Smartphone based Data Gathering from wireless sensor networks in city environment

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Abstract
In today's world, sensor networks play a huge role in information technology, One of the applications of this network is in cities, Which collects important information for each sensor, And sends it to the main server, One of the challenges of the urban sensor network is cost and energy consumption, It consumes a lot of energy to send data, Which causes nodes to be destroyed, For this problem, mobile phones in the city were used to collect data and deliver it to the original sink. In this thesis we have used a new approach to this topic that uses clustering and aggregation of data to be delivered to a mobile device. Simulation results show that the proposed method has a good performance.

Keywords
sensor network, mobile device, clustering, sensor.

1. Introduction

With the development of wireless communications and micro-sensors, wireless sensor networks have entered various areas. These networks include a large number of sensors that are in the study environment and sense the required data. Network nodes consist of three main components of the main processor, a wireless radio and one or more sensors. [1]

The wireless sensor network consists of hundreds or thousands of nodes randomly distributed in distant or hazardous areas. The main task of these nodes is to collect information from the environment, in which they are located; In fact, these nodes can collect information from these areas, which it is not possible to obtain this information in other ways. Each sensor node includes a sensor unit, a computing unit, memory, and a wireless communications unit with a limited communication range. The existence of these networks has had a major impact on the efficiency of many applications such as military, medical and environmental applications. When the energies of these nodes are completed, charging or replacing the energy source of these nodes is very difficult or sometimes impossible. Therefore, one of the most important challenges in these networks is the limited energy of the nodes. And the efficient use of low-energy sources and available for nodes in these networks is one of the main tasks of network designers [2]. The acquisition and collection of data through wireless sensor networks (WSN [1]) has traditionally been carried out by placing static structures and devices in the desired locations. These include base stations [2](Can and Demirbas, 2013). In addition, construction costs increase the minimum infrastructure costs and increase global energy consumption [3]. As a solution to this problem, smartphones are a favorite in researching wireless sensor networks because of their potential to serve at base stations in urban areas.

Allowing that nodes communicate with smartphones without relying on static infrastructures, can increase bioenergy and it expand the consistency of environmental management with natural resources. For example 1096

The amplifier nodes are used to collect the CO2 data from 100 sensor nodes (4). Gathering smartphone data using sensor nodes reduces costs compared to static amplifier nose. Due to its inclusiveness and portability, smartphones are used to collect data from mobile networks of sensor networks in urban environments. Smartphones as mobile data collectors can collect wireless sensor network data and send it to the central controller. Although data collection with smartphones causes delays due to the mobility of humans, but there are some applications that can be ignored by this delay [5]. While researching data collection with mobile pickups in wireless sensor networks [6] and on sensors by mobile phones [7], Limited efforts have been made to evaluate smartphones as data collectors from wireless sensor networks. A mobile data plan has been developed to understand common people's social behaviors.

Where human movements are concentrated in a particular region, areas are found in which no record has been made. Therefore, there is also research on the effects of the mobility of humans on the collection of data in wireless sensor networks using smartphones [8]. Therefore, we need a comprehensive analysis to determine the relationship between human mobility and data collection

[1] Wireless Sensor Network
[2] Base Station

Manuscript received July 5, 2017
Manuscript revised July 20, 2017

in this way. This analysis should also take into account the energy consumption of wireless sensor network nodes. The use of wireless sensor networks for a variety of purposes, such as environmental identification, study of climate conditions, military applications, industrial applications, medicine, etc., has been widely considered in recent decades [8]. As you can see, wireless sensor networks have found many applications in different areas of life. Therefore, it is necessary to conduct research in these areas more quickly to lead to more human services and ease of work. Data collection by smartphones using wireless sensor networks is also one of these applications, which this is one of the most up-to-date researches in this field. We are trying to investigate this issue in this research. This research is done in the same way as any other research. The practical results of this research as a model that leads to lower energy consumption and productivity increases can be useful both within and outside the country's borders. Therefore, the results of this research can be used by universities and research institutes, government agencies, service companies, municipalities and etc.

