Research Article

An Agricultural Soil Environment Monitoring Using Wireless Multimedia Sensor Network

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Abstract: In the networking research community, Wireless Sensor Networks (WSN) has achieved considerable significance in the past years and it can be used in extensive variety of domains. In recent years, the tremendous growth of WSN does not meet all the necessities of environmental monitoring. Wireless Multimedia Sensor Network (WMSN) is required to fulfill the requirements of environment monitoring. In this paper, WMSN is used to monitor the agriculture soil environment. In order to ensure optimal use of the sensor nodes in WMSN and accurate access to the collected data,the routing protocols with both energy efficiency and quality of service (QoS) properties are necessary for the transmission of photo, video and scalar data.This paper proposes a priority aware energy efficient QoS based data transmission for agriculture soil environment and also detects the pest. It utilizes the available bandwidth and data rate in the best way and in order to be more energy efficient during data transmission.For performance analysis, the proposed system is simulated using Java and the results of the experiments suggest that the proposed algorithm is more efficient compared to other methods in terms of delay and energy consumption.

Keywords: Wireless multimedia sensor networks, Agriculture, Soil, Monitoring,

1. INTRODUCTION

The development of Wireless Multimedia Sensor Networks (WMSN), i.e. wireless interconnected computer networks capable of capturing video and audio streams, still images, and scalar sensor data, was facilitated by the availability of economical hardware capable of capturing multimedia content from the environment, such as CMOS cameras and microphones. In addition to improving existing sensor network applications such as tracking, home automation and environmental monitoring, wireless multimedia sensor networks will also allow several new apps, such as advanced healthcare, multimedia surveillance, traffic avoidance and industrial process management[2].

WMSN is an advanced wireless gadget network capable of continuously acquiring environmental video, audio transmission, photographic graphs, and sensor scalar data[3]. Akyildiz et al.[2] explored the evolution of multimedia WSNs and highlighted the key WMSN challenges. To develop WMSN, algorithms, protocols, and hardware were surveyed, and open tests for the above-mentioned problems were carried out. Hayat et al. [4] suggested classification of multichannel assignment protocols, including the identification of different channel selection policies, channel assignment types, and channel assignment methods. Environmental control is one of the uses of WMSN. Figure 1 demonstrates the control framework of the area [5].

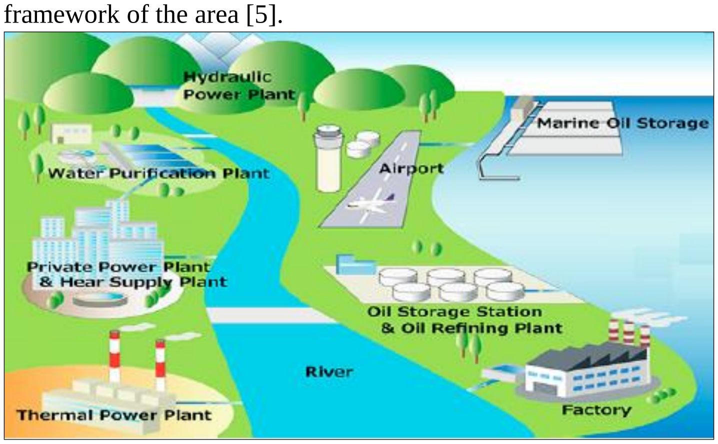

Figure 1Monitoring Environment

Environment monitoring is the processes of collecting one or more measurements which are used to determine an environment's status such as soil, water and plants etc. This paper considers the agriculture soil environment. By calculating various soil parameters such as soil moisture, soil temperature, ambient temperature and relative humidity, it makes it easier for growers to properly irrigate their fields. These are the key parameters in the field of precision farming that play a crucial role. In order to improve crop productivity, monitoring of these parameters is important through the management of irrigation and the application of fertilizers over time[6].

