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CONSTRUCTION OF WIRELESS SENSOR NETWORK MANAGEMENT SYSTEM BASED ON FUZZY CLUSTER ANALYSIS

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ABSTRACT

Wireless sensor network is used to sense the objective physical world, access to the information of the physical world. Fuzzy cluster analysis, it is involving the fuzzy boundaries between things of things according to certain requirements for the classification of mathematical methods. Wireless sensor network is used to sense the objective physical world, access to the information of the physical world. The paper presents construction of Wireless sensor network management system based on Fuzzy cluster analysis. Wireless sensor network system based on Fuzzy cluster analysis is a large number of stationary or moving sensors consisting of self-organization and multi-hop wireless network with the aim of the collaboration awareness, acquisition.

Keywords: *Wireless Sensor Network, Fuzzy Cluster Analysis, System Clustering*

1. INTRODUCTION

Wireless sensor network is a large number of stationary or moving sensors consisting of self-organization and multi-hop wireless network with the aim of the collaboration awareness, acquisition; processing and transmission network covers the perception of objects in the geographic area of monitoring information and report back trousers. Referred to as WSN, a large number of sensor nodes will detect the data sent to other networks through the aggregation node user.

Sensor network is composed by a large number of sensor nodes, they are placed in the intensive monitoring of environmental or very close to the measurement environment, nodes without going through the engineering process or pre-positioning, and randomly placed in the human inaccessible terrain or disaster area, and the node is running sensor network protocols and algorithms with self-organization [1]. Another feature of the sensor nodes is mutual cooperation between the nodes, the nodes are equipped with a small processor node is not a lot of the original data transmission to the sink node, but only part of the data need to be addressed to the sink node.

Wireless sensor network is deployed in the monitoring area of a large number of cheap micro-sensor nodes, the formation of a multi-hop self-organizing wireless communications network system, the purpose of collaboration to perception, acquisition and processing of network coverage area in the perceived object information, and send observers. Sensors, perception of the object and the observer constitute the three elements of the wireless sensor networks.

Fuzzy cluster analysis, it is involving the fuzzy boundaries between things of things according to certain requirements for the classification of mathematical methods. Cluster analysis is a multivariate analysis method in mathematical statistics; it is mathematically to quantitatively determine the affinities of the samples, which objectively classified the type. The boundaries between things and some exact, while others are vague. For example, the boundaries between the crowd in the face of similar extent is vague, overcast weather, clear boundaries between vague. Clustering involves the fuzzy boundaries between things, the use of fuzzy clustering analysis method. Fuzzy cluster analysis is widely used in weather forecasting, geology, agriculture, forestry and other aspects. Clustering things usually referred to as samples, clustering a group of things is called the sample set. Fuzzy Cluster Analysis There is two basic methods: system clustering method and step-by-step clustering method.

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The sensor network system usually consists of a sensor node (sensor node), the aggregation node (sink node) and the management node. A large number of sensor nodes are randomly deployed in the monitoring within the region or near the network can constitute a self-organizing way. Sensor nodes monitoring data along the other sensor nodes hop by hop transmission in the transmission process monitoring data may be processed by multiple nodes, after multi-hop routing to the sink node, and finally reach the management node via the Internet or satellite. User management node sensor network configuration and management, it is monitoring tasks and to collect monitoring data for it.

Fuzzy clustering analysis of an important branch of the non-supervision and pattern recognition in the field of pattern recognition, data mining, computer vision and fuzzy control with a wide range of applications, but also the rapid development of a research hotspot in recent years. The sensor node consists of four parts of the sensor module, processor module, the wireless communication module and the energy supply module. The sensor module is responsible for the monitoring of the regional information collection and data conversion; processor module responsible for controlling the operation, storage and processing of the entire sensor node data collected and the data sent by other nodes; wireless communication module is responsible for wireless communication with other sensor nodes information and send and receive data collection, exchange control; energy supply module for the sensor nodes to provide the energy needed to run, usually miniature battery. The paper presents construction of Wireless sensor network management system based on Fuzzy cluster analysis.