Here is some of the research that has been done within the scope of this article:

1- Dokhman (2013) obtained topological relations and their changes only for cavity-free regions and focused on these areas [9].
2- Jafar Sadeq et al. (2012) created a decentralized spatial algorithm called qualitative identification of the region's development in the network. And tested it for discovering topology events in areas monitored by a wireless sensor network. The empirical assessment of this algorithm in their research suggests that decentralized method can improve network communication more efficiently than other centralized methods [10].
3- Abbasi and Abouei (1395) presented a new method for reducing energy consumption, increasing load balancing between nodes and lifetime in wireless sensor networks. Simulation results using the WCDG algorithm indicate that the proposed method significantly improves performance in terms of energy consumption and load balances in the network compared to other methods [11].
4- 4. Vaezi et al. (1395) examined the new protocol of routing based on the quality of services in wireless sensor networks by analyzing hierarchical data. The proposed protocol has been implemented in MATLAB environment and its effect has been evaluated, and compared with the BERR protocol. The simulation results show that the proposed algorithm works better than the BERR protocol in large-scale networks, which is about 50% energy efficient and 150% over the lifetime of the network. Since the proposed method is attempting to select the shortest paths and reuse the lost packets, It can improve the average delay of about 30% in large-scale networks and have high reliability. [12]

2. Recommended method:

The principle of the proposed method is based on clustering, first, the sensors are clustered and a cluster is selected, and the cluster is tasked with collecting data and delivering it to a mobile device.

The proposed method in this research consists of the following parts:

• Formation of the central spine of the network to create the best path and data transmission
• Clustering
• Data aggregation within the cluster
• Data aggregation between clusters
• Data collection by mobile device

2.1.Result discussion

To compare the proposed method, the method [13] is presented; the proposed protocol considers the reliability and latency of the link between adjacent nodes as routing parameters for sending packets. And for increasing reliability, it sends data in a multi-path and solves the linear programming problem. This protocol does not consider the parameters of the neighboring nodes and the transmission speed of the send to determine the appropriate route for sending. In this protocol packets are also sent to nodes that are congested. For this reason, the number of time-sensitive packages at the destination is reduced due to congestion in the nodes. In method [14], cumulative data has been used to reduce energy consumption in the urban network, which collects information in stages and locally. In this way, nodes organize themselves in local clusters, So that a node in the cluster acts as a head cluster. In order to prevent the whole cluster from running and the cluster life does not stop when the node cluster energy is exhausted, the high energy nodes in the cluster are randomly selected as head cluster. In addition, the data collectively aggregate to the amount of data that should be sent to the base station3, resulting in lower energy consumption, and longer network lifetime. In this way, the sensor selects itself with a certain probability as a cluster head. These cluster heads inform their network status of other network nodes. Each node chooses a cluster based on the minimum energy of communication, and it becomes member of that cluster. When all the nodes were organized in clusters, Any cluster

3 Base Stations

head creates a scheduler for cluster nodes. Non-core nodes on the basis of this scheduling program only turn their radio hardware on when it is time to send them. And in other times it is in silent mode, which also saves energy consumption.
When the cluster node aggregates the data of all members, it aggregates the data and delivers the cached data to the mobile device. In this method, the nodes decide, based on their remaining energy, to get the cluster head. Each node decides independently of other nodes. Therefore, additional negotiations are needed to diagnose the headroom.

3. Simulation parameters

Matlab software is used to implement proposed algorithms. Simulations are carried out in an environment of 100 meters at 100 meters. In order to investigate the efficiency of the algorithm, the coverage parameters, the number of live nodes and the remaining energy of the proposed algorithm are compared with the other method.
The simulation conditions and scenario are as follows.
• Number of variable nodes from 20 to 100
• Network range from (10*10) to (150 * 150)
• The energy needed to send every message is 0.03 j
• The energy needed to receive each message is 0.02 j
• The primary energy of each node is 0.1 to 0.5
• The minimum distance between nodes is one meter.
• The signal range is variable and dependent on the network size
• The type of routing is static
Since most of the proposed methods are random, each method has been executed five times and the mean values obtained in simulations are used to evaluate the performance of each method. In order to reduce the complexity, a simpler comparison between the proposed methods from a base station has been used.