When monitoring these values at certain time intervals using WMSN, the following problems occur: packet loss, reduced bandwidth, data redundancy, and time delay that decrease the sensor nodes' energy consumption and lifespan. Effective data transmission is important to increase energy consumption, since WMSN has limited sensor node resources, such as energy , memory, etc.This work proposes efficient data transmission which uses various QoS parameter based data collection and priority based data transmission. The sensor nodes are randomly distributed all over the agriculture area. It collects different scalar data like soil moisture, temperature and leaf still images. The sink node provides the solution based on these collected values.

2. LITERATURE SURVEY

Mao et al.[8] present CitySee, an urban-area real-time CO2 monitoring system using sensor networks, structures the remainder of this article as follows. Large-scale wireless sensor networks comprising 1096 relay nodes and 100 sensor nodes are being used for simulation in “Wuxi & “China et al.[9]” analysed the huge resolved Ultrafine Particles (UFPs) data set in Zurich , Switzerland, for measurements of air quality. Those that threaten human health, “such as nitrogen dioxide (NO2) , carbon monoxide (CO), ozone (O3) and ultrafine particles (UFPs)”, are the target pollutants. Severe conditions such as respiratory illnesses, cardiovascular complications, etc. are responsible for these toxins.

Jiang et al.,[10] examine the realistic experience of introducing citizen recognition for urban environmental monitoring. A bottom-up model is defined and evaluated in which people create and use sensors for monitoring the environment. It focuses on a case study using NO2 sensors for air quality monitoring from the Amsterdam Smart Citizens Lab. The implementation of a distributed monitoring system in a commercial greenhouse using the WSN was presented in[11]. Initially, a WSN prototype was developed to analyse the effects of environmental factors on the efficiency of the network's operation and to evaluate its performance and the viability of its operation in a commercial greenhouse.

Liu[12] in the IoT greenhouse, developed an intelligent environmental monitoring system for precise grape cultivation. Sensors were designed to gain numerous types of data that were then combined and stored , processed and modified at the gateway in the background. Environmental variables were air temperature, air moisture, illumination, soil moisture, and CO2 concentration. In addition, videos and photographs were taken during the production of grapes.

3. Methodology

This section presents the proposed priority for energy-efficient wireless multimedia sensor network data transmission in the agricultural domain, based on QoS.

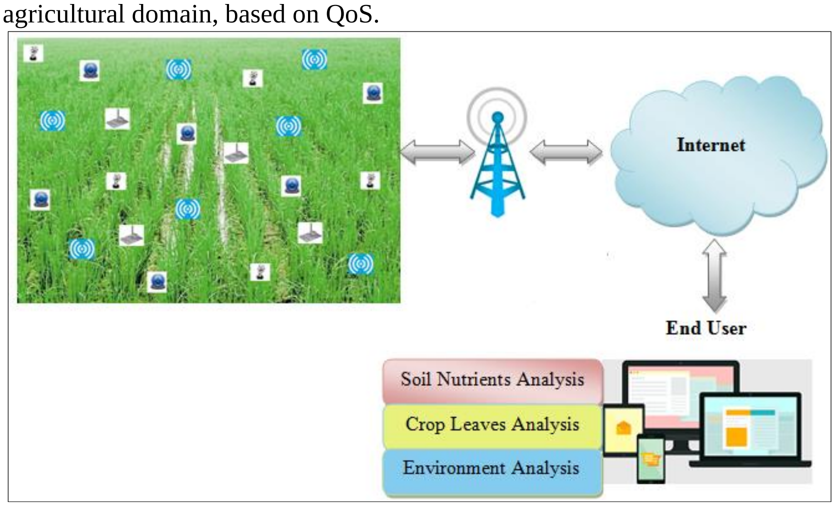

Figure 2 General Architecture

The general architecture of the work proposed is shown in Figure 2.The system model contains sensor nodes and gateway nodes deployed in agriculture area, Base Station, Internet Connection and End User Application.