2. THE RESEARCH OF WIRELESS SENSOR NETWORK MANAGEMENT

Usually deploy a large number of sensor nodes in order to obtain accurate information in the monitoring region; the number of sensor nodes may reach tens of thousands, or even more. Large-scale sensor networks, including two meanings: one is the sensor nodes are distributed in a large geographic area, such as sensor networks in the primeval forest, forest fire prevention and environmental monitoring, the need to deploy a large number of sensor nodes; another aspects of sensor node deployment is very intensive, a large number of sensor nodes densely deployed in an area is not a lot of space [2]. The large-scale sensor network has the following advantages: a greater signal to noise ratio information obtained by the different spatial perspective; distributed processing of large amount of collected information to improve monitoring accuracy, reduce to a single node sensor accuracy requirements; a large number of the existence of redundant nodes, making the system highly fault tolerant performance; large number of nodes to increase the coverage of the monitoring area, reducing the cave or blind.

Traditional wireless sensor networks using a "flat" structure, the deployment of micro-sensor node for data acquisition in the monitoring area is isomorphic to the computing power of each node, the communication distance and energy supply is considerable. Node data collected through multi-hop communication, with other nodes within the network to forward the data back to the sink node, aggregation nodes and other network connections, remote access and network query management. Flat structure of the network to work, but with the number of nodes increases, the expansion of network coverage, the communication path will lead to packet loss probability increases, the network performance. Can lead to an intermediate node for forwarding data more energy consumption, reduce network lifetime. According to the characteristics of IPv6 wireless sensor networks, practical applications are generally composed of heterogeneous nodes, hierarchical network, as is shown by equation1.

$$X(m+1) := \left[x^T(m+1,1), x^T(m+1,2), \cdots, x^T(m+1,M)\right]^T := \left[x^T(mM+1), x^T((mM+2), \cdots, x^T(mM+M)\right]^T \quad (1)$$

Wireless sensor networks need to achieve self-organizing network technology, relative to the general sense of self-organizing networks, sensor networks have the following characteristics, need special consideration in the design of the architecture.(1) wireless sensor networks in a large number of nodes, this sensor network scalability requirements of sensor networks typically do not have globally unique address identifies the number of sensor nodes, a large overhead, which makes the sensor network and transport layers of the network is greatly simplified compared to the general network.

(2)characteristics of self-organizing sensor network is energy constrained sensor nodes subject to environmental constraints, is usually limited by the power and non-replaceable battery-powered, so consider the sensor network architecture, as well as layers of protocol design, energy-saving designed to

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consider one of the goals [3]. (3) Due to the special environment of sensor network applications, the characteristics of wireless channel instability, and energy-constrained sensor network nodes the probability of damage is much larger than the traditional network nodes, so the robustness of self-organizing network security is necessary to ensure that damage to the part of the sensor network does not affect the global task. (4) High density of sensor node deployment, the network topology changes quickly. Maintenance of the topology also poses a challenge.

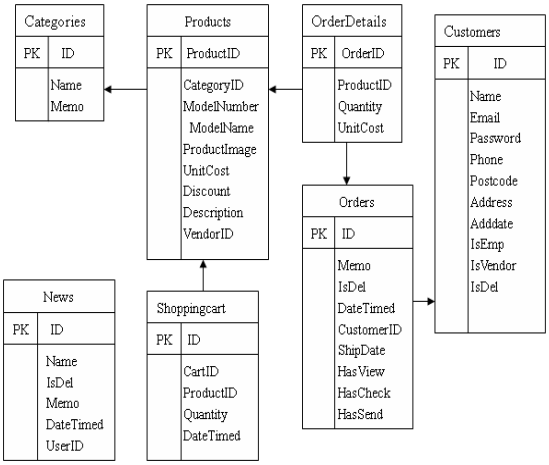

Figure1. Mesh Self-Organizing Sensor Network Application

Multiple sensors can be connected to the local smart meter display local data terminal node of wireless sensor networks intelligent instruments collected from multiple sensors and data forwarding to go out, so that we can greatly reduce the wireless sensor network terminal node number, the more efficient use of the terminal node. Seen this program in the practical application of the actual situation of the site the flexibility to use both wired and wireless solution makes system configuration more flexible to meet the data output and input control commands on a variety of sensors and secondary instruments, making the existing wireless industrial network.

