The Application of Information Fusion Technology in Wireless Sensor Network

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Abstract

Sensor network is an important component of the Internet of Things and sensor network technology is a basic technique of it. Information perception, a main task of sensor network, provides users with valid and valuable statistics by collecting the information of things and screening them in accordance with the needs of the application purposes and processing the information through information fusion technology. The article, makes an analysis of the situation, problems, solving methods and future development of the application of information fusion technology in the wireless sensor network from the perspective of its theory, sorts, levels, fields, difference and safety to lay a good technique foundation of the perfection of sensor network and the further development of the internet of things.

*Keywords: information fusion, sensor, internet of things*

1. Internet of Things and Wireless Sensor Network

1.1. Internet of Things

Internet of Things, short as LOT, is firstly raised in 1999 by the Auto-ID Center in MIT (Sundmaeker *et al.*, 2010) [1]. In Nov. 2005, International Telecommunication Union, short as ITU, published a report called ITU the Report of Internet 2005: the Internet of Things in which the definition of the Internet of Things was confirmed [2].

The report pointed out that the development of the internet of things relies in RFID, WSN, IET, MT and NT. The internet of things, a network of intelligent identification, location, track, monitor and management, realises the exchange of information between people and things as well as things and things through connecting different kinds of things with internet.

The hierarchical structure of the internet of things as picture 1.1.
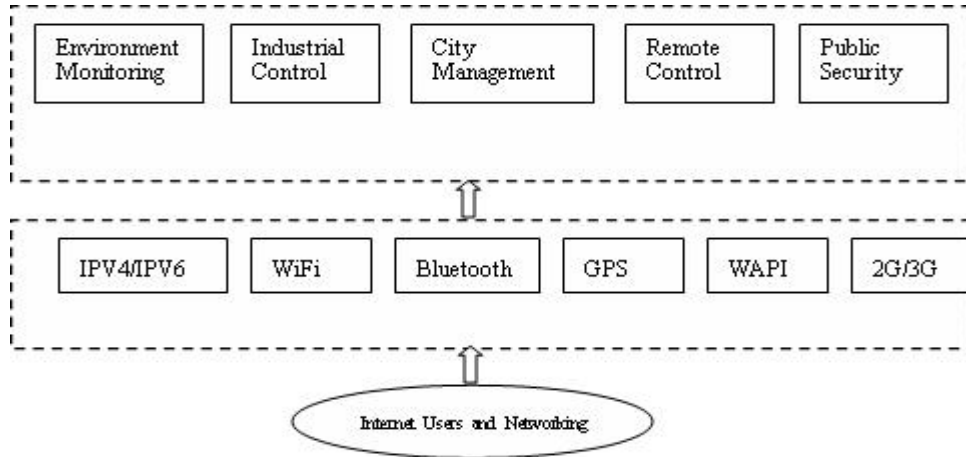
Figure 1.1. The Hierarchical Structure of the Internet of Things

1.2. Wireless Sensor Network

Sensor network technology is one of the most important technology in the internet of things. Wireless sensor network, an important part of the internet of things, connects the micro sensors in the monitor area to compose a vaulting network system with the purpose of cooperatively sensing, collecting and processing the information of the sensed object in the area to send them to the observers [3].

Wireless sensor network's structure as picture 1.2.
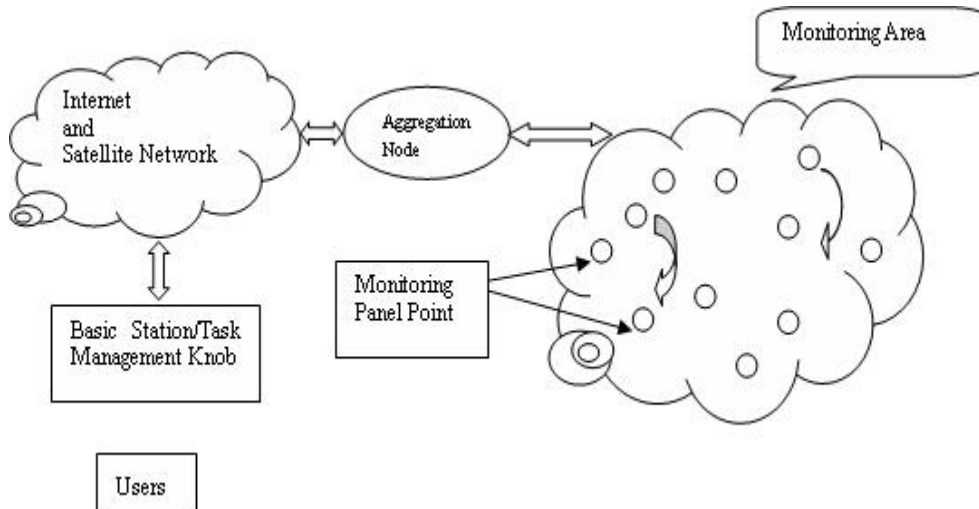
Figure 1.2. Wireless Sensor Network's Structure

In the picture above, monitoring panel point is a micro embedded system which can process and deal with the local information and process the statistics, storage, management and fusion of the statistics from other points. The main task of panel points are to connect sensor network, internet and some other external networks to realise the information exchange among protocol stacks. Task manager or the basic station could be a computer or a working station that bears a big statistics processing or storage center and interactive platform

of people and computer. Combined with the internet of things, sensor network is injected into new energy and the application ability as well as the application scope, raising higher demands to other aspects.