3.1 System Entities

Sensor Nodes: Sensor node is responsible to collect the information about agricultural soil. There are three types of heterogeneous sensor nodes (video, audio and scalar) are used to collect the information. The senor nodes are arranged for sensing and broadcasting the agriculture soil information like, leave still images, recorded sound of animals, birds, soil temperature, moisture, air quality and nutrients. The configuration of the sensor node is shown in Figure 3. The information obtained is transmitted to the Gateway.

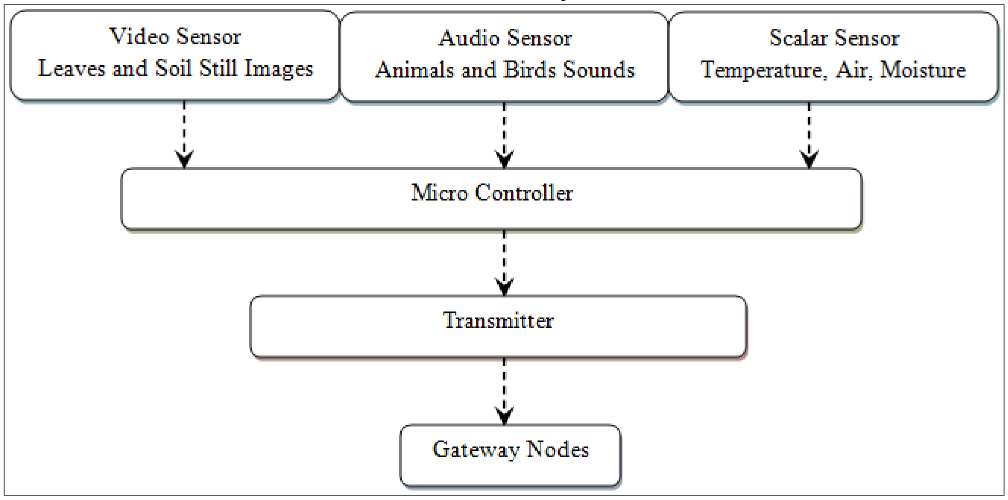

Figure 3 Structure of Sensor

Gateway Nodes: The gateway nodes are responsible for processing the sensed information from the sensor nodes and transmitting it to the Base Station. Gateway nodes maintain the priority queues shown in Figure 4.

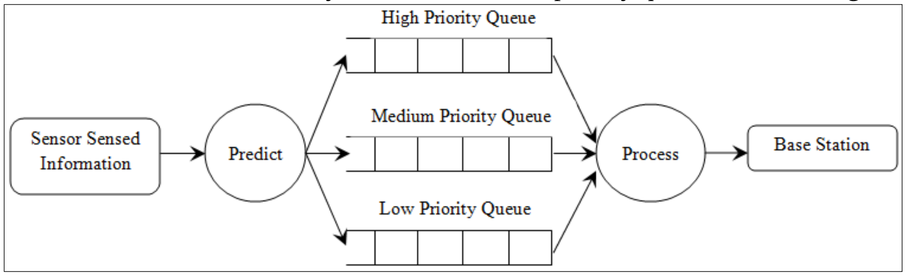

Figure 4 Priority Structure of Gateway Node

Base Station: The base station receives gateway information and transmits it via an internet link to the user. Base station collects the information about the agriculture soil and sends to user to take the corresponding action.

3.2 Sleep Wake- up Model

This section explains the sleep wakeup model of the proposed work. The network of sensing area is splits into number of regions. Each region contains certain number of sensor nodes. Randomly selects 50 % of nodes in each region and set a time slot for sleep and wakeup.