The sensor network system usually consists of sensor nodes, sink nodes and management nodes. A large number of sensor nodes is randomly deployed in the monitoring within the region or near the network can constitute a self-organizing way. Sensor nodes monitoring data along the other sensor nodes hop by hop transmission in the transmission process monitoring data may be processed by multiple nodes, after multi-hop routing to the sink node, and finally reach the management node via the Internet or satellite [4]. User management node sensor network configuration and management, and monitoring tasks and to collect monitoring data for, as is shown by equation 2.

$$H = \sum_{X \in \Omega_i} \left[\frac{\partial I}{\partial W} \frac{\partial W}{\partial P} \right]^T \left[\frac{\partial I}{\partial W} \frac{\partial W}{\partial P} \right] \quad (2)$$

Broad application prospects of wireless sensor networks have caused a high degree of attention in academia and industry. Due to the limitations of the various conditions, most of the current research for wireless sensor networks based on the simulation environment (such as the NS-2), however, in the actual network system will encounter unforeseen problems in a simulated environment. Therefore, the experimental platform for the realization of wireless sensor networks occupies a very important role in the entire sensor network research. This paper introduces how to set up the experimental platform of wireless sensor networks, including the use of TinyOS in sensor hardware to be tested to ensure the normal wireless communication between sensor nodes; these are the premise of the sensor application instance [5]. This article will focus on how to use the Crossbow's wireless sensor products to achieve the experimental platform of wireless sensor network and node authentication based on this experimental platform; of Crossbow company's 5040 series of hardware products; in TinyOS system and sensor hardware verification.

Wireless sensor network is used to sense the objective physical world, access to the information of the physical world. Different sensor network applications concern different physical quantities, so the different application background will lead to a different node hardware platforms, software systems and network protocols. Wireless sensor networks can not, like Internet, with a unified communication protocol platform, sensor network technology to study the specific application [6]. This is also different from the traditional network systems, wireless sensor network features.

Data transmission subsystem consists of a wireless sensor network node, the micro control unit (Micro Controller Unit, the MCU), GPRS / GSM / CDMA module, the satellite communication network, is responsible for the collection of data uploaded to the management center. Wireless sensor network node has a dual function, on the one hand, to connect various types of sensors, to receive the corresponding data, and the other hand, the package is responsible for data transmission to act

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as a route by it [7]. Wireless sensor network is a self-organizing network, once deployed automatically networking, you can choose the next hop node, so that the data uploaded to the sink node multi-hop relay through multiple nodes. Micro-control unit is responsible for receiving and forwarding data to the management center through GPRS / GSM / CDMA module. GPRS / GSM / CDMA data transmission module, the satellite communications network for remote data transmission, and in general to be monitored region from the management center distance, using the GPRS / GSM / CDMA data transmission mode is more flexible and efficient.

Each wireless sensor as a node, with wireless communication capabilities, but also has a certain signal processing and network data smart. Depending on the type of application, each node can have a specified address. Figure 2 shows a diagram of the general structure of a node. It generally includes a sensing device, a data processing micro-controller and a wireless connection between the RF modules. According to the different definition of the network, the RF module can play a simple transmitter or transceiver (TX / RX) role. Node design, attention to current consumption and processing power is very important. The memory of the microcontroller is very dependent on the software stack.

