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Wireless Sensor Data Access Through Mobile Cloud Computing

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ABSTRACT

This paper focuses on integrating Wireless Sensor Networks (WSN) and Mobile Cloud Computing (MCC), to provide reliable information to the mobile users from Wireless Sensor Network through Mobile Cloud. With TPSDT technique WSN data are stored in the mobile cloud in regular interval, which makes the users to retrieve real time data by fetching the most recently updated information from the cloud. This paper also proposes TLPSDT technique which provides data to the mobile users based on time, location and priority that are specified by them. For improving user experience, location based data transmission and preference based notifications are sent to the mobile users automatically.

1. INTRODUCTION

1.1. Wireless Sensor Network

Wireless sensor network is a distributed network that monitors and records physical or environmental conditions at different locations (e.g., temperature, humidity, etc.) [1],[2].A sensor network contains a collection of sensor nodes which are portable and equipped with transducer, microcomputer, transceiver and power source. Electrical signals are generated by transducer on sensing physical environment, which are further processed and stored by the microcomputer andtransmitted to the computer by transceiver on receiving a request. There are different types of sensors available to monitor the atmospheric conditions and they are thermal, infrared visual, radar seismic, acoustic. Batteries are generally used as the power source by the sensors. With the ability of sensors to gather and deal with larger amount of data, it has greater potential to be used in different applications in various fields like military , weather forecast, coal mines, etc. An example is coal mine monitoring - Sensors are deployed in underground coal mine walls, floor andpoles to keep track of the environmental conditions like humidity, temperature, gas leakage, etc[3].

1.2. Mobile Cloud Computing

Mobile cloud computing is the integration of mobile computing and cloud computing to provide enhanced processing capabilities to mobile phones and alleviates the limitations on mobile resources like storage, processor, battery, etc. The main feature of MCC is computation offloading, which migrates the resource based computational operations from mobile phones to resource efficient cloud or servers[4]. For example, when mobile users wants to play a multiplayer mobile game, mobile cloud acts as a centralized server that controls all the processing tasks like computing scores, lifetime, power ups, etc. Generally the mobile cloud computing are based on standard cloud service models which includes Platform as a Service (PaaS) [6], Infrastructure as a Service (IaaS) [5], and Software as a Service (SaaS) [7][8].

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1.3. Integration of WSN and MCC

The integration of WSN and MCC includes the use of gateway through which the data are transmitted to the mobile cloud. The data sensed by the wireless sensors are first transferred to gateway in a hop-by-hop manner, which is then processed and sent to the cloud. Further the data is stored and processed in cloud by the powerful servers present and made accessible by the mobile users anytime andfrom anywhere.[9] With WSN acting as the data source in the integration of WSN-MCC, it becomes easy for the mobile users to get the environmental information with simple click of buttons.

2. RESEARCH MOTIVATION AND RESEARCH CONTRIBUTION AND ORGANIZATION

2.1. Research Motivation

The integration of WSN-MCC has led to number of efficient applications such as disaster detection, agriculture and irrigation control, transportation and vehicle real-time visualization, tunnel monitoring, healthcare monitoring, etc.,[10]. All these application makes use of WSN depending on its requirements and store the sensory data to the cloud depending on the request of the mobile users.

Consider a warehouse monitoring system in which sensors are deployed, through which information like temperature, humidity, etc., and videos are offloaded to the cloud so that the owner can access the data from their mobile device in real-time. And by monitoring the possible entrances trespassers can be caught or stopped. Here all information transferred from WSN to cloud is not useful to the user so, theuseful data should only be transferred to the cloud in order to utilize bandwidth properly.

2.2. Research Contribution and Organization

To support the usefulness of WSN-MCC integration and to overcome the issues involved in the integration, in this paper a scheme called TLPSDT (Time, Location and Priority based Selective Data Transmission) is proposed. The TLPSDT technique enables user to receive the environmental information based on time and priority defined by the user. Along with the user defined information, TLPSDT also considers the user's current location and sends data to their mobile device on request.

This paper also uses PSS (Priority-based Sleep Scheduling) algorithm[11] which makes the sensor to be in sleep mode when there is no use of it. This reduces the consumption of battery by the sensors. So that data can be gathered and transmitted only when it is required.

The key features of this paper are summarized as follows.

- This paper incorporates the WSN-MCC integration in order to enhance the usefulness of sensory data being used in mobile cloud computing.
- It is the first paper that proposes the technique of TPLSDT which makes it more easy for users to get data according to the current location and on their priority.
- Through TPLSDT users get automated notifications regularly as requested by them according to their daily need.

The rest of the paper deals with the following sections. Section III comprises the system model and PT table, which elaborates about the entire working of the system and priority table. Section IV explains the system model of WSN-MCC integration in the form of terminologies. Further, in section V we have introduced a technique called TPLSDT that explains the way of selectively transmitting data to the user based on time, priority and location. The importance of sensory data and how much people are dependent on it in daily life is discussed in section VI. Section VII explains briefly about the works that are related to WSN-MCC integration. Finally, section VIII concludes this paper.

