



Research on Multi-source Heterogeneous Sensor Information Fusion Method Under Internet of Things Technology

Feng Jin¹(✉) and Li-li Xu²

¹ Information and Communication College,
National University of Defense Technology, Changsha, China
jingfeng250052@sohu.com

² 95795 Troop of Guilin City in Guangxi, Xi'an, China

Abstract. Multi-heterogeneous sensor information fusion under traditional technology conditions was slow, inaccurate, incomplete, and inconsistent, which led to errors in data analysis and affect evaluation results. To this end, IoT technology was used to study the multi-source heterogeneous sensor information fusion method. Four methods of data acquisition, data abstraction and access, feature fusion algorithm design of high attribute dimension data, and feature level information fusion method were used to creatively change the traditional operation method. The experiment proved that the IoT data information presented new characteristics under the universal characteristics of the Internet of Things, and used the high-level knowledge evolution mechanism of the information resource development chain to study the state evolution of the Internet of Things information in its life cycle. The mechanism was to customize the guiding strategy for the integration of high-quality information in the Internet of Things.

Keywords: Information fusion · Internet of Things · Multiple heterogeneous sensors · Noumenon

1 Introduction

The concept of the Internet of Things originated from the Auto-ID Labs, which was founded by the Massachusetts Institute of Technology (MIT) in 1999. The center hopes to pass all the items through the RF by building a network radio frequency identification (RFID) system. Identification and other sensing devices are connected to the Internet to complete the intelligent identification and management of items [1]. The initial Internet of Things was developed and developed with the background of the logistics industry as its target. Based on radio frequency identification technology, it realized the intelligent management of the logistics system [2]. With the rapid development of science and technology, the connotation of the Internet of Things has been further deepened. In 2005, at the World Summit on the Information Society (WSIS) in

Tunis, the International Telecommunication Union (ITU: International Telecommunication Union) released the ITU Internet reports 2005 the Internet of things, which officially defined the concept of “Internet of Things” and elaborated on it. The characteristics of networking, related technologies, possible challenges and future global market opportunities [3]. At present, related technologies and applications of the Internet of Things include: intelligent industry, smart agriculture, intelligent logistics, intelligent transportation, smart grid, environmental protection, security protection, smart medical care and smart home. Even IBM and Google have launched a larger IoT program: IBM’s Smarter Planet program and Google’s Internet of Planet program, exploring large-scale application of the Internet of Things through cross-regional and cross-industry joint research [4].

With the development of Internet of things technology, information fusion technology of Internet of things has made some achievements. Information fusion technology refers to the process of collecting, analyzing, refining and processing a large amount of information data obtained by sensors according to certain rules and conditions in a certain sequence by using computer information technology. Through the information fusion technology, obtain the required accurate information data. It can be said that information fusion is the process of refining and integrating a large number of different information to obtain more refined and accurate data through information fusion, providing information data support for certain decision-making needs or data requirements. The main function of information fusion is to refine the information and improve the availability of information. With the continuous development of the information fusion technology, information fusion and widening applications from military to civilian in the field of application of the Internet of things technology rapid development today, but also plays an important role in information fusion technology, under the circumstances of Internet of things technology multiple heterogeneous sensor fusion method is studied.

2 IoT Multi-source Heterogeneous Sensor Information Fusion Method

2.1 Raw Data Collection

Using the IRIS series of nodes, we deployed a sensor network that monitors the indoor environment of the lab in three lab rooms, as shown in Fig. 1. The sensor node has a temperature sensor, an air humidity sensor, an illumination sensor, an atmospheric pressure sensor, etc. [5]. The data store uses experimental observations collected by SQL Server 2008 storage.