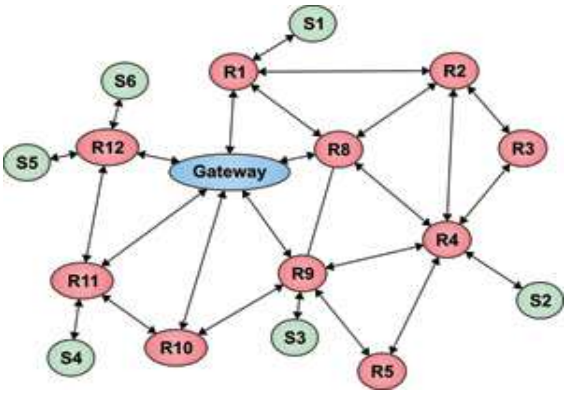

Figure2. Mesh Network Topology Used In The WSN Application

Mesh network topology, shown in Figure1, the node is connected with many redundant interconnections. If a node failure, there are many other ways for two nodes to communicate. This topology has good reliability, but pay the price of current consumption and the software overhead is very large. This topology can be achieved through ownership or Zigbee standard.

Automatically configure the wireless sensor network in terms of civilian and military has a very high value of the collection, processing and dissemination of complex environmental data can be used in a wide range. Nodes in wireless sensor networks generally use a battery-powered, can be used in very limited power for wireless sensor networks with thousands of nodes, battery replacement is very difficult or even impossible [8]. But the survival time of wireless sensor networks require several months or even years, therefore, does not affect the function under the premise, as far as possible to save the battery power of wireless sensor networks as the core issue in the wireless sensor network hardware and software design, but also the focus of attention of domestic and foreign research institutions, as is shown by equation3.

$$q(n)=\frac{\gamma^{-1}R^{-1}(n-1)x(n)}{1+\gamma^{-1}x^{H}(n)\ R^{-1}(n-1)x(n)} \quad (3)$$

The WSN every day in the development of a new standard appears more and more. However, it should be noted that most of these standards have not yet reached a mature level. Instead, they are still in the fledgling stage. A rigorous WSN design engineers in the framework and specific standards of competence; in-depth study of its network needs in order to meet current consumption, the key requirement of the maximum allowable number of nodes, battery life, data rate, and operating frequency.

3. THE MECHANISM OF FUZZY CLUSTER ANALYSIS

Cluster analysis is a multivariate analysis method in mathematical statistics; it is mathematically to quantitatively determine the affinities of the samples, which objectively classified the type.

The concept of cluster analysis from multivariate statistical analysis, for example, consider the two-dimensional coordinate system on the number of points scattered, then, need to be reasonably classified scatter, you need the knowledge of clustering [9]. The fuzzy clustering analysis method focuses on this question: for elements in the sample space P contains more than one property, the elements of which a reasonable classification. Could eventually be rendered in the form of a dendrogram hand type and automatically generate two ways, automatically generated, is also a key part of the program in this article.

Numbers can describe the characteristics of the sample. Based clustering sample set X = {x1, ...,

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xn}. P characteristics of each sample are denoted by xi = (xi1, ..., XIP); i = 1,2, ..., n; XIP description of sample xi p the number of features. ② The provisions of the sample between the similarity coefficients rij ($0 \le rij \le 1$; i, j = 1, ..., n). rij describe the differences between the samples xi and xj or similar degree. rij more close to 1 indicate that the smaller the difference between the samples xi and xj; rij is the closer to 0, indicating that the greater the difference between xi and xj. rij available subjective assessment or collective score approach provides also available formula, such as using the cosine method, the minimum, arithmetic mean of the smallest law, as is shown by equation4.

$$\begin{cases} \bar{x}_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \\ s_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_{ij} - \bar{x}_j)^2} \end{cases} \quad (4)$$

Fuzzy partition matrix, there are infinitely many such fuzzy partition matrix of all the known as the fuzzy partition space. The optimal classification standard is the square of the distance and the smallest of the samples and cluster centers. Because a sample of various types of belonging to a different degree of membership, it should be taking into account the distance of each type of cluster centers. Progressive clustering method iteratively is in order to calculate the heavy workload to be carried out on the computer [10]. Calculate the optimal fuzzy partition matrix; you must also obtain the corresponding conventional division. Cluster center will be the computer, the sample re-enter one by one, to each cluster center, which cluster center closest to which category.