3. SYSTEM MODEL AND PT TABLE

3.1. System Model

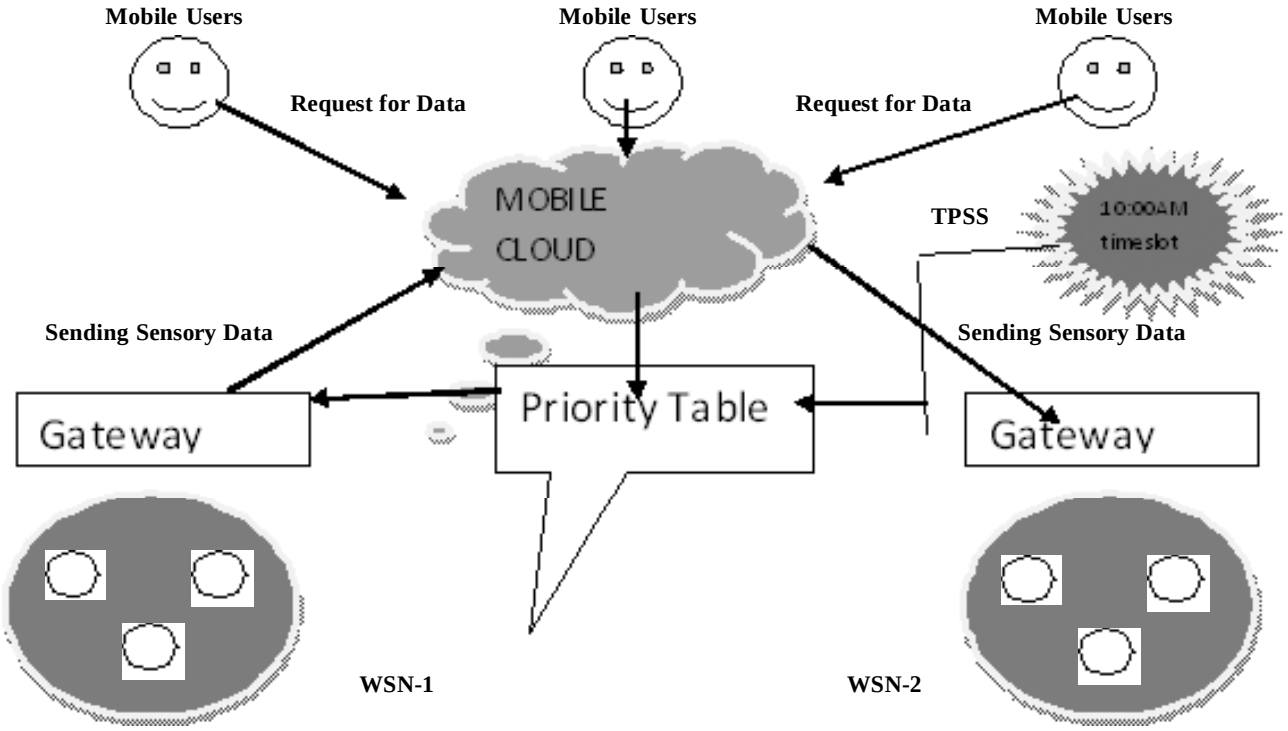

Figure 1: System model as shown in fig.1, the system model consist of three different entities: Mobile user, Mobile cloud, Wireless sensor network.

The WSN is a collection of sensors grouped together to form a network, in which different kinds of sensors are deployed which can sense different environmental conditions. These sensors are deployed at different locations and they are responsible for sensing the environmental condition. The sensed information are sent to the mobile cloud in pre-specified regular intervals through gateway.The gateway is the one which transfers data from wireless sensor network to mobile cloud. It maintains a priority table based on which the data is filtered and only the data with higher priority is sent first. The priority table is maintained based on, what kind of information is requested by majority of users at a particular time. For example, if 80% of users request for traffic information between 8AM and 10AM, then traffic information is given more preference for that particular time.

The next entity is mobile cloud, which is responsible for storing the values received from the WSN. The mobile cloud maintains different tables for different locations and keeps updating the sensory values of different type of sensors at regular interval. These values are sent to the mobile users, whenever they request to know about the current environmental condition. The final entity is the mobile user who registers for services and request for the environmental information from the mobile cloud. When an end user requests for data, the most recent value stored in cloud is transferred to user.

3.2. PT TABLE

In general two tables are maintained in order to prioritize the data to decide which has to be given more preference. Those tables are namely, request table and Priority and time table.

The request table records the pattern in which the users generally requests for data. And this table manages the detail of which is the maximum requested service at a particular time interval. Time is taken as the primary

Table 1
Request table

Sensor nodes	7am-8am	8am-9am	9am-10am	.....
S_1	20%	35%	42%	...
S_2	15%	22%	11%	...
S3	38%	16%	24%	...
S4	10	34%	4%	...
⋮	⋮	⋮	⋮	⋮

Table 2
Priority and time table

S. No.	7am-8am	8am-9am	9am-10am	.....
1.	S_3	S_1	S_1	...
2.	S_1	S_4	S_3	...
3.	S_2	S_2	S_2	...
4.	S_4	S_3	S_4	...
⋮	⋮	⋮	⋮	⋮

consideration and at a particular interval what kind of environmental information is requested by the maximum percentage of users is noted. Similarly for every hour the most requested data is filled in the table.