2. Wireless Sensor Network Protocol Stack and Information Fusion Technique

2.1. Wireless Sensor Network Protocol Stack

Wireless sensor network protocol stack corresponds with the 5th protocol of the 7 protocols of the internet which consists of physical layer, data link layer, network layer, transport layer and application layer.

See picture 2.1.
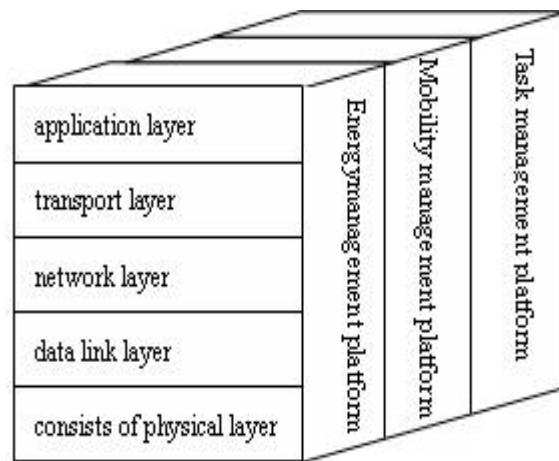
**Figure 2.1. Wireless Sensor Network Protocol Stack**

In addition, protocol stack consists of energy management platform, mobility management platform and task management platform. Through the management platform, sensor points could co-work in an energy-efficient way and transmit statistics in wireless sensor network and can work multitask and share the resources [4].

2.2. Information Fusion Technique

Information perception, a main task of sensor network, provides users with valid and valuable statistics by collecting the information of things and screening them in accordance with the needs of the application purposes and processing the information through information fusion technology. As the limited ability of the internet in transmitting, processing and analyzing, the statistics are usually dealt by information fusion technology to realise the efficient perception of information.

Information fusion means that in the certain rules, making analysis and synthesis of multi-source information through computer technology to realise the sorting of different application. According to the information extraction level [5], information fusion technology in the internet of things could be divided into three levels: data level, feature fusion level, and decision fusion level.

See picture 2.2.
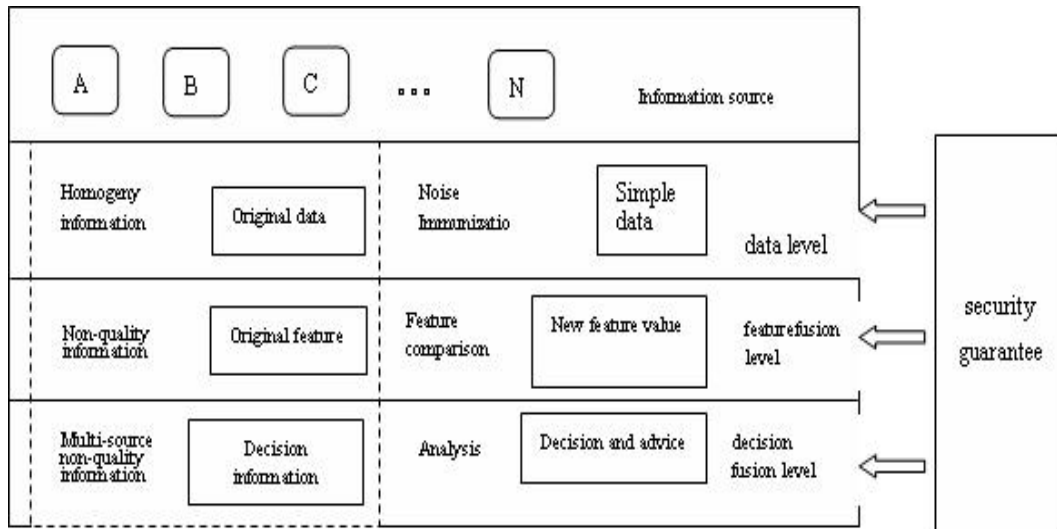
Figure 2.2. Information Fusion Layer Model

Data level fusion is mainly responsible for the noise in the data input, while feature level fusion and decision level fusion inclines to gathering valuable information related to actual application.

