clouds have grown in popularity in today's research era because to their ability to collect data and store it for long periods of time before transmitting it to users for a variety of real-time applications.

Figure 1 depicts the key parts of a sensor cloud system.

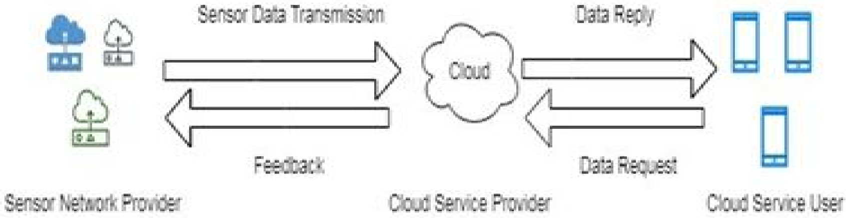

Fig. 1 Example of Sensor Cloud Scenario

1. Sensor Network Service Provider.
2. Provider of Cloud Services
3. User of a Cloud Service. Client Service Providers serve as information sources for Client Service Users. Sensor Network Providers, like Cloud Service Providers, serve as data sources.

D. Organization of the Paper

The rest of the work is organised as follows. Section II discusses the backdrop of the previous work. The literature review is briefly discussed in Section III. The Existing structure is mentioned in Section IV. Section V discusses planned work. Section VI concludes our investigation.

BACKGROUND

A. Wireless Sensor Networks

Wireless Sensor Network has attracted the interest of researchers in both theoretical and practical aspects throughout the last decade. A wireless sensor network is a network that incorporates sensor nodes or modes that collect physical or environmental data. Sensor nodes are modest in size yet offer a variety of functions. Sensor nodes detect environmental properties such as sound, pressure, motion, and temperature. Sensor nodes, in general, contain some fundamental capabilities such as detecting, processing, and communicating. Despite having several fantastic properties, sensor networks suffer some fundamental issues in terms of resources, communication, and design.

B. Cloud Computing

Cloud Computing is currently popular due to the advancement of processing and storage technologies, improved usage of the internet, and the availability of resources like as computing platforms that give quick and precise computational power. The ability to process data as well as store data is a major aspect of cloud computing. Cloud Computing is also significant in terms of accessibility, efficiency, and scalability. The biggest downside of cloud computing is security.

C. Cloud Computing Service Deployment

The decision on cloud implementation is critical for the deployment of cloud services. In recent years, there have primarily been three types of cloud accessible - public cloud, private cloud, and hybrid cloud:

1) Public Cloud

The public cloud is the most broad and widely used method for establishing cloud-enabled services. The third party that offers us with cloud services makes use of the most typical cloud resources, such as network, servers, and storage. The consumer must pay on a per-use basis. In terms of security, public clouds are not recommended when compared to alternative cloud architectures.

2) Private Cloud

Private clouds operate inside the confines of any organization's data centre. Private cloud security is more accurate than public cloud security since only legitimate users belonging to that specific company have access to the private cloud. Private clouds make it more easier to manage all types of resource management and updates, as well as give greater security and control.

3) Hybrid Cloud

Hybrid cloud, which combines both public and private clouds, is another essential form of cloud computing service. Managing both data and applications via the internet is more safe and secured. All end users may access data through the internet using a hybrid cloud. In Hybrid Cloud, public and private clouds are linked to select external cloud services for improved cloud service results.

D. Sensor Cloud Architecture

The formal architecture of the integration of two technologies, wireless sensor networks and cloud computing, is shown in Figure 2. Wireless sensor networks supply certain sensing data, and cloud computing stores and processes that data based on the needs of various types of users. The sensed data from the sensor network is collected and sent to the cloud environment through a sink node. Wireless sensor networks have a number of drawbacks, including limited battery life, storage issues, and so on. For certain real-world applications, this integration provides a cost-effective, efficient, and scalable approach. Virtualization is a vital component of sensor cloud combination, since it allows for the creation of many virtual sensors.