This method to know in advance the number of categories, such as the number of categories is unreasonable, on the re-calculation [11]. It is better to use the system clustering method based on fuzzy equivalence relation, but the cluster center, the various types of mode samples, which often is required. Available fuzzy equivalence relations between these results as the initial classification, and then by an iterative method to obtain better results, is as follows.

$$P_{MUSIC} = \left[\sum_{i=M+1}^{N} a^H(\theta) e_i e_i^H a(\theta) \right]^{-1} \quad (5)$$

The stepwise clustering method is based on the fuzzy partition of the fuzzy clustering analysis. It is pre-determined to be classified sample should be divided into several categories, and then the principle of optimization for re-sorting through several iterations until the classification is a more reasonable date. In the classification process can be considered a sample to a certain degree of membership belonging to a class, again another degree of membership belonging to the other. Fuzzy clustering analysis of such samples is not explicitly belonging or not belongs to a class. Sample set of n samples into c-Class, it is the fuzzy partition matrix that end c × n fuzzy partition matrix has the following characteristics: ① The uij ∈ [0,1]; i = 1, ..., c; j = 1, ..., n. ② that each sample belongs to the various types of membership 1. ③ that each class of fuzzy subsets is not empty set, as is shown by figure3.

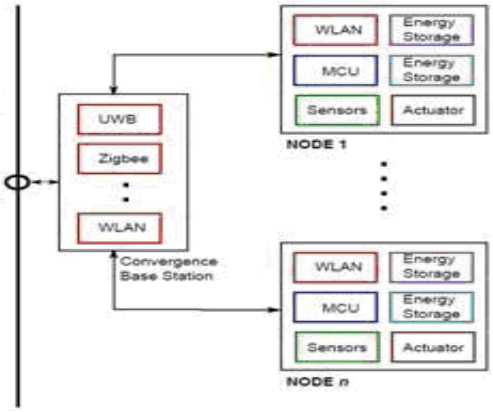

Figure3. Zigbee Of Fuzzy Partition Of The Fuzzy Clustering Analysis

A random delay mechanism is used to adjust the network coverage and scheduling caused network performance to improve the balance between. Sensor nodes into hibernation, waiting for a random time, the adjacent points, based on its activities at the end of the waiting time, the sensor nodes to update their perception of information, according to the updated values dormancy probability, if a node in the network is scheduled to enter dormant, one that contains the node sleep information messages are broadcast in its range in the adjacent points, so random delay mechanism to avoid a sub-regional network nodes into sleep mode caused by monitoring blind spots.

From the perspective of the practical application of cluster analysis is one of the main tasks of data mining. And clustering can be used as an independent tool for the distribution of the data to observe the characteristics of each cluster data, focus on further analysis of the specific clustering set. Cluster analysis can also serve as the other

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algorithms (such as a preprocessing step for classification and characterization of the induction algorithm).

Web data matrix R0 construct fuzzy similarity matrix R '. Let, U = {x1, x2, ..., xn} For the clustering of the Web object collection, where xi = {xi1, xi2, ..., xim from} [12]. The main task of the calibration step is to create a Web fuzzy similarity matrix. The establishment of this matrix to determine said first Web object xi and xj a similar degree of similarity coefficient rij = R (xi, xj). Method for calculating the similarity coefficient, the scalar product, the correlation coefficient method, the maximum and minimum, the cosine method, the absolute value of the subtrahend. The maximum and minimum method is here.

We direct clustering method directly from the obtained web fuzzy similarity matrix R by setting the cut set cut-off λ the matrix, in order to obtain the clustering result. λ between 0 and 1, the set should be moderate, due to the greater the λ value, the higher the classification accuracy; λ is smaller the value, classification is more coarse. λ can be feedback to dynamically adjust the number of clustering results in practice. The resulting web fuzzy similarity matrix R '= (rij) n × n in each other the same elements arranged by descending order the number set l (1 = λ1> λ2, ...> λm).

Fuzzy similarity matrix - cluster, through the above calibration, the fuzzy similarity matrix, reflecting the similarity between samples, but it only has a reflexivity and symmetry, transitivity, this time, you can get through the square method transitive closure, the domain of a fuzzy equivalence matrix, choose a different value to different level sets, the dynamic clustering results, and generate dynamic clustering tree.

