Data Aggregation Methodology For Precision Agriculture

Venkateshwar A
Department of Computer Science and Engineering, Ballari Institute of Technology And Management, Bellary, Karnataka, India.

Venkanagouda C Patil
Department of Electronic and Communication Engineering Ballari Institute of Technology And Management, Bellary, Karnataka, India.

Anand Mundewadi
Department of Computer Science and Engineering, Ballari Institute of Technology and Management, Bellary, Karnataka, India.

ABSTRACT
The Wireless Sensor Network is characterized by rapid information collection, information transmission with reliability and intelligent information processing. It is applied to monitor the large-scale agriculture production, and then the system will be more unified and yields more. It is effective to promote the productivity with efficient data aggregation, data reconstruction and reduce the overall data transmission and improve network lifetime. The proposed system analyzes the features and functions of wireless sensor network data aggregation and accurate reconstruction of data, based on Matching Pursuit Algorithm for repeat iterative approximation, reconstruction of data and Beam Forming Algorithm for signal processing technique used to control the directionality of the reception or transmission of data.

Keywords
Matching pursuit, Beam forming, Data Aggregation, Precision Agriculture

1. INTRODUCTION
Precision agriculture is an important form of modern agriculture production. It developed on the basis of a series of latest high-tech achievements, such as modern information technology, biotechnology and engineering technology. In this paper, the WSN network technology is applied into precision agriculture [1]. The agriculture area is controlled and monitored effectively by the use of wireless sensor technology. Fertility and other soil conditions are easily analyzed with the sensed data from each and every sensor nodes. The communication between these sensor nodes are accomplished by the wireless links i.e. links which connects sensor nodes to cluster head node are with comparatively smaller capacity and the links with connects cluster head node to sink node are with higher capacity. The system is shown in Figure 1 WSN as three-tier design.

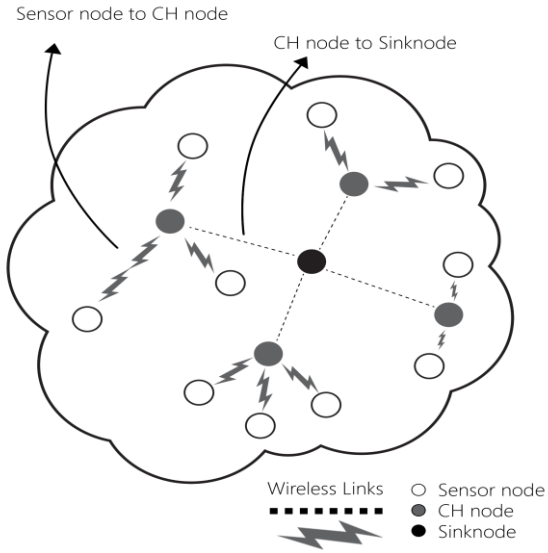

Figure 1: WSN with three - tier design

System can take the measures such as precision irrigation [2], ventilation and sun shading by the surveillance of the temperature, humidity and light intensity and the requirements for the humiture that varies with the crops. This paper focuses on the study of the information aggregation and transmission to achieve large-scale data collection. This paper analyzes the features and functions of wireless sensor network data aggregation, an aggregation algorithm based on matching pursuit and beam forming [4] are used together to get better results. The data collected by wireless sensor will be spared and the data aggregation transfer realizes. The data redundancy is decreased, improves accuracy in data reconstruction and the life of network extends.

2. OBJECTIVES OF THE PROBLEM
- To achieve an accurate data aggregation in Precision agriculture.
- To ensure reliable end to end data transmission.
- To reduces the network energy consumption to improve the network life.
- To achieve accurate data aggregation and reconstruction with minimal error.
- To reduce the amount of network data transmission.

3. SCOPE OF THE PROBLEM

The purpose of design and developing a prototype of irrigation control system using the data aggregation methodology to achieve effective and efficient crops growth monitoring. Data aggregation and reconstruction is achieved using Matching Pursuit and Beam Forming algorithm [6] [9].