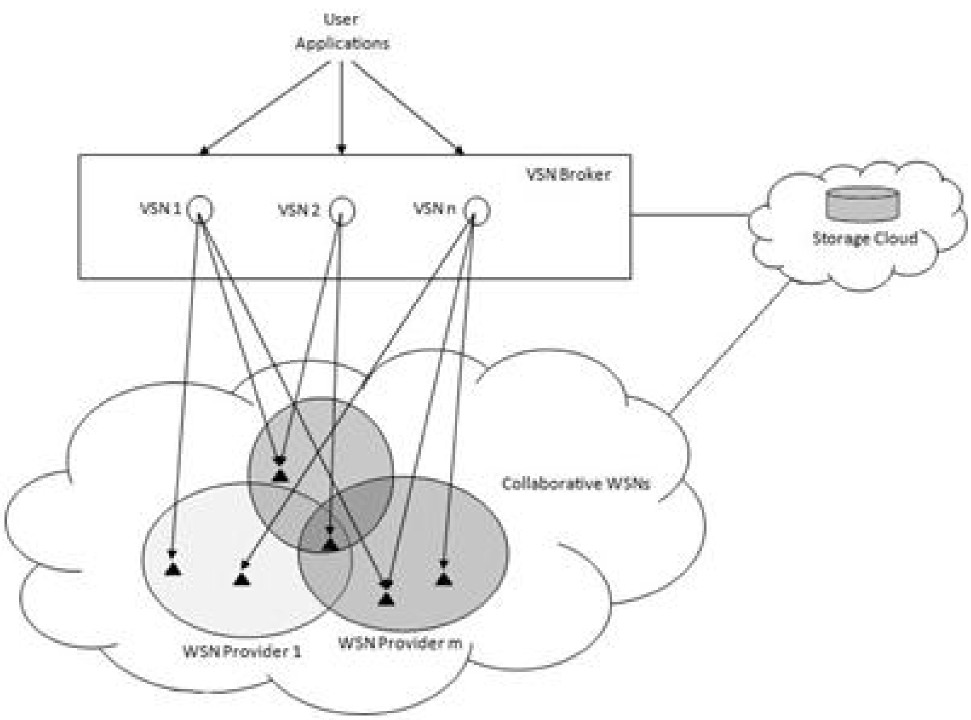

Fig. 2 Sensor Cloud Architecture

E. Integration of Cloud with Wireless Sensor Network

Figure 3 depicts a cloud-integrated sensor network combination that describes the whole situation for sensor cloud mechanisms. Wireless Sensor Networks have a variety of real-time applications that are typically combined with a variety of methods. With the assistance of a cloud-integrated sensor network, which collects critical information from various types of sensors and transmits it to a cloud computing platform.

In a cloud computing platform, data is processed first and then stored in the cloud. This critical and processed data may be accessed by the user at any time and from any location as needed. When compared to traditional wireless sensor networks, the cloud integrated sensor network paradigm is significantly quicker, more cost effective, and scalable, serving people better.

This sensor cloud approach is extremely beneficial in terms of data storage, security, and transport. On terms of security, Processed Data may be saved in the cloud at a safe location, and storage is also superior.

Following are the important elements of cloud integrated sensor network.

- **End User:** The processed data can be accessed by the end user through the internet in a cloud environment.

- **Provision Server:** The Provisional Server provides critical services to the sensor node.

- **Portal:** This is the bridge between design of sensor cloud and sensor.

- **Virtual Sensor:** A virtual sensor is a type of virtual device or logical device that makes use of processed data gathered by sensors.

- **Physical Sensor:** this is the real time entity from the wireless sensor network.