3.1. Clustering energy consumption

One of the things that spend a lot of energy is clustering because many messages are redirected. In this section, the energy used for clustering has been evaluated. The results of this simulation are visible in the figure 1.

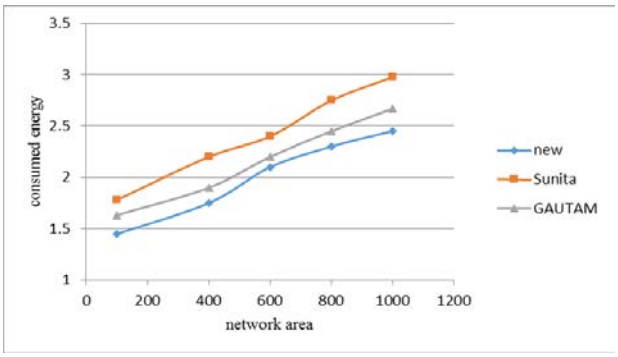

Figure 1.Consumed energy for clustering

The proposed method uses less energy than clustering in the past, which increases network lifetime energy.

3.2. Scheduled energy saving

One of the ways to reduce energy and maintain the life of the network is to increase the coverage of the network by using the scheduling of data transmission, So that the sensor nodes that are placed together and the location of the data being sent are similar. It sends data at the time of sending, which will save energy in nodes. The simulation scenario of this solution is to compare the amount of energy remaining from the network in a constant time for the new method and the two common methods. The simulation results are visible in the figure 2.

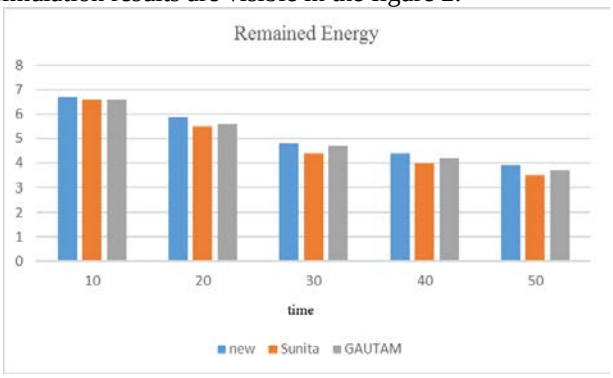

Figure 2.Remained energy

3.3. Network lifetime

In this scenario, we plan to investigate how long the entire network can last. In this situation, several random nodes are sent to send and send their packet to the main station, the simulation expires. All nodes lose their energy. The result is shown in Figure 3.

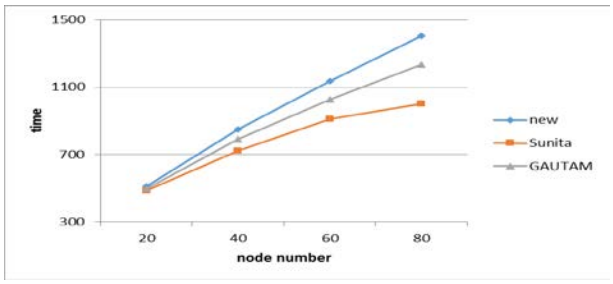

Figure 3.Node life time

As the figure 3 shows, the lifetime of the network has increased in the proposed method.

3.4. The time the message arrives to the central station

In the simulation scenario, the goal is to get the message from the node to the base station for a while. Each node contains a message that sends it to the cluster header, and the cluster sends the message to the central station. Since the central station's proposed method is at the optimal point, the cluster can communicate with it faster. In the form of time, the proposed method is compared with the previous method. In this scenario, the network size is constant and the number of nodes varies. The message speed is considered to be one meter per second.