4. PROBLEM FORMULAE

To promote a data aggregation methodology for irrigation control system in precision agriculture. The proposed system consists of sensor nodes, cluster head node and sink node. The sensor nodes collect environmental factors like temperature, humidity, soil moisture in desired direction using beam forming algorithm. Sensor nodes send sensed data to cluster head node, at cluster head redundancy is removed from aggregated data using matching pursuit algorithm. Cluster head sends aggregated data to sink node, at sink node the data is processed and analyzed after data reconstruction.

Existing system and its limitations: The system works based on Window Fourier Transform and Wavelet transform techniques. The system is incapable of efficient data aggregation and after aggregation the reconstruction introduces error.

Limitation: Unreliable data transmission as nodes needs to transfer longer distance. More amount of network energy consumption for data transmission. The data reconstruction accuracy is low because of higher rate of error intrusion.

Proposed system: The proposed system is merger of Matching pursuit and Beam forming algorithm. The coefficients are generated for each nodes based on the sensed data at cluster head node, coefficients are transmitted to the Sink node instead of data itself which improves the transmission efficiency and reduces the amount of data to be transmitted [5]. And based on coefficients the data reconstruction is achieved at Sink node and decision making is done after data reconstruction and efficiency is measured.

5. DATA AGGREGATION METHODOLOGY

The WSN undertakes the data acquisition in monitoring area. The sensor nodes not only collect and process the local information, but also transmit the data from other nodes to complete the monitoring together. And the collected data are sent to base station nodes through the node routing data according to the upload period. This system in which Figure 5.1 shows data aggregation methodology with three tier design, Figure 5.2 shows block diagram of the system and Figure 5.3 shows system architecture.

The three – tier Wireless sensor network consists of group of Sensor nodes, group of Cluster heads and Sink or Base station. Communication and data transmission between nodes takes place with the wireless links between them. The system works in three levels, First at Sensor node for sensing the physical factors and transmits the data to Cluster Head. Second, at Cluster head data aggregation achieved based on all the sensor nodes. Third, at Sink the reconstruction of sensed data is accomplished for each sensor nodes. And finally decision making, performance analyses is made for

the prototype system [8].

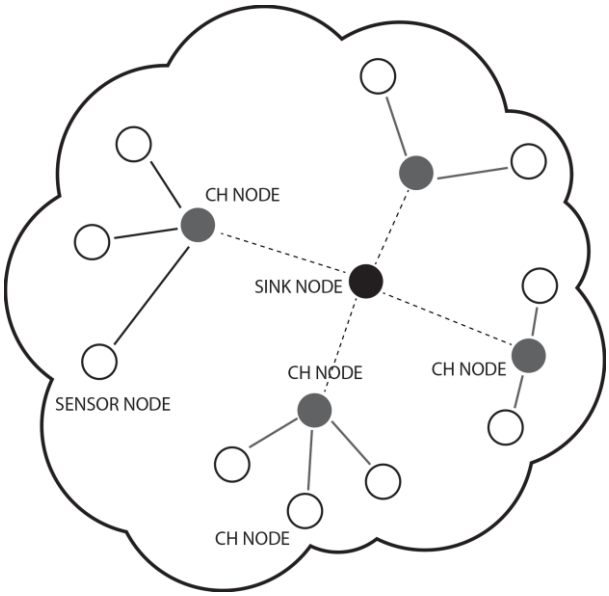

Figure 5.1: Data aggregation system with three - tier design

The system block diagram includes three modules, Sensor node, Cluster head, and Sink node, which describes each modules functions in details.

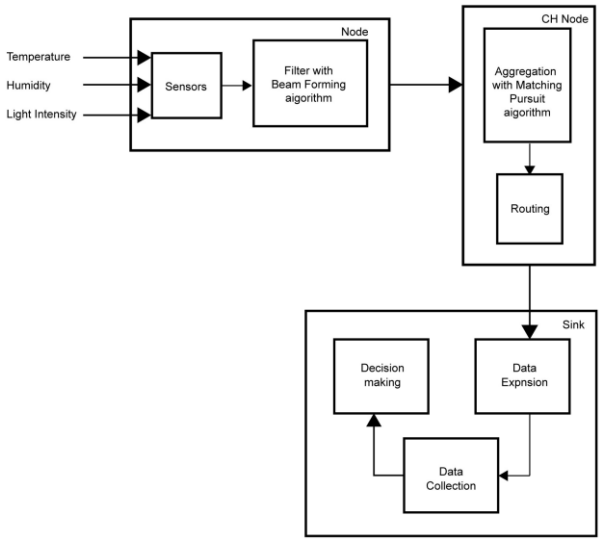

Figure 5.2: System block diagram

The prototype systems whole process of data aggregation is encompassed with the functions and such facilities are listed out in the below section.

