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Efficient Energy Conservation using ARM Algorithm in Wireless Sensor Networks

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Abstract*: *The Wireless Sensor Network (WSN) is that technology that provides ideal solutions that are cost-effective and used for a varied range of the applications that are used from environment to military operations, from healthcare to agriculture and so on. In the agricultural environment and its monitoring, the WSN will play a critical role owing to the cost effective and the comfortable WSN deployment. India is that country in which there are sufficient resources available naturally and these are based on the agriculture that contributes to the socioeconomic status and the economy. The very powerful tool which generates the vast as well as the diverse data that includes all the agricultural datasets is called Association Rule Mining (ARM). A very interesting topic in data mining in recent times is the association rules and their ranking. The work will deal with the network of agricultural sensors that measures the moisture of soil, the humidity, temperature and the ARM that is based on its ranking.

Index Terms*: *Agricultural Environment Monitoring, Association Rule Mining (ARM), Data Mining and Ranking of Association Rules, Wireless Sensor Network (WSN).

I. INTRODUCTION

The WSN has been made of several sensor nodes that have capabilities of radio communication [1]. The WSN node has sensors, Analog to Digital convertor (ADC), micro controllers, DC-to-DC power convertors, radio frequency electronics and a small source of power. Either one or more of the sensors that are supported using sensors with various parameters that are related to several physical phenomena converted into the electrical signals that are digitized and data duly forwarded to the Base Station (BS).

In agriculture there are a wide range of such sensors that are found to be useful and the data will be accumulated being the introduction of the WSN using the data that is accumulated through the WSN that is processed for production of such effective results. There are some alerts that are set in case there is a need for indicating the variable measured in the threshold along with an alerts that may be sent as either messages or emails. This field's productivity for this field that has been increased using the introduction of such types of technology and their inputs will be needed for agriculture that is brought down.

The Monitoring as well as the controlling of multiple parameters in the field of agriculture is given by means of the WSN technology and its development and the Wireless Radio Frequency (RF) with the sensor convergence through the internet has enabled the increase in the applications in the agriculture and its sensor systems. A Precision agriculture has been well suited with the emerging wireless and their technologies using the low power seeds as well as capabilities of low rate of data. A well suited technology in that of the WSN that will be able to monitor the environment in agriculture. The WSNs make use of this based on the ones that are used in the remaining industries as well as industrial controls, their automation, and their security systems [2].

Some basic nutrients that are needed for the plants to grow will be based on the conditions of the environment where the plan grows that include the soil, the temperature, light, moisture, humidity and finally CO2. The productivity and the quality of the growth of plants will be directly affected because of the factors of the climate and they are interrelated with no effect on each other. Any farmer will have to be aware of the problems that may occur and also have a proper understanding of such factors with their correlation for the wellbeing of such plans with proper measures that are taken in their prevention.

The plat development process like the absorption, the transpiration, photosynthesis and the flowering that is influenced by its temperature. The temperature range for every such plant will be influenced by its temperature and if this is changed it can render the enzymes inactive. Therefore, it is very critical to maintain an optimal level of temperature.

The loss of moisture from the plants is influenced by the humidity and using many such tiny pores in leaves the CO2's entry and the oxygen's exit will happen. The plants and their development are affected using high humidity as the fungal diseases spread along with that of the air and its saturation that takes place with the water vapor with the transpiration that has been restricted.

Another critical energy source for the plants is the light. Humans and animals derive their energy from food but the plants get it from sunlight by means of photosynthesis. When there is no light energy is not produced by the plants. The organs of plants and their growth will take place only with light and the experiments that are conducted based on the growth of the plants using normal light as well as complete darkness has proven this [3].

One more critical factor is the moisture of the soil that ensures the right amount of water reaches the plants by means of irrigation. With the root system, the water will be taken and will be lost because of transpiration. The condition of the soil, the air-flow, the humidity in air and the environmental temperature will determine the water loss and its rate.