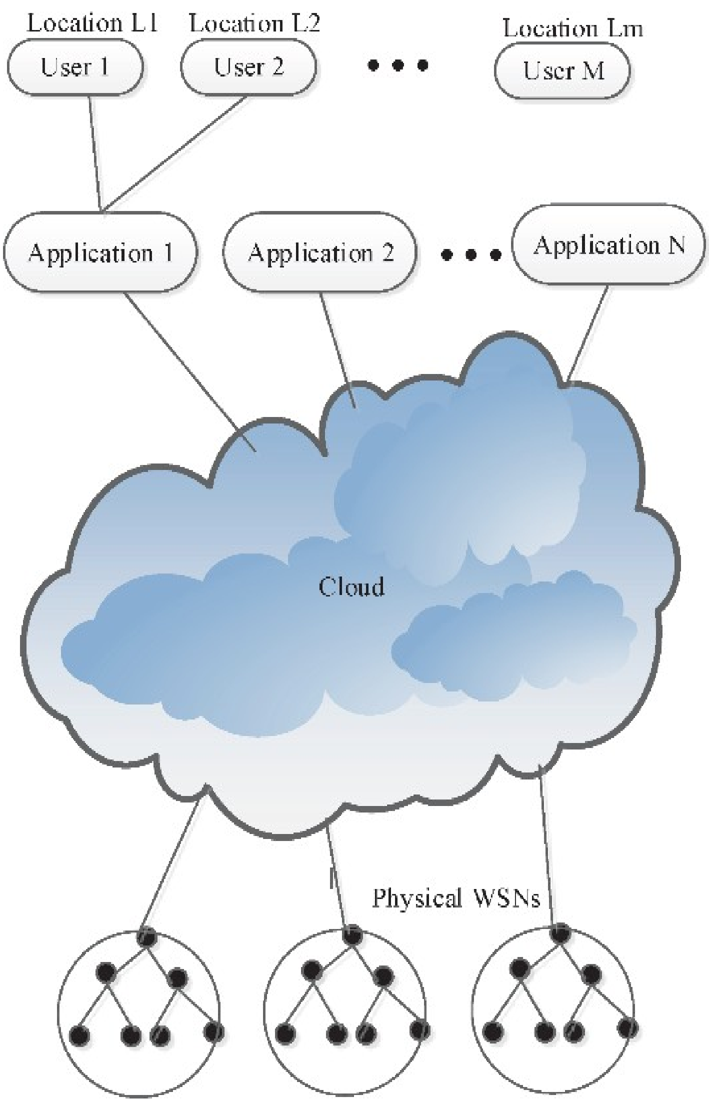

Fig. 3 Sensor Cloud Integration

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F. Advantages of Sensor-Cloud

The following are some of the most prominent advantages and benefits of sensor clouds.

1. Analysis. Users want various sorts of observations and analysis for sensor data and cloud computing models because they provide scalable, secure, and critical processing capacity.

2. Scalability. Sensor-Cloud is capable of adjusting the size or scale of the sensor network as well as the cloud model. It is relatively easy for the system to grow itself when it comes to resource management in the sensor cloud.

3. Collaboration. Sensor-Cloud is capable of sharing critical and efficient sensor data through the collaboration of many types of sensor networks. It is also capable of critical data dissemination between clouds.

4. Visualization. Sensor cloud combination provides visualisation API. It is used to create and depict data, as well as diagrams. A user might theoretically compute recent trends with the use of a graphical approach and tool.

5. Unlimited Storage and Processing. Sensor clouds have limitless processing and storage capacity to manage various resources such as enormous amounts of data and applications.

6. Automation. Sensor cloud automation service provides large time-consuming and high-cost data processing capacity.

7. Flexibility. Sensor-Cloud provides time and sharing resources additional flexibility to its users.

8. Resource Management: Cloud-integrated Sensor Platform capable of efficient resource use by allowing them to share their sources for a variety of real-time applications.

G. Sensor-Cloud Applications

There are several established sensor cloud-based data and infrastructure applications. Below, we will go over various applications.

1) Nimbits

Nimbits is a sensor cloud service that is built on recording data and sharing information on the cloud. Nimbits can also be used for data computation, data and information alarm mechanisms, and data compression techniques that include simple mathematical calculations.

2) Pachube Platform.

Pachube platform is a type of service provider-related database that allows users to connect to the internet directly or indirectly. Pachube platform is a cloud-oriented IOT platform. This platform offers services as well as solutions for users to explore and exchange real-time sensed data.