2.2.1. Data Level Fusion Technology

Data level fusion refers to the fusion after the gathering of original resources under the circumstances of the fusion of homogeny information. So far, data level fusion is usually realised with traditional method of weighted mean, feature matching and pyramid method. Mechitov [6] raised that to get the coordinate positions of the points in the track by the position of the sensor with the method of weighted mean.

On the basis of geometric theory, Cui Xunxue [7] raised that to get the position of two-value sensor in the three-circle theory which can get the position of the object in the track of straight line as well as circle. Method of weighted mean, simple and fast, can appress noise effectively, but the fusion comparison is relatively low and cannot infect the important effect of some information.

2.2.2. Feature Level Fusion Technology

Feature level fusion mainly means in the method of feature value comparison after the eigenvalue extraction of the original statistics but couldn't get any analysis or judgment on the results. In the feature fusion stage [8], K-Nearest Neighbor, Kalman filtering and clustering algorithm are usually applied. Ye *et al.*, combines clustering algorithm and K-Nearest Neighbor, raising Clustering and Classification Algorithm-Supervised which established monitoring study method and solving the problem of the dependence on K in the traditional K-Nearest Neighbor [9].

Rosa *et al.*, to find out the best K value fast, raised that to combine genetic algorithm and K-Nearest Neighbor to optimize K value and increase nicety of grading of K-Nearest Neighbor [10].Chen Lifei and Guo Gongde raised Multi-Representatives for Efficient Classification, short for MEC to use in the nearest neighbour sorting, based on the smallest K

value under the lowest structural risk. In comparison to the traditional method, MEC could analyze the complex structural statistics and accuracy and efficiency are greatly increased.

To increase the accuracy of traditional calculation, Jin Di raised a network clustering algorithm based on structural similarity to transmit vector quantity into K neighbour network and cluster K near network with Structural Similarity based Network Clustering Algorithm [11]. Kalman filtering is a kind of best random filtering technology which can eliminate the interference of the noise to the signal, but classical and expanded Kalman filtering are usually limited to Gaussian linear system.

2.2.3. Decision Fusion Technology

Decision fusion can pre-process,extract, identify and reliability distribute of non-homo quality to get the best decision with its characteristics as fusion of the statistics from the sensors and get the decision and advice through analysis and judgment. Compared to the first two fusions, it is the best fusion of all as its fault freedom is pretty wide and can be extensively applied. Common decision fusion level are expert system, Bayes organon and evidence theory, *etc* [12]. Expert system is mainly consisted of knowledge base, inference engine, synthesis database, interpreter and connector, *etc*. There are many kinds of expert system, such as the one based on rules, on frame, on model, on case and most intelligence systems are based on the expert system.

3. Existing Problem

Information fusion can decrease the quantity of the data, the clash of data in the transmission and the jams in the internet to properly make use of the internet. Therefore, information fusion technology has become the vital technology and the research hot spot of wireless sensor network. To make the information fusion faster and more efficient, there are many aspects to improve.

3.1. Problems in Fusion of Heterogeneous Multi-source Information

As the sensors gathered different information, time interference, expression method of information output, kinds of objects and big number of sensors, the information needs to be dealt by fusion is heterogeneous multi-sourced. Besides, as the points share great differences in the internet, in the fusion process, different points bear difference in the process, transmission and storage of information quantity.

Therefore,information fusion technology in the internet are the fallowing four: first, internet information, in expression way and semantic knowledge must be unitized so there is a problem to find out a kind of way to express and describe. Second, as internet points in the information fusion provides different measure dimensions, there is a problem to decrease the dimensions of the multi-dimension information [13].

Third, different internet points bear difference in sampling frequency and synchronous rate in the information; the fusion process bear the problem of ensure information in the process. Fourth, in the fusion process, a great many internet points are needed, thus there is a problem in the distribution of time, fault freedom management and the use of information in each point.

3.2. Problems in the Fusion of Big Data

There are so many sorts and forms of things that can be connected to the internet which requires the sorts of the sensor be of great number and the information be collected of great

amount. To provide useful information to the user, the information must be dealt in great amount. The existing wireless sensor network is usually simple and less than 1,000 in scale with its single sensor sort which couldn't give a whole description of the purpose. With the network scale expanding, the points in it are increasing in geometry as well as the sensor sorts, thus the information increases in great scale.

As the research on information fusion technology of large-scale sensor still in its beginning stage, most fusion technology could only be applied into small-scaled fusion. Therefore, there are still some research on the problems as panel point load balancing, wireless network delay, algorithm energy consumption and data transmission credibility.

3.3. Security Problems in Information Fusion

As the range of application of the internet expanding, the information scale covered by fusion has been expanded which includes some sensitive one [14].Therefore, security has become one of the most important problem. In the fusion process, if one of the penal points were infected by virus and distorted, the normal and venom information will be very difficult for blending points to find out. As information blending point locates in the middle center of the perception and the exchange part of the information, the damage of it will generate mistakes and lead the internet users to make wrong decisions under the wrong leading.