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The farmers need to have the knowledge to know the actual effects of the moist soil and the content of oxygen of this root will substrate that is decreased in case the flooding takes place. The root ultimately gets damaged and cannot extract water or nutrients form soil. Therefore, a sufficient amount of water is supplied to them and this process is known as 'precise irrigation.' There are several demerits of this biotype system of monitoring for the large-scale system of biotype monitoring and as the growth of this cycle of the crop will be long and will also cover a very wide area including impedance of fields, maintenance difficulties, increased consumption of energy, consumption inequality, decrease in the service time and certain other issues. Another very effective data mining technique is the ARM [4] that will be able to search the desired and the unseen patterns in large data. The technique's focal point will be to identify the correlation among different items in that of a database which will be transactional. These elements have been discovered using the ARM that will be able to correlated continuously, inside a dataset containing several non-dependent element selection that includes the transaction purchasing and for the discovery of rules. At the time of choosing the top ones among them, there are a large volume of such rules that are created and so it is quite critical to rank the rules from their biological data that is one more important research area. In agriculture, a rank-based association of the rule mining has been proposed. A study of certain relevant literature has been discussed in the section 2. Methodology and techniques are discussed in Section 3 with section 4 explaining the results in detail. Finally, Section 5 gives the conclusion.

II. RELATED WORK

In order to handle the dilatation method in case of agriculture an improvement to the DV-Hop Algorithm for locating the range positioning method was proposed by Yu[5]. The analog test is run and is also developed for the location of average errors the anchor nodes and their connectivity. On the basis of such results of such analogs, a proper effect has been obtained on the error of average locating that can enhance the accuracy.

The WSN has been presented as an ideal way for solving the problems in agriculture by Kassim et al [6]. There is real time information that has been provided through this approach on the lands and the crops that can help the farmers in taking the right decisions and the basic principles in the internet where the technology of WSN has been used the network architecture and the hardware along with the process control of the software for the irrigation system that is based on that of the Internet Of Things (IOT) has been explained. The using of such water fertilizers have been optimized through the implementation of the WSN and the yield of such crops get maximized.

Even though the focus is on industrialization, the agricultural sector is still the economy's backbone based on the Gross Domestic Product (the GDP) which is a major source of employment to many millions of people. In the process of agricultural decisions, the characteristic of soil and the weather will play a very important role. Many such techniques in data mining have been assessed by Geeta [4] using the application for evaluation of various techniques of data mining using a database of social science for establishing a proper correlation that is created. Using the Soil Science India, a large dataset of the database will be collected and the paper has provided the techniques of database that is used in case of agriculture that includes the Apriori.

A technique of weighted rule-mining (which can be RANWAR or the rank-based rule-mining of weighted association) has been presented by Mallik et al., [7] where the rules will be ranked with two novel measures of rule interestingness which are the rank-based Weighted Condensed Support (the WCS) and the Weighted Condensed Confidence (the WCC) based measures for bypassing this problem. The rank of such items or the genes will be the measures and their basic measures. The weight has been assigned for every one of them that make use of the ranks. When compared to that of the latest algorithms of rule mining, the RANWAR will generate lower number of item sets and in the time of such execution of the algorithm which is saved. On the basis of the expression of genes and the methylation datasets, the RANWAR will be run using the Gene Ontologies (GO) and their genes in the top rules have been biologically validated and their analysis has been made using the KEGG pathway. In relation to the diseases there are some signification relationships among the rules that are top ranked which have been extracted from the RANAR that will hold such poor ranking in the conventional Apriori. The top rules will ultimately be evolved from the RANWAR that are reported as not being are Apriori.

The two innovative measures of rule-interestingness have been used with the Rank Based Weighted Association Rule Mining (RANWAR) for the purpose of ranking such rules. They get ranked on the basis of the condensed support that is weighted and the confidence measures that are weight condensed for overcoming such issues. The Rank of the genes will be the bases for such measures and will generate lesser items sets when compared to the other state-of-the-art mining techniques. But on the basis of such techniques, it can take a long time to generate such item sets. A Temporal Apriori algorithm had been proposed for ranking such items using the weighted support that is condensed and the measures are also based on that of the weight condensed confidence. On the basis of such rank values for each item set such weight values will be calculated. Lastly, it had been concluded that such a proposed scenario will yield a performance that is superior as opposed to the scenario which will exist by the Temporary Apriori algorithm [8].