The System provides the following facilities: (i) Sense data at sensor node (ii) Filter data using beam forming (iii) Data aggregation at Cluster head using Matching pursuit (iv) Reconstruction of data at Sink (v) Decision making after reconstruction [13].

The System block diagram explains clearly the functionalities of each modules with the specification of each modules, node module senses the factors of the irrigation area and sends to the cluster head, CH node does the aggregation of sensed data based on Matching pursuit algorithm and then sends to sink node, which is the base station were the decision making accomplished.

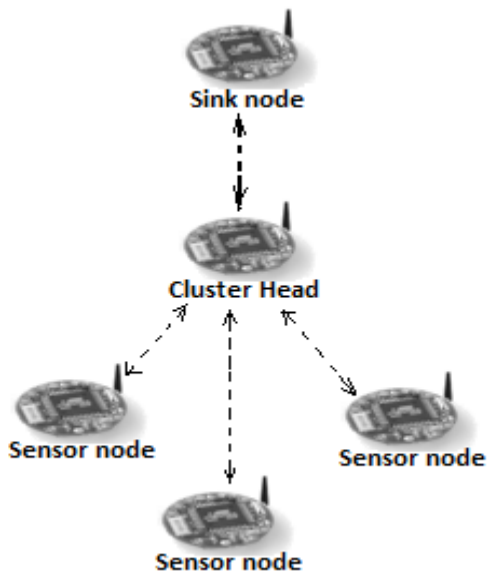

Figure 5.3: System Architecture

Following steps are followed at sensor, cluster head and sink nodes:

At Sensor node

(i). Sensor node initiates and senses environmental factors that include temperature, humidity, soil moisture and which affect the crops growth.

(ii). Filters the sensed data in desired direction by using Beam Forming algorithm.

(iii). Sensed data is transmitted to respective cluster head node.

At Cluster Head node

(i). Cluster head collects the sensed data from all nodes in the desired direction.

(ii). Since the sensed data is accumulated at cluster head the duplicated signals are eliminated through aggregation.

(iii). Data aggregation and reconstruction accuracy of sensed data is achieved using Matching Pursuit algorithm.

At Sink node

(i). Sink node is the destination node and aggregates data from all cluster heads.

(ii). Sink node consists of three sub components

Data Expansion: The collected or aggregated data is decomposed and analyzed by based on each and individual node and then provides to Data collection unit.

Data Collection: The data collection collects data separately for each and individual nodes and then provides to Decision making unit.

Decision making: The aggregated data is used for decision making and the results are used to accomplish, Space complexity, Time complexity and Performance of the system.

6. PSEUDO CODE OF ALGORITHM

6.1 Matching Pursuit Algorithm

The algorithm iteratively generates approximated signal for any given signal ***f*(t)**, the residual after calculating g_n and a_n is an atom denoted as R_{n+1} [6] .

Input: Signal ***f*(t)**

Output: List of coefficients – **(**a_n , g_n **)** where

a_n – atom and g_n – residual

Initiation:

Step1: ***f(t)*** $\rightarrow R_1$;

Step2: **1 → n;**

Step3: Repeat

Find g_n which is belongs to ***f(t)***

With maximum product of (R_n, g_n)

Step4: $(R_n, g_n) \rightarrow a_n$;

Step5: $[R_n - (a_n, g_n)] \rightarrow R_{n+1}$;

Step6: **(n+1) →n;**

Until stop condition $R_n <$ threshold

The algorithm takes the data generated from sensors over a period of time as the input and from this finds the best approximation of values by iterating over all values in terms of least squares and gives the best approximation of the signal.