A Sensor in sleep mode, it cannot sense or transmit the information. A tiny amount of energy is consumed when the node is in sleep mode. A sensor can sense and transmit the information to gateway during wakeup mode. This mode consumes more energy compared to the sleep mode. Pseudo code for sleep wakeup model is explained in algorithm -1

Algorithm-1: Sleep Wakeup Model

Step1. Initialize Time Slot TS
Step2. Divide the Networks into n region R={r_1,r_2, r_3,.. r_n}
Step3. For each region in R
Step4. Select 50% of nodes S={s_1,s_2, s_3,.. s_m}
Step5. For each node in S
Step6. A = rand(0,1);
Step7. If A> = 0.5

Step8. Set 'Node as Wakeup Mode'
Step9. Set Time Value
Step10. Else
Step11. Set 'Node as Sleep Mode'
Step12. Set Time Value
Step13. End If
Step14. End For
Step15. End For

For each region in the network, randomly select 50% of nodes for sleep wakeup model. Generate the random between 0 and 1. If the value is greater than 0.5 then the current node is set as wakeup mode other it is in sleep model. The time value is set based on their current energy level.

$$SetTimeforwakeup = \begin{cases} 15min, & forhighenergy \\ 5min, & forlowenergy \end{cases}$$

$$SetTimeforsleep = \begin{cases} 5min, & forhighenergy \\ 15min, & forlowenergy \end{cases}$$

4.3 Data Transmission Model

This section explains the data transmission model of the proposed work. Pseudo code for sleep wakeup model is explained in algorithm-2.

Algorithm-2 Data Transmission Model

Sensor Node

Step1. For each node in SN
Step2. If sn_i is in Wakeup Mode
Step3. Sense Soil Information ($event_i$)
Step4. Generate Packets
Step5. Compute Distance between sn_i and all nearest gateways
Step6. Select minDis(sn_i,G_i)
Step7 Send Packets to minimum Distance Gateway
Step8. End If
Step9. End For

Gateway Node

Step10. For each node in GW
Step11. If gw_i receive packets from sensor
Step12. Check the type of the packet ($event_{pri}$)
Step13. Put into priority queue (High, Medium and Low)
Step14. Process the packets in priority order
Step15. Send to Base Station
Step16. End If
Step17. End For

Each sensor nodes maintain QoS value. Based on these values and the sensed information of particular sensor node, the gateway decided the priority of the packet.

The following QoS parameters are considered: Reliability, Energy and Delay. Table 2 shows the priority level.

Table 1 Priority Level of Data

Priority	Attribute
High	Data value is less than threshold
Medium	Still Images and Audio Data
Low	Normal Sensed Information

Table 3 shows the some of the soil parameters threshold value [15].

Table 2 Threshold Value for Soil Parameter

Soil Parameters	Threshold Value
Soil Moisture (%)	80%
Soil Temperature (°C)	42°C
Soil PH	65

Soil EC	25
Humidity (%)	50%
Light Intensity (Lux)	700 Lux
Carbon Monoxide (ppm)	50 ppm

4. Simulation Result

In this part, the exhibition investigation of the proposed work by means of the reproduction model is introduced. The simulation setup and the output metrics that are used are also explained in this section. It uses the Java framework to simulate the proposed job. EMRGA[7] and EEQA[22] have been compared to the proposed work. The parameters used in the simulation can be seen in Table 4.

Table 3 Simulation Parameter

Parameters	Value
Network Area	100m × 100m
Sensor Nodes	100
Gateway Node	25
Communication Range	50m
Sensor node init energy	5 J
Transmitter Power	12.3 mW

The simulation process is as follows: The Java platform is used to model the world. Build a WMSN with 100 node sensors. The initial co-ordinates of the sensor were generated at random using the Java function. The sensor nodes were then placed in the given space based on the randomly generated co-ordinates. Then, by establishing a bidirectional connexion between them, nodes were linked when their distance was less than or equal to the contact radius. Apply the suggested algorithms. The system runs in rounds and certain WMSN parameters, such as the time between the sensor nodes and the energy consumption of the packet being sent, have been calculated.