Therefore, much attention must be paid on the security problem in the blending of the information which requires the blending points' system to distinguish the data validity to protect the user's privacy by judging the validity of the information fast and accurately.

4. Summary

As a new network in which things are connected to the internet by various sensing equipments, the internet of things has aroused extensive attention in various fields for its information sensing. However, that the network resources are limited makes the information fusion problem become increasingly prominent. The paper gave a review about the information fusion problem in the internet of things. It divided the information fusion technologies in the internet of things into three main classes: data-level fusion, feature-level fusion, and decision-level fusion. It also made a comprehensive commentary on the different types of technologies from the principle, applicability and the differences between themselves. On this basis, it showed the problems and challenges existing in the information fusion process in the internet of things, and put forward several research directions in the future as well.

The sensor network nodes are deployed in harsh environments, with the environmental conditions, subject to resource constraints caused by many types of security threats or attacks. Therefore, the number of unsolved security issues of wireless sensor networks is still one of the most popular research topics, and secure communication between sensor nodes is a fundamental challenge to the security services for wireless sensor networks. Analyzes the security issues of wireless sensor networks and in different types of attacks the WSN layered architecture, defensive measures and future research directions.

Wireless sensor network information fusion technology comes down to many fields, as a key link in the process of internet information conception; it has still to be improved in many aspects. The article mainly discusses three information fusion technologies as data level fusion, feature level fusion and decision fusion as well as the fusion of information, dig data and the security problem in the fusion process. By concluding the content above, wireless sensor network information fusion technology can get a better development to provide the internet of things a strong impetus.

References

[1] H. Sundmaeker, P. Guillemin and P. Friess, "Vision and Challenges for Realising the Internet of Things", Brussels: Publications Office of the European Union, **(20101)**, pp. 1-2.

[2] International Telecommunication Union (ITU) Strategy and Policy Unit (SPU), ITU Internet Reports 2005: The Internetof Things, Geneva: International Telecommunication Union, **(2005)**, pp. 12-16.

[3] L. Zhongzhi, "Research on Security Problem Based on Wireless Sensor Network of the Internet of Things", Modern Computer, **(2011)**, pp. 17-20.

[4] W. Liu, R. Luo and H. Z. Yang, "Cryptography Overhead Evalua-tion and Analysis for Wireless Sensor Networks", Proceedings of the 2009 WRI International Conference on Communications and Mobile Computing. Washington, DC: IEEE Computer Society, **(2009)**, pp. 496-501.

[5] E. F. Nakamura, A. A. F. Loureiro and A. C. Frery, "Information fusion for wireless sensor networks: Methods, models, and classifications", ACM Computer Survey, vol. 39, no. 3, **(2009)**, pp. 1-55.

[6] K. Mechitov, S. Sundresh and Y. Kwon, "Cooperative trackingwith binary detection sensor networks", Conference OnEmbedded Networked Sensor Systems: Proceedings of the 1st international conference on Embedded networked sensor systems. New York: ACM Press, **(2003)**, pp. 332-333.

[7] C. Xunxue, Z. Qiang and F. Zhen, "Three Circle Two-value Sensor Network Tracking Method", Calculation, Research and Development, vol. 48, no. 2, **(2011)**, pp. 21-25.

[8] J. Pearl, "Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference", San Mateo: Morgan KaufmanCA, **(1998)**, vol. 277-306.

[9] M. Hong and H. Guo, "Design of Multi-Service Smart Card Systems for High Security and Performance", IJSIA, vol. 3, no. 1, **(2009)**, pp. 87-100.

[10] D.-S. Wang and J.-P. Li, "A Novel Mutual Authentication Scheme Based on Fingerprint Biometric and Nonce Using Smart Cards", IJSIA, **(2011)**, vol. 5, no. 2, pp. 49-60.

[11] W.-C. Kuo, K. Chain, J.-C. Cheng and J.-F. Yang, "An Enhanced Robust and Efficient Password-Authenticated Key Agreement Using Smart Cards", IJSIA, vol. 6, no. 2, **(2012)**, pp. 127-132.

[12] Y. An, "Security Enhancements of a Password-Based Mutual Authentication Scheme Using Smart Cards", IJMUE, vol. 7, no. 2, **(2012)**, pp. 53-62.

[13] C.-T. Li, C.-C. Lee, H. Mei and C.-H. Yang, "A Password and Smart Card Based User Authentication Mechanism for Multi-Server Environments", IJFGCN, vol. 5, no. 4, **(2012)**, pp. 153-164.

[14] R. G. Tantiado, "Comparative Mutagenic Effects of Laboratory Dyes on Drosophila melanogaster", IJBSBT, vol. 4, no. 4, **(2012)**, pp. 55-62.

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