The PT table prioritizes the different kinds of sensory data which has to be fetched from the WSN. The data in the PT table varies based on the data being updated on the request table. The type of environmental information that is mostly requested by the maximum number of user at a particular time interval is considered to have the maximum priority and that is placed at the first row of that particular time interval column. The PT table's data is considered every time whenever the value is fetched from the WSN. And the environment condition that is having the maximum priority at the particular time interval is fetched first into the mobile cloud for the users to access.

4. WSN-MCC INTEGRATION SYSTEM MODEL

The integration of WSN-MCC is explained using following assumptions.

- There is one mobile cloud C and mobile users U (i.e., M = (m_1, m_2, ..., m_U)). To satisfy request from every mobile user each WSN collects and transfers data to the cloud.
- There are N sensor nodes (i.e., S = (s_1, s_2, ... s_N)) and one gateway g, that are present in N WSNs (i.e., WSN = (wsn_1, wsn_2,.....wsn_N)).
- Each mobile user mis connected to the mobile cloud C individually and this mobile cloud receives data from WSN through gateway g.
- Each sensor node i is supplied with a limited energy resource, which has initial energy e_0 and residual energy e_1.

5. TPLSDT

In this paper, we propose a technique known as TPLSDT which is a selective data transmission technique. Selective data transmission denotes the method of transmitting only the necessary data for the particular

user at a specified time. TPLSDT works based on the user's priority of data, time at which he generally request for the particular environmental condition and based on the exact location where he is currently being. TPLSDT can be elaborated in detail as follows.

- The priority factor plays an vital role in the TPLSDT technique. When a user registers for services, user is made to prioritize the environmental information which user would be more interested at different time interval. This information can be used to send the automated notification to the user.
- The next factor that is considered in TPLSDT technique islocation. Whenever an user enter a new location, this technique enables the user to get current environmental information about the particular area. Before transmitting the data to the user it checks the priority information provided by that user in order to know which kind of data user will be more interested.
- Time is the final entity of this technique, which makes the user to receive notification on time. This technique records the pattern of time at which the user generally makes request. So depending on this, at that particular time the data is automatically sent to the user. Similarly F. Wang et al proposes a technique to transmit data to users based on the time at which users will be needing the data[12].
- Consider the following example in which, if a user requests for traffic information everyday between 8 am and 10 am then from next day traffic data is automatically sent as a notification to the user for that time interval.

6. NEED OF SENSORY DATA

As the technology is developing every day in different aspects, the need and use of sensory data also increases. Now-a-days almost everyone directly or indirectly depends on the sensory data. These sensory data have become useful in starting from knowing the traffic condition in earth to knowing the atmospheric condition at moon. For example, P.Yang et al proposed a method providing warning on hazardous lightning by the use of sensor which detect and analysis the electric field present in the atmosphere.

7. RELATED WORK

The WSN-MCC integration is the technique on which a number of related works are going on. These works generally focuses on the following aspects. They are 1) To improve the WSN's performance, and 2) To properly utilize the sensory data from WSN.

Specifically, on the aspect of improving WSN performance in WSN-MCC integration, it is said in [14] that the WSN-MCC integration can support the dynamic loads which the environmental WSN application generally generate. In [13] the integration of WSN-MCC is deployed to improve the performance of environmental monitoring applications by providing dynamic and elastic computational capabilities. In [15] it is demonstrated that the WSN-MCC integration can address the challenges involved in managing the data present in the patient supervision using WSN. In addition to it, [16] suggest that visualization performance of WSN for living environments can be potentially enhanced by cloud. In order to improve the lifetime and performance of the network of integrated WSN, in [17] a collaborative location-based sleep scheduling.

In addition, there are number of works going on the aspect of properly utilizing the sensory data from WSN. [18] Focuses on proposing a framework that will utilize intensively increasing sensory data for different community centric sensing application. The focus of [19] is to make the task of shifting data from WSN to cloud easier, so that the economically valuable WSN data can be utilized fully. To make the data owners trust the security of management of sensitive data, [20] proposes a design for user control processing and storage of sensory data. Finally, [21] shows a framework that provides desirable data to user in a faster way with data analysis technique.

8. CONCLUSION

The integration of WSN-MCC has become an emerging research topic because of itsvarious advantages to mobile user. In this paper, we have incorporated WSN-MCC integration to utilize its abilities and this integration has reduced our work with powerful storage and data processing capabilities.We have proposed a technique called TPLSDT to make the user get proper data on time.Through this technique we have tried to utilize the maximum out of effective WSN-MCC integration.This method reduces the job of user by automatically sending notifications. This is an enhanced technique to fetch sensory data based on location and for providing notification according to regular usage of user. This approach can achieve a good rate of success in providing data to the userat a particular time at which user will require.

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