6.2 Beam Forming Algorithm

The Beam Forming algorithm [10] is used to filter the sensing data in desired directions and is accomplished at the sensor node. The sensing angle is set at the sensor node and the same angle of reception is also set at the every cluster head and when these two angles are same then the transmission and receiving of sensed data accomplished.

Input:

Cluster head node location (pos1_x,pos1_y),

Node location (pos2_x, pos2_y)

Output:

The angle in which nodes should send data to Cluster Head node

Steps are:

Step 1: **deltaY = pos2_y - pos1_y**

deltaX = pos2_x - pos1_x

Step 2: **angleOfSensorToSend –** angle of sensor node

Step 3:

angleInDegrees = arctan (deltaY /deltaX) * 180 / PI

Step 4: angleInDegrees – Desired directional angle of sending data

Step 5:

if (angleOfSensorToSend == angleInDegrees) then

Send sensed data to cluster node – CHNode

else

Drop data to be sent to cluster head, Reject the sensed data

7. SIMULATION RESULTS

7.1 Packet Delivery Ration

Table 7.1: Packet delivery ratio

NUMBER OF NODES	USING MP & BFA	USING MP
25	0.8174	0.6619
30	0.7726	0.6605
35	0.8177	0.6541
45	0.8293	0.6634
60	0.7959	0.6367

From the Table 7.1 and below Figure 7.1 graph shows using MP and BFA prototype system provides better data packet delivery ratio comparisons.

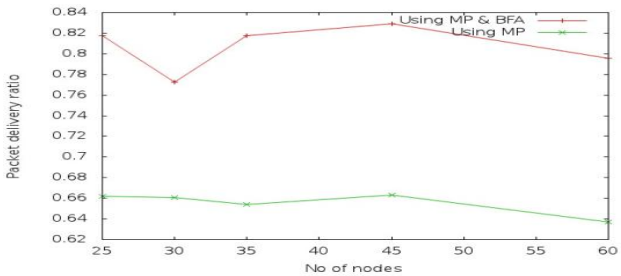

Figure 7.1: Packet delivery ratio

7.2 Reconstruction Error

Table 7.2: Reconstruction error

USING MP & BFA	USING MP
0.0667	0.07178
0.0655	0.07057
0.0655	0.07057
0.0663	0.07133
0.0678	0.07282
0.0672	0.07223
0.0670	0.07208
0.0678	0.07282
0.0668	0.06980
0.0677	0.07370
0.0662	0.07026

From the Table 7.2 shows using MP and BFA prototype system provide improved and accuracy in data reconstruction with minimum errors. The data reconstruction objective can be achieved and error values at different time shows the reconstruction quality.

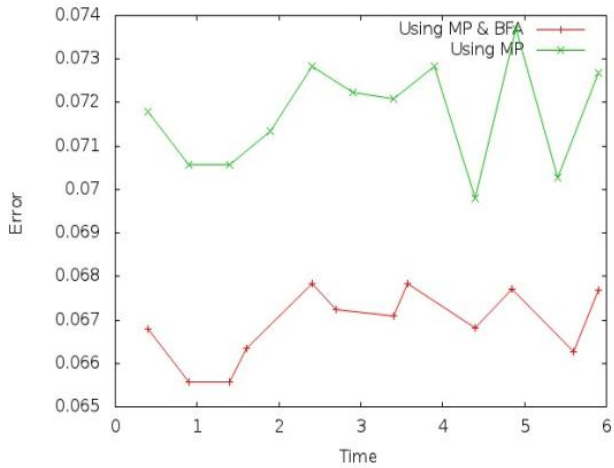

Figure 7.2: Reconstruction error

8. CONCLUSION

The proposed system primarily focuses on the precision agriculture. To meet the actual demand of precision agriculture, the environmental monitoring system based on wireless sensor networks is designed. And according to the characteristics and function of data aggregation in wireless sensor networks, matching pursuit algorithm, beam forming algorithm are merged to get the better aggregation and reconstruction quality. The data redundancy is reduced, improves accuracy in data reconstruction, reduces the amount of network data transmission and the life of network extends.

9. FUTURE WORNK

As a future work, there is a scope in improvement of the reconstruction quality, even more data aggregation efficiency and also concentrations needs to be made on the network energy consumption so that it can improve the network life time.

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