III. METHODOLOGY

In this a well detailed discussion on that of the association rule mining in the WSN and the weighted association rule mining that is rank based.

A. Association Rule Mining (ARM)

A prime technique in data mining are the association rules. The frequent patterns, the correlations, the associations, or the structures that are informal that have been detected in the items or the objects for the transactional databases.

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There has been a dramatic increase in the volume owing to the data that is generated with daily activities. Therefore, using any increase in volumes owing to the data that has been generated. Using the mining rules there has been a huge data volume in this data base with many such industries that help in decision making. The relations have been identified among items using techniques to discover the rules of association from data. Therefore, a specific pattern that is local and is determined using association rules that may be interpreted easily and also communicated [9]. The discovery of the association rule mining from that of the databases in agriculture including data relating to soil, geographical conditions and soil. The decisions relating to the crops, the environment, the resources are derived through rule mining [10].

The Support and the confidence have been the basic measures in association and if there are two items the support will be of the ratio of such occurrence of the items that is of a minimum support. The confidence will be the possibility of checking the consequence of the rule under such transactional conditions. A Minimum confidence will be the one in which the rules give some more confidence to the consequence that is user-defined.

A rule of Association will be an implication of P=>Q, in which P ∩ Q = Φ and the P and Q will be the subsets of all the item sets I which are the Support (σ) and the Confidence (T). Both reflect the rules and their certainty and the rule P=>Q (the support σ = 10%, the confidence T = 80%) has shown that about 10% of all of these transactions that have been under the analysis has proved the simultaneous purchases of the items P and also Q by the customers with about 80% of the confidence shows who had bought the item P and item Q [3]. The Association rules will relate to the objects and the manner in which they group together. The Association rules are grouped in many ways handled as rule (the Boolean association rule or the Quantitative association rule), that has been based on that of the dimensions of all the data involved (the Single dimension or the Multidimensional) and have been on the basis of the abstractions that are involved (the Single level association rules or the Multilevel association rules).

For the mining of algorithms two phases of association rules have been proposed.

I. The frequent item sets will be the ones that have the support and the confidence of the minimum support (σ) and also the minimum confidence (T).

II. The desired rules of association have been found using frequent items to ensure parameters satisfy the minimum support (σ) with minimum confidence (T).

Relating to the mining association rules the Apriori algorithm has been an important accomplishment and the method is based on the property that a subset of a large item set has to be large as well. Also, the assumption that any item set inside an item set will be in a lexicographic order.

B. Association Rule Mining (ARM) in WSN

These candidate item sets have been generated by the Apriori connecting the large ones of the previous pass and subsets that are small considering the large item sets in the earlier pass where there is a reduction in the large item sets. The Sensing, its processing and its transmitting is made through developing the sensor nodes and the WSN design permits a novel trend in the technology of the sensors and the events that have been detected will be sent to any node which has been developed known as the sink in the Multihop fashion. There is a relay that is periodic to predicate being met and having an appropriate amount of proof to the success of the WSANs for several applications that need intricate monitoring for the physical environments that are subjected to the critical conditions.

From all the sensed data values the rules get carried out to that of a sink node and the data get collected form such sensor nodes. The weighted rule mining for this data has been extracted in this way and the weighted support and the confidence values have been calculated with the reduction of data transfer traffic and also the data scan with the process of rule mining. In the production process these weight values will be assigned relating to the factors of quality.

The very basis of the problem and its definition for the rules of the association having the proposition of these transactional databases and their domain. There is an even that is detected by such sensors and it is not its value in case there is a sensor that is interested. If $S = \{s_1; s_2; \ldots; s_m\}$ is a set of such sensors in a given sensor network. The actual time has been divided into some equalized slots $\{t_1, t_2 \ldots t_n\}$ so that $t_{i+1} - t_i = \lambda$ for all 1 < i < n, in which λ denotes the actual size of every time slot, and here the T_his= tn - t1 will represent its historical period for that of its behavioral data that has been defined at the time of the process of data extraction. Here, P= (s1, s2 . . . sk} C S as the pattern of such sensors.