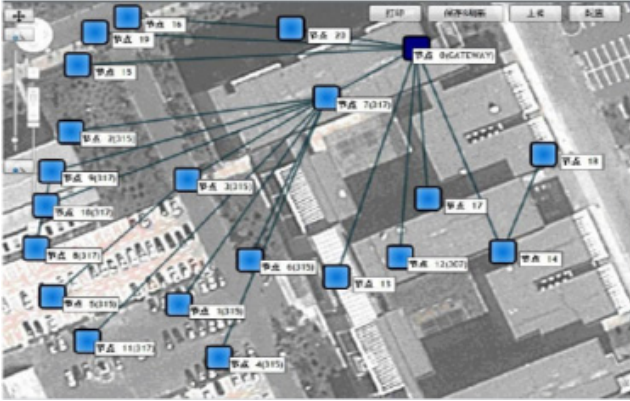


Fig. 1. Device deployment extreme network topology

2.2 Data Abstraction and Access

The D2RQ platform is an open source system that can establish a virtual mapping between read-only RDF data and a relational database, thereby enabling query and access to data existing in a relational database using RDF data access methods [6]. Based on a customized description model of the target object, we use the D2RQ mapping language to map the data in the relational database with the RDF type data. We first construct an observation-based ontology description model based on the semantic sensor network description model (W3C SSN Ontology) (as shown in Fig. 2). Table 1 shows the associated attributes used by the ontology description model and their descriptions, and then applies the D2RQ mapping language to convert the collected monitoring data stored in the relational database SQL Server 2008 into RDF data form for the next realization of the foundation for annotation and abstraction of monitoring data.

Table 1. Association properties between system models

Property name	Explanation
ssn:observationResult	Points to the time when the observation result
ssn:observedBy	Points to a sensor which produced the observation
ssn:observedBy	Points to the specific quality of the feature
eos:hasParent	Points to the parent nodes
eos:hasBoard	Points to the sensor board ID
ssn:hasValue	Points to the actual value of the observation data
eos:roomBelong	Points to the room ID which the nodes belong to
eos:unit	Points to the measuring unit of the observation

As can be seen from the table, SPARQL is a query and acquisition protocol developed for RDF data. It is the W3C recommendation for RDF data query on the Internet [7]. We can use the SPARQL tool to query and integrate multi-source

associated data information represented by resources, thus enabling further fusion of multi-source heterogeneous data.

2.3 Feature Fusion Algorithm Design for High Attribute Dimensional Data

In order to improve the efficiency of high-dimensional IoT data feature fusion calculation, we present an efficient algorithm [8].

Suppose the data fusion model is K , and the data fusion model has its standard template feature vector, expressed as $Z_1, Z_2, Z_3, Z_4, Z_5 \dots Z_m$, therefore, the length between the unknown data fusion model vector X and the standard vector Z_i of the W_i model is:

$$D_i(X) = d(X, Z_i) = |X - Z_i| = \sqrt{X - Z_i^n} (X - Z_i) \tag{1}$$

Where $i = 2, 4, 6, \dots K$.

This algorithm is based on the idea of partitioning, cutting high attribute dimensional data into data of relatively low attribute dimensions. Firstly, the data of these relatively low attribute dimensions are processed, and then the necessary feature attributes of the original high attribute dimensional data are calculated by using these processing results to ensure that the obtained result is the same as the direct calculation of the high attribute dimensional data directly [9].

$$\mu_A(X) e^{-D(x)} \tag{2}$$

Where

$$\mu_{A1}(X), \mu_{A2}(X), \mu_{A3}(X), \mu_{A4}(X) \tag{3}$$

Based on this formula, the trust function is:

When $\mu_A(X) = \alpha$, then X belongs to the original data.

When $\mu_A(X) = \beta$, then X belongs to third-party data.

When $\mu_A(X) = \delta$, then X belongs to the basic data (Table 2).

Table 2. Differences in different sensor types (measurement unit: V/g)

	a	b	c	d	e	f
U	3	0.23	5.61	6.72	14.12	7.45
B	2	0.41	*	6.21	11.21	7.82
D	3.64	0.72	6.26	5.27	*	7.31
S	0.974	2	5.85	2	2	8
A	4	6.6	0.64	7	1	*

Our algorithm is divided into four steps: data preprocessing and modeling, high-dimensional data partitioning, nuclear attribute set calculation at all levels, and feature

system always has measurement and description errors inevitably, and lacks prior knowledge of the monitored environmental entities. In the real-time multi-target monitoring process, the measurement or description acquired by the same target on multiple sources must have some similar characteristics due to the same physical source. Such as from the same source, the description object name is the same, the time or location is the same. At the same time, the characteristics of these descriptions and measurements must not be exactly the same due to the angle of concern or the instability of the information collector's own performance. The purpose of data association is to use the similar features of the description to determine whether the measurements or descriptions whose characteristics are not identical are derived from the same target, thereby performing data association, constructing a complete description of the same target, and forming an Internet of Things state. The dynamic view below is shown in Fig. 3.