Data objects assigned to different classes is a very important step, data based on different methods were assigned to different classes, partitioning and hierarchical methods are the two main methods of cluster analysis classification method is generally from the initial division, and optimization of a clustering standard start. Crisp, Clustering, and each of its data belong to a separate class; of Fuzzy Clustering, each of its data may be in any one category, Crisp, Clustering, and Fuzzy of Clustering in two main technologies of the division method, the partitioning clustering is based on a standard to produce a nested division series, it can measure the reparability between different classes of similarity or a class used to merge and split classes, the clustering method also includes the density-based clustering, based on the model clustering, grid-based clustering [13].

Subject classification, and fuzzy mathematics closer to the main soft computing methods such as artificial neural networks, genetic algorithms, DNA computing. They solve some of the commonly used methods can not or are difficult to resolve, quite good results. Fuzzy mathematics can solve the problem: data classification, pattern recognition, fuzzy decision-making and control. Cite some examples to illustrate: If you can use the C-MEAN method to a picture segmentation, to extract the information (cluster analysis).

4. THE DEVELOPMENT OF WIRELESS SENSOR NETWORK MANAGEMENT SYSTEM BASED ON FUZZY CLUSTER ANALYSIS

Wireless sensor networks is a new information retrieval system of monitoring within the region a lot of cheap micro-sensor nodes deployed in the formation of a multi-hop self-organizing wireless communications network system, its purpose is to collaboratively monitoring, sensing and gathering network covering the region perceived object, and information processing, and ultimately sent to the observer. Wireless sensor network is a low-power, self-organizing network, generally by one or more base station (Sink node) and the mass deployment of the monitoring area with various types of wireless sensor network nodes. Each node, low cost, low power consumption, it is with a certain processing power, communications capability. A single node data collection is not accurate, nor reliable, but the large number of nodes cooperates to form a highly uniform network structure to improve data collection accuracy and reliability of operation can be deployed in enemy territory, disaster areas, nuclear reactors human is not up to the special area of data collection, transmission, etc.

Wireless sensor network lifetime requirement for several months or even years, therefore, does not affect the function under the premise, as far as possible to save the battery power of wireless sensor networks as the core issue in the wireless sensor network hardware and software design, but also the current domestic and foreign research institutions focus of attention. Node consists of four parts: (1) constituted by a microprocessor or microcontroller computing subsystem; (2) short-range wireless transceiver circuits for wireless communication, the communication subsystem; (3) the node with the physical world linked by a group of sensors and incentive devices consisting of

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sensor subsystem; (4) energy supply subsystem, including the battery and AC-DC converter, as is shown by equation6.

$$X' = W(X,P) = \begin{pmatrix} a_1 & a_2 & d_1 \\ a_3 & a_4 & d_2 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} \quad (6)$$

As the sensor nodes with limited hardware resources and the dynamic changes in topology, network protocols can not be too complex but also highly efficient. The current study focuses on the network layer protocol and data link layer protocol. Network layer routing protocol determines the transmission path of the detected information, the present multiple types of agreements, such as more energy aware routing protocol, directed diffusion and rumor routing is based on a query routing protocol, GEAR and GEM-based location routing protocol of SPEED and ReInForM, support of QoS routing protocols. The data link layer MAC used to build the underlying infrastructure, and control the communication process and the operating mode of the sensor nodes. The present S-MAC, T-MAC and Sift based MAC protocol, DEANA, TRAMA, the DMAC and periodic scheduling time division multiplexing of the MAC protocol.