In case the frequency of the targeted application and its confidence will be higher or equal to its specific minimum support (the min sup) and the minimum confidence (the min con) of percentage, and there will be an interest to the now targeted application. It will have to be further noted that the support as well as the frequency will be interchangeable and the minimal epochs of frequency need to be satisfied especially if it has been represented with a min sup. With a specific size of time slot and period this data base has the issue of mining the sensors and their association rules for promoting the interest rules to those present. There are two steps in this which are: 1. The generation of a Frequent pattern which is the one that has a frequency ≥ min sup; 2. The Generation of the rules which satisfy their min con and their restriction. These rules relating to the association of the sensors have to be straight forward.

There are two modalities that have been presented using the mining system at the time of extraction of behavioral data needed to mining sensor applications and the direct reporting will be the first technique in the data transfer for sinking with no sensor nodes in reporting. The next is the overall resources that are limited in which every one of them is optimized to the messages that are sent and the architecture of the network and methodology is all described:

C.Rank-based Weighted Association Rule-Mining (RANWAR)

Another measure that is updated for the RANWAR is the Apriori (the WCS and the WCC). The performance of the RANWAR has been compared with the current techniques and in different minimum support values the item sets that are frequent are compared among the RANWAR.

The relevant and the useful results will be the ranking of rules for the datasets. For accomplishing this the support and the confidence have been introduced. The issue here is the development of the increased number of the items that lead to an increase in the computation time. For overcoming such an issue will be to introduce in the module that is ranked as well as the weighted rule mining for the gene dataset that has been named. This is else called the rank-based association rules that are weighted.

of genes by Limma), flag of sorting the evolved rules sortFlag (w.r.t. either wcs or wcc), minimum support threshold min wsupp, minimum confidence threshold min wconf.

Output: Set of rules Rules, support RuleSupp, confidence RuleConf.

1: **procedure** RANWAR

2: Normalize the data-matrix D using zero-mean normalization.

3: Calculate rank of genes (i.e., rank k(:)) according to original gene list A1.

4: Assign weights wt(:) to all genes according to their ranks rank k(:).

5: Transpose the normalized data-matrix.

6: Choose initial seed values for using k-means clustering.

7: Discretize the transposed matrix applying standard k-means clustering sample-wise.

8: Apply post-discretization technique.

9: Initialize k = 1.

10: Find frequent 1-itemsets, Flk = {i | i ∈ A1 ∧ wcs(i) ≥ min wsupp}.

11: **repeat**

12: k=k+1.

13: Generate candidate itemsets, Clk from Flk−1 itemsets.

14: **for** each candidate itemset, c ∈ Clk **do**

15: Calculate wcs(c) for each candidate itemset, c.

16: **if** wcs(c) >= min wsupp **then**

IV. RESULTS AND DISCUSSION

By utilizing the network of agricultural sensor, the data simulation has been conducted using experiments and one dataset of about 50000 readings had been collected from the sensors and the performance has been evaluated using investigations relating to the messages their execution time and usage of memory. These cumulative sensors that are used are 150 and the time that is consumed is only one minute. The number of messages, the time of execution and the usage of memory for the value of varying support are shown in tables and Fig 1 to 3.