3) IDigi.

iDigi is a significant PaaS service that removes many barriers to developing certain cost-effective and secure solutions that may bring together data, apps, and device assets. iDigiDia is user connector software that simplifies data integration and connectivity.

RELATEDWORK

Sensor cloud-based parameters such as energy efficiency, security, authorization, and service quality are key research concerns. Table 1 shows a brief overview of the literature assessment based on a survey of cloud integrated sensor frameworks for parameter and resource management.

Table: - 1 Related Work

Author	Summary of Contribution	Features of Research
Jayesh M. Patel et al. 2018	VM allocation and migration policy of mobile cloud	Mobile Cloud Computing, SVM, Virtual Machine
Chunsheng Zhu Et al. 2015	CLSS for WSNs integrated with MCC	integration, location, network lifetime, sleep scheduling
Pawan Kumar Thakur et al. 2015	Using Offloading Technique	Energy Saving, Offloading
Rubing Liang et al. 2018	cloudlet based energy-saved data transfer model (EDTM)	date transfer model, cloudlet
Rajalakshmi Krishnamurthi et al. 2019	computation offloading Into the Cloud	Reduce Energy Consumption
Buddesab et al. 2018	SCLSS for MCC integrated With WSN	Security. Packet delivery ratio

Mohammad Farhan Khan etal. 2019	Energy efficient data transmission in sensor cloud	Data transmission
N. Mahendran et al. 2016	Sleep Scheduling Schemes Based on Location of Sensor-Cloud	Energy efficiency
Xuefeng ding and jiangwu et al. 2019	Optimization Scheduling for Internet of Things	Reduce energy consuption
ShreyasPatole et al. 2019	MCC	MCC Related Parameters
HalahMohammed Al-Kadhim et al.2019	IoT	Energy Efficient and Reliable Transport of Data
Qun Jin et al. 2019	Fog computing	Algorithm for workload balance
Tian Wang et al. 2015	Industrial sensor cloud	Big data cleaning
Tian Wang et al. 2019	Sensor cloud	Sensor cloud characteristics
VennilaSanthanam et al.2018	Sensor Cloud Platform	Middleware Service Utilization
Martin Pandurski et al. 2018	Cloud Integrated Sensor Platform	Resource Management
Nahla F. Omran et al. 2018	IoT Health Care Projects	IoT Related Parameters
Falguni Jindal et al. 2018	IoT	IoT Characteristics
Hyun-Jong Cha et al. 2018	Fog Computing Architecture	Combination of Fog and Sensor Network
NGOC-THANH DINH et al. 2018	Energy Efficinet Model	Energy Reduction in Sensor Cloud
ThanhDinh et al. 2017	Information Centric Sensor Cloud	Improve Network Lifetime
Hany F. Atlam et al. 2017	IoT with Cloud	Reserch and Challenges of Cloud and IoT
SudipMisra et al. 2017	Sensor Cloud Paradigm	Issue and Challenges of Sensor Cloud

EXISTING FRAMEWORK

Figure 4 depicts an established cloud-integrated sensor infrastructure for resource management that describes the full scenario. Sensor Cloud Combination begins with a sensor sensing environmental or physical properties such as temperature, sound, moisture, pollution, vibration, and so on, and then sends it to a cloud environment for storage and processing. The cloud processes the complete data set according to the user's specifications and provides it to the user on a pay-per-use basis.