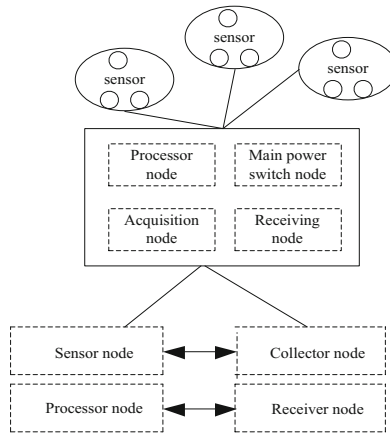


Fig. 3. Dynamic view of the Internet of Things

3 Experimental Results and Analysis

In order to ensure the effectiveness of the research on multi-source heterogeneous sensor information fusion method under the Internet of Things technology, the experimental demonstration was carried out. Two different types of target sensors were selected for the multi-source heterogeneous sensor information fusion method under the Internet of Things technology. In the experiment, the two types of sensors were placed under the same conditions to observe the experimental objectives of different methods and record the data at any time. Among them, the multi-source heterogeneous sensor information fusion effect of different methods is shown in Fig. 4.

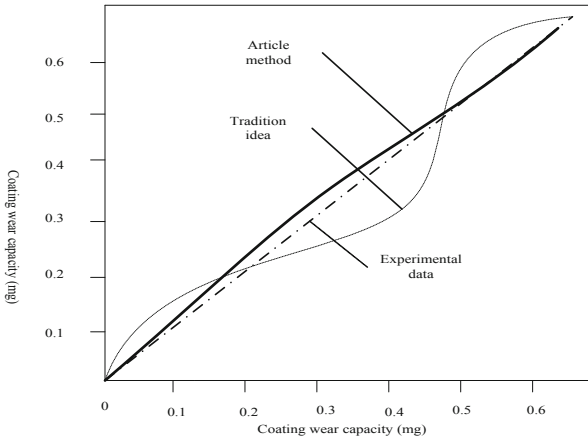


Fig. 4. Comparison of experimental results

In Fig. 4, the traditional idea refers to the multi-source heterogeneous sensor information fusion method based on statistics. Experimental data refers to the experimental data which is closest to the actual value after the fusion of the two kinds of sensor information, through multiple comparisons, screening and improvement. Analysis of the above figure shows that the information fusion results of traditional ideas far deviate from the experimental data, and the information fusion results of this method are close to the experimental data, so it can be shown that the information fusion precision of this method is high, and the actual application effect is better.

On the basis of the above experiments, the time of information fusion is compared, and the experimental results are shown in Fig. 5.