Table 1 Number of messages ranked for varying support value

support value	Number of message
0	23142
0.1	21423
0.2	18652
0.3	12879
0.4	11678
0.5	9854
0.6	8924
0.7	6532
0.8	3321
0.9	1896

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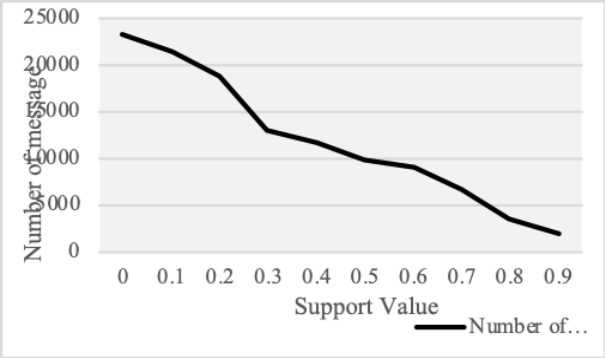

Fig 1 Number of messages for varying support value

Table 1 and Fig 1 shows the number of messages required to report the sensors behaviour for different support value. Support values have been expressed as percentages of the number of epochs present in the databases for the simulator and the real data. The number of messages obtained using direct reporting is given at zero support value. It is observed that the number of messages reduce with increase in support value.

An Intel I3 2.2 GHz processor with 2 GB RAM was used to measure the execution time and memory usage.

Table 2 Execution time for varying support values

Support value	Execution time in second
0.1	16.1
0.2	12.2
0.3	11.1
0.4	9.6
0.5	7.4
0.6	6.4
0.7	4.8
0.8	3.7
0.9	2.1

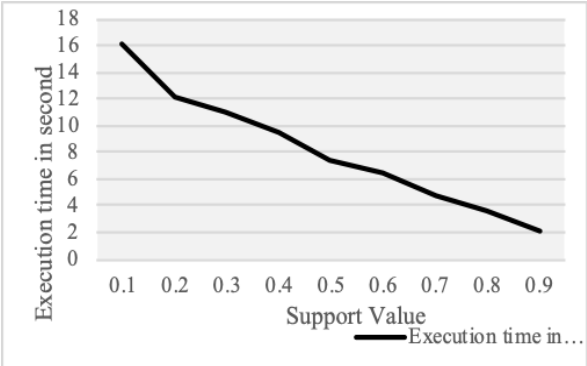

Fig 2 Execution time for varying support value

Table 2 and Fig 2 shows the execution time for varying support values required to report the sensors behaviour for different support value. Support values have been expressed as percentages of the number of epochs present in the databases for the simulator and the real data. Results show that when support value increases the execution time is reduced.

Table 3 Memory usage for varying support values

Support value	Memory usage (Mb)
0.1	365
0.2	320
0.3	310
0.4	260
0.5	210
0.6	160
0.7	140
0.8	90
0.9	80

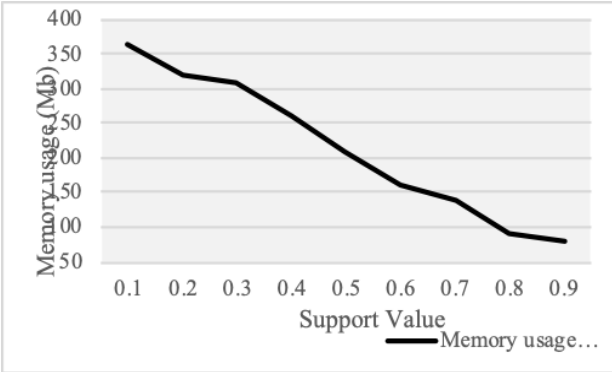

Fig 3 Memory usage for varying support value

Table 3 and Fig 3 shows the memory usage for varying support values required to report the sensors behaviour for different support value. Support values have been expressed as percentages of the number of epochs present in the databases for the simulator and the real data. Results show that when support value increases the memory usage is reduced.

V. CONCLUSION

A technology that is modern integrating the sensor knowledge, the automation control, the transmission of digital network for integrating the sensor knowledge, the control of automation, the transmission of digital network, the storage of information and the processing in the WSN. Recently the quality and the efficiency has been improved using the tools and the effect the environment has on the crops will come down. One important technique of data mining will be the ARM that has been used for the detection of the relationships among items. The estimation of actual number of messages are studied relating to the time of execution and the usage of memory. For the metrics of performance, its initial value of the support vector will be the best and at the time there is an increase in the support value the metrics of performance like the messages, the time of execution and the usage of memory has been brought down to a great extent.

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