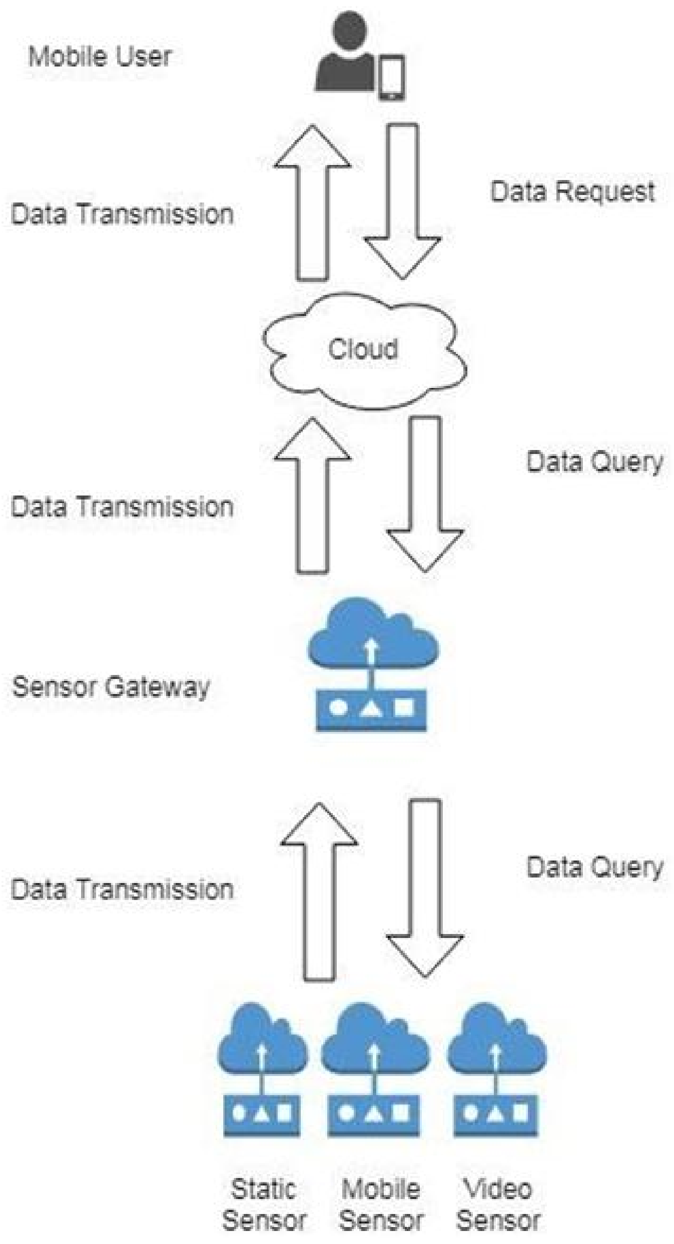

Fig. 4 Sensor cloud Framework Overview

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Some characteristics are frequently considered in sensor cloud networks, such as energy, security, storage, data transmission, and QoS. Many cloud integrated sensor network algorithms overlook energy consumption, network lifetime, and QoS criteria (accuracy, throughput, and availability). As a result, in our suggested work, we will completely focus on these factors.

1. Authorization Issue- The most difficult issue in sensor cloud integration is authorization. This problem occurs when someone attempts to enter the network without first obtaining authorization from the administrator.

2. Energy Issue- When it comes to sensor clouds, energy consumption is a major issue since sensor nodes require a lot of power to function properly for data collection and transmission.

3. Security Issue- The key worry in any type of data transfer as well as network for managing and maintaining integrity in cloud integrated sensor network for everyday routine is security.

4. Storage Issue- Data storage is a key problem in Cloud integrated sensor networks since storing huge amounts of data in a safe location is difficult.

PROPOSED WORK

CLSS1 and CLSS2 are the two schemes. CLSS1 is used to increase energy consumption, whereas CLSS2 is utilised to make the device more scalable and resilient while consuming less energy. So we are combining these two schemes in order to boost efficiency and remove all limitations of CLSS schemes, as well as to establish a new scheme. CLSS 3. If the limitation cannot be removed, we will utilise another strategy, such as the NOSS (new optimum sleep scheduling) technique. Figure 6 depicts a suggested technique for a cloud sensor network, also known as a Sensor Cloud, for various parameters [14]. The following two observations are ignored by MCC and WSN integration schemes: 1) The precise data that cloud customers seek is generally determined by their current location. 2) Most sensors are often fitted with non-rechargeable, limited-energy batteries. In this study, we suggest a combination of two unique collaborative location-based sleep scheduling (CLSS) techniques for WSNs to integrate with MCC, prompted by the aforementioned two difficulties. This new CLSS plan will address the shortcomings of the previous two schemes while also being more energy efficient. The current location lu of mobileu seruis acquired by cloudc initially appears in the CLSS1 scheme picture below (Step1ofCLSS1). The cloud then sends a flag Aor Zissent to the base station s based on whether lu is in the location list L or not (Step 2 of CLSS1). The flag is then propagated via base stations, and each sensor node I evaluates whether it is awake or sleeping based on the flag it receives during the epoch T. (Step 3 to Step 5 of CLSS1). In terms of CLSS2, the first four phases are identical to those of CLSS1. The distinction between CLSS2 and CLSS1 is found in step 5.