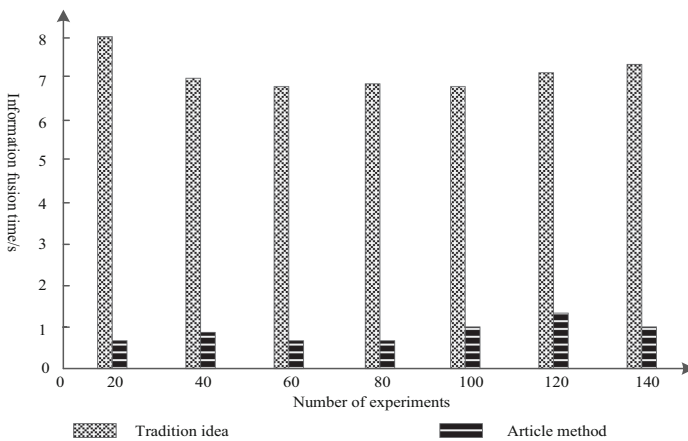


Fig. 5. Time comparison of information fusion

The shorter the time of information fusion, the higher the efficiency of information fusion, which can realize multi-source heterogeneous sensor information fusion in a short time. According to Fig. 5, the information fusion time of traditional ideas varies between 6.8 s and 8.0 s, while the information fusion time of the method in this paper is. With the change between 07 s–1.2 s, the information fusion time is far lower than the traditional thought, which indicates that this method can realize the information fusion of multi-source and heterogeneous sensors in a relatively short time, and the information fusion efficiency is high. The method has low information fusion time because this method adopts data acquisition, data extraction and access, high attribute dimensional data fusion algorithm design, characteristics of four kinds of methods, such as information fusion, creatively changed the traditional operation method, improve the effect of information fusion at the same time improve the efficiency of information fusion.

4 Conclusion

This paper mainly studies the multi-source heterogeneous sensor information fusion method under the Internet of Things technology, which can effectively obtain information resources from multi-source heterogeneous sensors by using Internet of Things technology. The identification and fusion of information resources to help us obtain more meaningful multi-source heterogeneous sensor information provides a valuable means for us to develop a fusion method for multi-source heterogeneous sensor information resources.

Through the elaboration and research and analysis of this paper, we can know that the research on multi-source heterogeneous sensor information fusion method under IoT technology has obvious and far-reaching significance. Even though the multi-source heterogeneous sensor information fusion method under the Internet of Things technology has made some obvious progress in recent years, there are still many research gaps waiting for us to explore. In this regard, we must be brave in innovation, aggressive, and strive to acquire and study the multi-source heterogeneous sensor information fusion method under the Internet of Things technology. Thereby obtaining effective resource information, and thus better serving the multi-source heterogeneous sensor information fusion business under the Internet of Things technology in China.

References

1. Saghafian, S., Tomlin, B., Biller, S.: The internet of things and information fusion: who talks to who? *Soc. Sci. Electron. Publ.* **6**(1), 39–51 (2018)
2. Blasch, E., Kadar, I., Grewe, L.L., et al.: Panel summary of cyber-physical systems (CPS) and Internet of Things (IoT) opportunities with information fusion. *Sig. Process., Sens./Inf. Fus. Target Recogn.* **XXVI** **111**(9), 2–12 (2017)
3. Bo, S., Rho, S., Zhou, X., et al.: A delay-aware schedule method for distributed information fusion with elastic and inelastic traffic. *Inf. Fus.* **36**(2), 68–79 (2017)

4. Guo, K., Tang, Y., Zhang, P.: CSF: crowd sourcing semantic fusion for heterogeneous media big data in the internet of things. *Inf. Fus.* **37**(2), 77–85 (2017)
5. Xie, N.F., Cao, C.G., Guo, H.Y.: A knowledge fusion model for web information. In: *Proceedings of IEEE/WIC/ACM International Conference on Web Intelligence*, vol. 12, no. 5, pp. 67–72, Compiegne Cedex (2018)
6. Ruta, M., Scioscia, F., Gramegna, F., et al.: A knowledge fusion approach for context awareness in vehicular networks. *IEEE Internet Things J.* **5**(4), 2407–2419 (2018)
7. Iacca, G., Iacca, G., Tejada, A., et al.: Spatial anomaly detection in sensor networks using neighborhood information. *Inf. Fus.* **33**, 41–56 (2017)
8. Li, G., Zhang, L., Sun, Y., Kong, J.: Towards the sEMG hand: internet of things sensors and haptic feedback application. *Multimedia Tools Appl.* **78**(21), 29765–29782 (2018). <https://doi.org/10.1007/s11042-018-6293-x>
9. Liu, S., Fu, W., Zhao, W.: A novel fusion method by static and moving facial capture. *Math. Probl. Eng.* (2013). <https://doi.org/10.1155/2013/503924>
10. Wenzhao, W., Peihao, Z., Xinzhong, T., et al.: Multiple access protocol based on TDMA and FDMA fusion in internet of things. *J. Comput. Theor. Nanosci.* **14**(11), 5155–5159 (2017)