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A Kind of Agricultural Content Networking Information Fusion Method Based on Ontology

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Abstract. The rapid development of agricultural Internet of things is difficult to deal with a lot of information. This paper proposes a method based on ontology of agricultural network information fusion, from this point the basis of ontology and information fusion classification and methods, basic principle, technology in agricultural Internet information fusion as a foundation, in view of the agricultural Internet information uncertainty, heterogeneity and representation problem, put forward agricultural content networking information fusion method based on ontology. It provides theoretical support for the information processing of agricultural Internet of things.

Keywords: Ontology · Agricultural internet of things · Neural networks Information fusion

1 Introduction

In the process of traditional agricultural production, raising management of all kinds of assignments and rely mainly on the manpower, workload is big, and easy to cause misjudgment and the management decision-making errors, the various inputs and the growth of crops or livestock demand does not match, imbalance, including time applying pesticide excessive, improper irrigation control, often overuse of chemical fertilizer, etc. This "misjudgment" and "mistake" not only increase agricultural inputs, but also may cause environmental pollution in the form of soil, degradation and eutrophication of water. In addition to the production habits, certain planting and breeding technologies, the key is the collection and processing of information such as breeding environment. The research and development application of Internet of things technology brings an opportunity for the development of agricultural informatization. The Internet of things is recognized as the world after computer, Internet and mobile communications, information industry and a new wave has been listed as one of the seven strategic industries in China, become a research hotspot in recent years. The efficient management of information of agricultural Internet of things is an effective way to renovate agricultural production mode, promote the construction of smart countryside, and promote the increase of farmers' production and income and improve the happiness index of life.

In the field of Agriculture, the United Nations Food and Agriculture Organization (FAO, Food and Agriculture Organization) has a lot of research on the agricultural

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ontology [2, 3]. In 2000, the FAO implemented the Agricultural Ontology Service plan (AOS) to establish the relevant standards for Agricultural information resources, and standardize Agricultural terminology in various languages. Moreover, the AOS international symposium has been held many times, so that the researchers of agricultural ontology can exchange and discuss together, and promote the integration and resource sharing of agricultural information systems in various countries of the world. At the same time, the FAO has developed various agricultural domain ontology, including fishery body, food safety ontology, antibacterial agent and so on. At home, the agricultural field also carried out some research on ontology knowledge service. Professor Qian of the Chinese academy of agricultural sciences first started the research on the theory of agricultural ontology. He first puts forward the concept of the agricultural ontology service, combined with China's national conditions in China is expounded the agricultural ontology service content and the organization form of [12], open the domestic agricultural ontology service in the new stage. Jing Li of the Chinese academy of sciences has designed and constructed a floral ontology retrieval system with a certain inference function [13]. Her first fused ontology in agricultural disciplines, the application research of agricultural ontology service, such as knowledge engineering, biological engineering, book information service in the field of ontology applied research provides exemplary role. In addition, Zhang Lu, China agricultural university, research on agricultural capital goods ontology [14], the Chinese academy of sciences Xu Yongdeng agricultural ontology construction process research given by the [15], for the agricultural domain ontology knowledge service provides a knowledge base.

Information fusion [17, 18] is a combination of multiple sources of information technology in order to get unified description results, is the sense of people or animals use a variety of access to information, and through the comprehensive analysis and understanding of the objective world a brain function simulation [8, 10]. The theory was originally put forward by the scholars (Camogolo) in 1959 the multi-source information integration theorem, namely: will all kinds of ways, at any time, any space information comprehensive analysis and processing as a whole, provides a basis for decision making and control [8]. In 1973, the United States, scientific research institutions in the study of sonar signal of target detection, the fusion of multiple independent signal, a single detection systems were obtained on enemy ships higher detection accuracy, promote the development of the theory of information fusion in military [10], in the late 1970s, the university of Connecticut Y Bar - professor Shalom in public for the first time in the literature and the basic methods of multi-sensor information fusion is given, namely: the Probabilistic Data Association Filter (Probabilistic Data Association Filter: PDAF [11]. Since the 1980s, the information fusion theory has been widely adopted in the tasks of target tracking, identification, situation assessment and threat estimation worldwide [4]. In 1998, the International Society of Information Fusion was founded by the International Society of Information Fusion (ISIF), which holds an annual International conference on Information Fusion to systematically summarize the research achievements in the field of Information Fusion. Since then, information fusion technology has been comprehensively developed as an independent subject and has been widely studied in various fields of military and civil [5–7, 9]. In China, the research on information fusion technology started late, and only began to be studied in the late 1980s. In the mid and late 1990s, some key technologies