The efficiency metrics used are delay and energy consumption. The delay is the amount of time it takes for sensed data to be transmitted from the sensor node to the sink node. In milliseconds, it's described. By applying various algorithms, Figure 6 shows the delay of sensor nodes. Compared to other algorithms , the proposed work involves a minimumwait

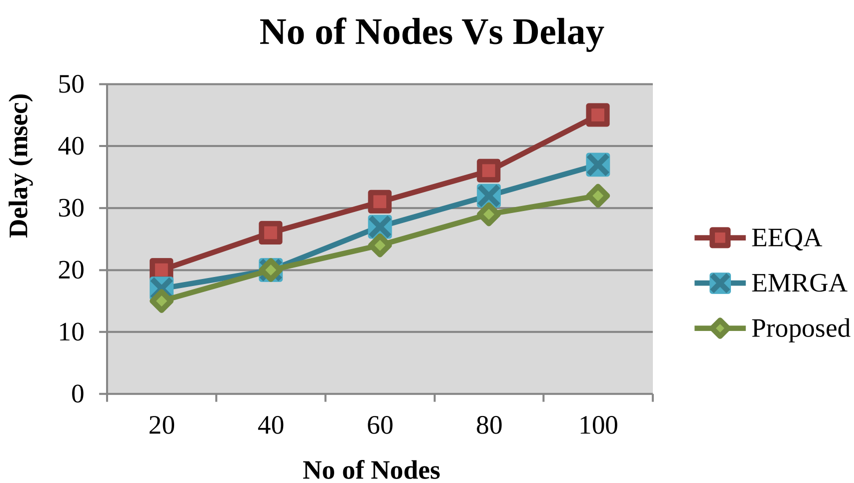

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Figure 5 Time Delay

Energy consumption is the accumulated energy that is needed to transfer the data to the sink node from the sensor nodes. In Figure 6, the energy consumption of sensor nodes is presented. The simulation outcome showed that the proposed algorithm used less energy to transmit data. The efficiency was much higher than the other algorithms as a consequence.

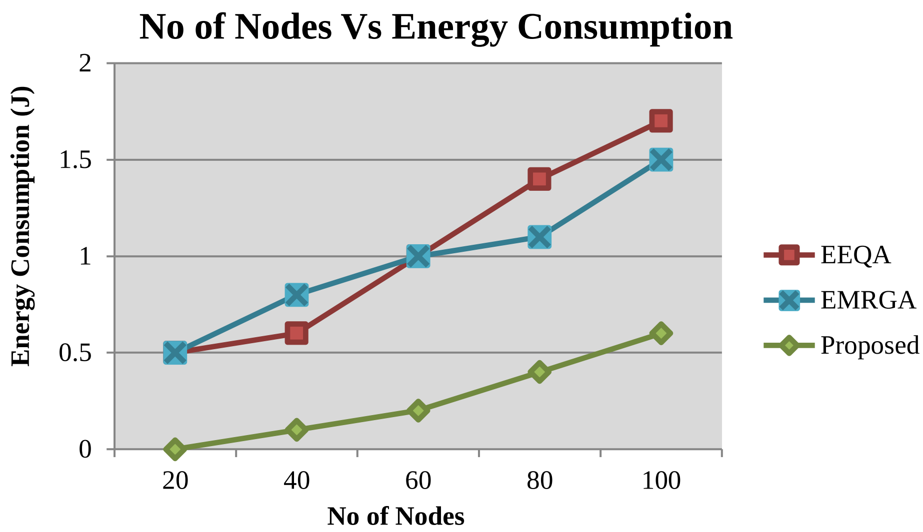

Figure 6 Energy Consumption

Figure 7 shows the time delay for different types of priority. The delay is increased when the distance between gateway nodes and base station is increased. These results indicate that the value of the data can be determined effectively by the data transmission algorithm so that the data of the high priority event can be transmitted through shorter and more stable data than the other forms.