When sensor node i receives flag Z in step 5 of CLSS2, i will be sleep scheduled based on the energy-consumption based connected k-neighborhood (ECCKN scheme). For EC-CKN sleep scheduling scheme , the current residual energy rank (e.g., Eranki) of each node i is got (Step 6 of CLSS2) and the subset Ci of i's currently awakeneighborshavingErank>Erankiiscomputed(Step10 of CLSS2). Before a node i can go to sleep in the epoch T, it needs to ensure that (1) all nodes in Ciare connected by nodes with Erank>Eranki (2) each of its neighbors has at least k neighbors from Ci(Step 11 ofCLSS2).

Pseudocode of CLSS1 scheme

Step 1: Cloud c obtains mobile user u's current location l_u.
Step 2: If $l_u \in L$, c sends flag A to base station s. Otherwise, c sends s flag Z.
Step 3: s broadcasts flag to sensor nodes.
Step 4: Run Step 5 at each node i.
Step 5: If node i receives flag A, remain awake. Otherwise, go to sleep.

Pseudocode of CLSS2 scheme

Step 1: Cloud c obtains mobile user u's current location l_u.
Step 2: If $l_u \in L$, c sends flag A to base station s. Otherwise, c sends s flag Z.
Step 3: s broadcasts flag to sensor nodes.
Step 4: Run Step 5 at each node i.
Step 5: If node i receives flag A, remain awake. Otherwise, run Step 6 to Step 12.

Step 6 to Step 12 are the pseudocodes of EC-CKN scheme

Step 6: Get the current residual energy $Erank_i$.
Step 7: Broadcast $Erank_i$ and receive the ranks of its currently awake neighbors N_i. Let R_i be the set of these ranks.
Step 8: Broadcast R_i and receive R_j from each $j \in N_i$.
Step 9: If $|N_i| < k$ or $|N_j| < k$ for any $j \in N_i$, remain awake. Go to Step 12.
Step 10: Compute $C_i = \{j | j \in N_i \text{ and } Erank_j > Erank_i\}$.
Step 11: Go to sleep if both the following conditions hold. Remain awake otherwise.

- Any two nodes in C_i are connected either directly themselves or indirectly through nodes within i's 2-hop neighborhood that have $Erank$ more than $Erank_i$.
- Any node in N_i has at least k neighbors from C_i.

Step 12: Return.

Fig. 6 algorithms used to combine in new algorithm

CONCLUSIONS AND FUTURE DIRECTIONS

In this study, we deal with two CLSS schemes (CLSS1 and CLSS2) for WSNs that are integrated with MCC. CLSS systems incorporate both the WSN and the cloud, and then dynamically adjust the awake or sleeping status of the sensor node in the integrated WSN based on mobile users' whereabouts. CLSS1 focuses on reducing the integrated WSN's energy usage, whereas CLSS2 focuses on the integrated WSN's scalability and resilience. Both theoretical and simulation findings for the integration of MCC and WSNs are provided, and they show that CLSS1 and CLSS2 might extend the lifetime of the integrated WSN while still meeting mobile users' data needs. We are constructing a new system that is more efficient than these two schemes using the aid of these two schemes.

In this, we will offer algorithms and prototypes for reducing power consumption while increasing resource efficiency and usage. We will continue to implement CLSS schemes. In the future, we will present the outcomes of our newly built method on the simulator.

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