of information fusion were obtained. After entering the 21st century, information fusion technology to get the attention of many domestic universities and research institutes, and on the electromagnetic space, land, airborne, naval and air multi-source information fusion in the field of applications such as object orientation, tracking and recognition technology is a comprehensive research and development, but it is still in its infancy.

Based on the comprehensive elaboration, on the basis of ontology, through using the method of information fusion, the comprehensive processing of the data of agricultural iot, agricultural content networking information fusion method based on ontology, to a certain extent brought agriculture information processing is convenient.

2 Ontology

Ontology is a philosophical term derived from the Greek "onto" and "logia", namely "the theory of existence"; Ontology is the study of the existence of a discipline, can answer such as "what is existence", "what is the nature can explain the existence", "the nature of how to explain the existence of different" and so on.

In the field of information system, ontology is applied and developed. McCarthy, realize the philosophical ontology and the logic of artificial intelligence theory similarities and overlaps between build activities, is put forward based on the logical concept of smart systems must be "to list all the things exist, and build an ontology to describe our world" point of view, and the researchers respectively from different point of view put forward the different understanding of the ontology, the ontology is not a unified concept. Perez et al. analyzed the existing ontology with taxonomy, and concluded 5 basic modeling primitives, that is, a complete ontology should have 5 parts:

(1) classes or concepts, which refer to any transaction, such as job description, function, behavior, strategy, and reasoning process. On semantic, said it is a collection of objects, the definition generally adopts frame (frame) structure, including the name of the concept, with the rest of the concept of the relationship between the collection, as well as the description of the concept in nature language.
(2) relationship (relations): the interaction between concepts in the domain. In terms of semantics, there are four basic relationships: part-of, kind-of, instance-of, attribute-of, as shown in Table 1. Of course, in the actual modeling process, the relationship between concepts can be added to the specific situation in the field.

Table 1. Relations among concepts

Relationship name	Describe relations
Part-of	Represents the relationship between the parts of the concept and the whole
Kind-of	Represents the inheritance relationship between concepts
Instance-of	Represents the relationship between an instance of a concept and a concept. Like "Zhang San" and "student"
Attribute-of	A concept is an attribute of another concept. Such as "title" and "teacher"

(3) functions: a special kind of relationship.
(4) axioms: the theorem that represents the eternal truth and the accepted right.
(5) instance (instances): represents the element, which is semantically represented by an object.

Ontology is a kind of scientific thought, which is to use computer model and language to conduct domain knowledge representation and organization, and to combine information sharing technology to carry out knowledge service methodology. And ontology is through active participation and collaboration of experts in the field and build system of domain concepts, axiom and field collection, in the form of a computer can understand and language knowledge description and organization, the purpose of the building ontology knowledge reuse and knowledge sharing and knowledge service.

Agricultural ontology is the combination and application of ontology thought and methodology in the field of agriculture. Agricultural ontology, also known as the agricultural knowledge concept system, in today's Internet age for huge amounts of information and knowledge management system is becoming more and more important. Agricultural ontology is through agriculture and other related fields (e.g., agricultural products processing, economic management, etc.) of experts actively involved in and work together to build models and expressed as a machine can understand the formal language and the organization of agriculture of agricultural information integration.

3 The Theoretical Basis of Information Fusion

3.1 Type of Information Fusion

In multi-sensor data fusion system, data fusion can be divided into three levels according to different levels of data processing: data level fusion, feature level fusion, decision level fusion [19–21].

Data Level (pixel level) Fusion. At the lowest level of fusion, the sensor's observation data is directly integrated and processed, and then the feature extraction and decision making are made based on the result of fusion (Fig. 1).