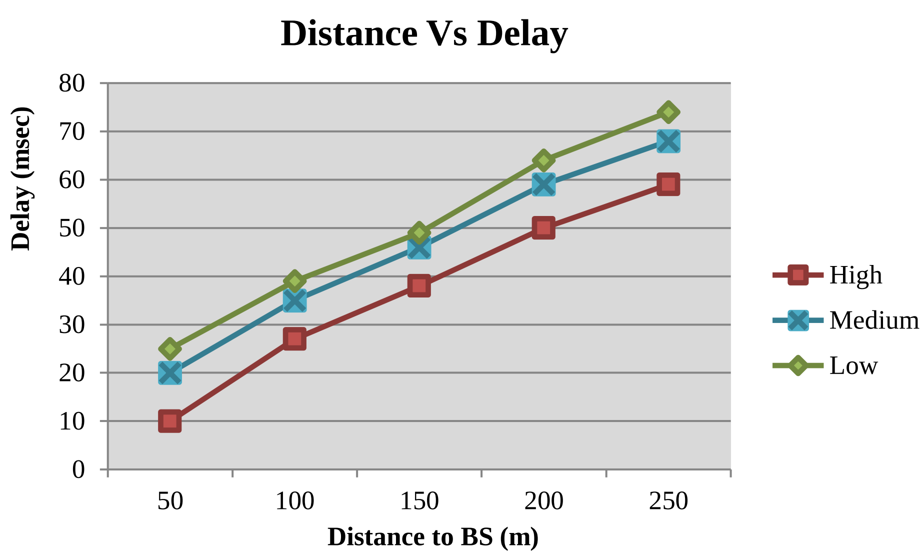

Figure 7 Delay for different Priority

The packet distribution ratio of sensor nodes with different priority queues can be seen in Figure 8. There are distinct delivery ratios between the various types of sensed data. There is the highest delivery ratio of the high priority event results. The explanation for this is that better gateway nodes are chosen to deliver the packet in a fast and reliable way.

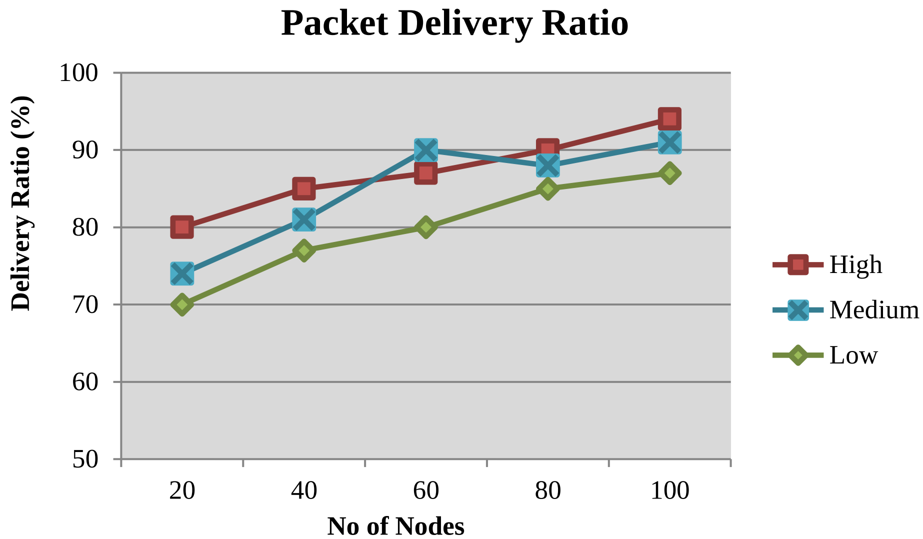

Figure 8 Packet Delivery Ratio

6. Conclusion

Wireless multimedia sensor network is used in many different fields. In this paper, agriculture soil monitoring using WMSN. This method considers the priority aware QoS based energy efficient data transmission for WMSN. Compared to the other current systems, this approach decreases the energy usage of the network.Agriculture soil information is used for predict the soil nutrients, leaves disease analysis and monitor the agriculture environments. The end user can use this valid information to take the further decision.

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