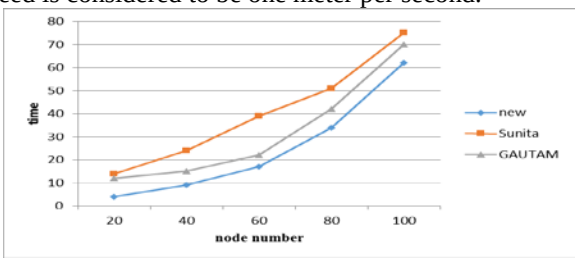

Figure 4.Arrival time comparison to central station

As the figure 4 shows, messages are sent faster to the central station in the proposed method.

3.5. Fairy load distribution

The next step to evaluate the proposed method is load distribution and network traffic on links between clusters. The more traffic is distributed equitably, the better network performance, And the network life span will increase. The simulation scenario in this case is as follows:

- Variable number of clusters
- Fixed posting number
- The sender and receiver are selected randomly

The average distribution of loads in the links is shown in the figure 5. To calculate the load distribution, the difference between the maximum and minimum load is displayed.

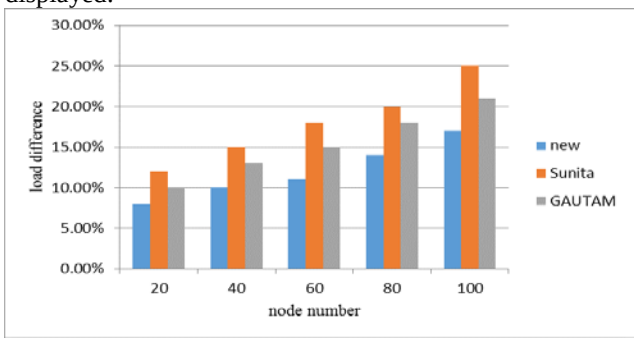

Figure 5.Load distribution with variable node number

The simulation shows that the proposed method has a better distribution because it acts greedily at each stage, which causes fair traffic to be distributed.

3.6. Correct sending rate

One of the most important evaluation criteria is to check the correct sending rate in the network, To simulate and evaluate this criterion, the size of the fixed network is considered, and in each step the number of sent packets is increased and the result is visible in the form.

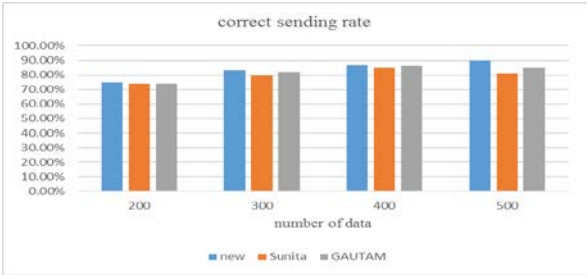

Figure 6.Correct sending rate

As the figure 6 shows, the correct delivery rate has improved in the proposed method.

4. Conclusion

The Wireless Sensor Network is a special type of case network and includes set of small nodes that can sense the environment, process information, store and exchange information with other nodes. Wireless sensor networks can be easily deployed in different environments and can collect information in a variety of ways. Sensor networks are event-based systems. The sensors receive data from the environment and send it to one or more central nodes. The main purpose of wireless sensor networks is to monitor and control the conditions and changes in the atmosphere, physical, biological and / or chemical in an

environment with a certain range. For example: monitoring habitat, tracking moving targets, detecting fire and so on.

Sensor nodes are usually released after being dispersed in unoccupied environments and their limited energy resources, the batteries, are hardly being replaced or recharged and with the energy of each of them and the death of the node, the lifetime of the network decreases. Therefore, data routing strategies are required based on the optimum use of energy for energy conservation and survival of these networks. When the sensor nodes are dense in the environment, Information collected by adjacent nodes may be similar, causing data redundancy and redundancy. As a result, the energy that needs to be spent to transfer these redundant data to the central node will reduce node energies and reduce network lifetime. In order to solve these problems and optimize energy consumption in wireless sensor networks, data aggregation methods using mobile networks can be used. In data aggregation, we try to combine and compress the data in the same way in the middle nodes, and then the data packet is fed from the aggregation of data to the central node.

In this dissertation, we present a new method for data aggregation in a wireless cellular network using a mobile device based on clustering. Simulation and comparison results show that the proposed method has a good performance.

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