Fuzzy clustering FCM algorithm is an unsupervised machine learning algorithm, the fuzzy weighted index m and the cluster number of classes c these two parameters before the cluster analysis to be given the appropriate assignment, otherwise it will affect the effect of algorithm analysis, directthe impact of cluster analysis a reasonable explanation of the results. The performance of the algorithm depends on the initial cluster centers [14]. Therefore, the required additional fast algorithm to determine the initial cluster centers, each with different initial cluster centers to start the algorithm, multiple runs of the FCM, as is shown by equation7.

$$p_i^{(b+1)} = \frac{\sum_{k=1}^{n} (\mu_{ik}^{(b+1)})^m \cdot x_k}{\sum_{k=1}^{n} (\mu_{ik}^{(b+1)})^m}, i = 1, 2, ...c \quad (7)$$

The sensor network energy is constraint. Reduce the amount of data can effectively save energy in the process of collecting data from each node can make use of local computing and storage capacity of the node to handle data integration, removal of redundant information, so as to achieve the purpose of energy saving. Node is prone to failure, sensor networks need data fusion technology to the synthesis of multiple copies of data, improve the accuracy of the information. But the integration of technology at the expense of other aspects of performance, it is such as the cost of delay and robustness. After web fuzzy clustering, the collection of Web objects to be classified is divided into J disjoint equivalence classes of uj. Clustering results can be expressed as an n-J of order matrix, Take λ2 for the matrix element values directly from the R 'to find where the degree of similarity (xi, xj) (rij = λ2,), λ2, elements corresponding corresponds to λ1 = 1 is equivalent to classification xiclass, and xj where the merge, combine all of these cases after the equivalent classification corresponds to λ2, as is shown by figure4.

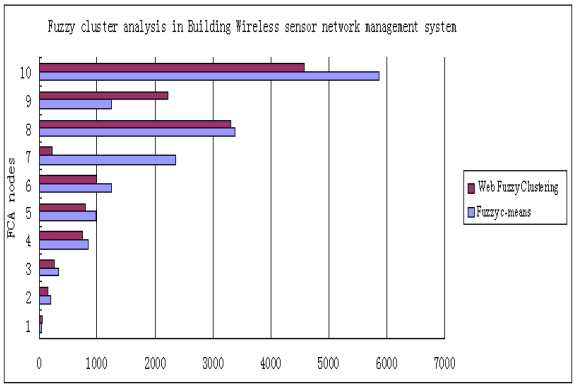

Figure4. Compare Of Mechanism Of Wireless Sensor Network Data Collection Based On Mobile Agent With Aggregation Tree

The paper presents the application of Fuzzy cluster analysis in Building Wireless sensor network management system. Order to optimize the objective function of the cluster analysis, fuzzy c-mean (FCM, Fuzzy c-means) clustering algorithm, which consists of the hard c-means (HCM, the Hardc-means) clustering algorithm evolved. Sensor networks and wireless ad hoc networks have similarities, but also there is a big difference. The sensor network is an integrated monitoring, control, and wireless communication network system, a much larger number of nodes (thousands or even tens of thousands), more densely distributed nodes;, the node is more prone to failure due to the environmental impact and energy depletion; environmental interference easily lead to changes in network topology and node failures; under normal circumstances, the majority of sensor nodes is fixed. In addition, the sensor node has the energy, processing power, storage capacity and communication capabilities are all very limited. The primary design goals of traditional wireless networks is to provide high service quality and

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efficient bandwidth utilization, followed by considering energy conservation; the primary design goals of sensor networks is the efficient use of energy, sensor networks and traditional networks one of the most important difference.

5. CONCLUSIONS

The practical application of the process of the wireless sensor network technology, there are the following constraints: (1) cost: the cost of the sensor network nodes is an important factor restricting its large-scale applications, balanced cost to be based on specific application requirements, data accuracy anytime of energy supply; (2) energy consumption: Most applications require the network using a one-time independent power supply system, thus requiring the network to low energy consumption, extend the network life cycle, this is an important factor for the enlargement of the application; (3) micro-: in some areas, requiring the volume of miniaturization of the node on the target itself does not have any impact or not to be found to complete a specific task. Ruspini proposed fuzzy set theory for clustering analysis, known as fuzzy clustering or soft clustering. The fuzzy clustering of the samples belonging to various categories of the degree of uncertainty, expressed sample generic intermediary can more objectively reflect the real world. The paper presents the development of Wireless sensor network management system based on Fuzzy cluster analysis.

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