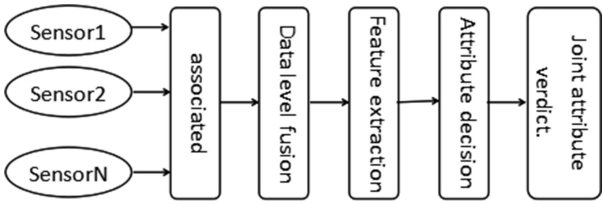

Fig. 1. Data level (pixel level) fusion

Feature Level Fusion. At the intermediate level, each sensor abstracts out its own feature vector, and then the fusion center completes the fusion process. It can be divided into two categories: target state and target feature information (Fig. 2).

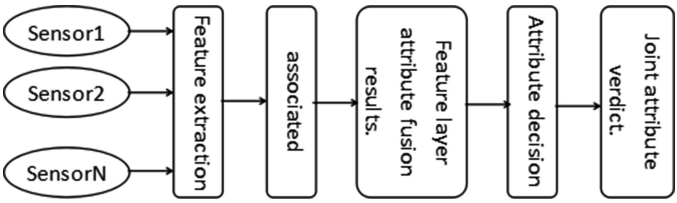

Fig. 2. Feature level fusion

Decision-Making Level Integration. At a high level of integration, each sensor makes decisions based on its own data, and then a local decision is made by the fusion center (Fig. 3).

Fig. 3. Decision level fusion

3.2 Method of Information Fusion

There are many methods for information fusion from existing research and analysis, which can be divided into probabilistic statistical methods, epistemological methods and information based methods. Commonly used Bayesian estimation method, the combination of evidence theory to estimate method belongs to the information fusion method based on probability and statistics, the method based on expert system, such as knowledge rules belongs to the method based on epistemology, and the method based on neural network information fusion method based on information theory.

Bayesian Estimation Fusion Method and D-S Evidence Combination Method. Bayesian fusion method is forecast the appearance and the measured values of estimated results in probability, by using Bayesian formula, on the basis of the given prior likelihood estimator, calculated by the new measured values (evidence), and reasoning forecast (posterior likelihood estimation). According to probability theory, Bayesian formula is expressed as:

If there are n incompatible A_1, A_2, … A_n. The fully assumed domain of An, B represents the fact or event of a observed value (or the sensor measured here), then.

$$P(A_j|B) = \frac{P(B|A_j)P(A_j)}{\sum_{i=1}^{n} P(B|A_i)P(A_i)} \tag{1}$$

The conditions that must be met are:

$$\sum_{j=1}^{n} P(A_j) = 1, \ \sum_{i=1}^{n} P(B|A_i)P(A_i) = P(B) \tag{2}$$

Where, $P(A_j)$ represents the event $A_j(j = 1,2 \ldots N)$ probability of occurrence, that is, the probability of an event (assuming) A_j is presented as a prior probability of $P(A_j)$; P(B) for observing the prior distribution of density, $P(B|A_i)$ as the conditions, under the assumption that the A_i is true for the probability of observed value B (evidence), $P(A_i|B)$ for the observation of conditions, according to the prior probability calculated assuming that A_j is really a posteriori probability.

For multi-source sensing information, the above Bayesian estimation formula and principle can be used to deduce and merge the obtained context and relevant information. Suppose the Internet of things USES n sensors, B_1, B_2, …, B_n (homogeneous or heterogeneous information acquisition device) to build information acquisition and processing system, and the one who has a m judging property targets, namely the incompatibility of the formula (1) hypothesis (or thesis) A_1, A_2, … A_m, then, based on Eqs. (1) and (2), calculate the maximum value of the joint probability at the time, which is the information and fusion result, when the joint probability is greater than that of a certain constant C; Otherwise, the sensor data source will be scanned again, and new observations will be formed, and the fusion calculation will be carried out according to the Bayesian formula.

It can be seen that the information fusion method based on Bayesian network has simple reasoning and strong reasoning ability. Which need a priori knowledge, however, this requires the active participation of relevant experts in the field of: in addition, when the observation value (sensor) any increase or decrease, need to recalculate the joint likelihood distribution function.

The evidence combination theory was first proposed by Dempster and expanded by his student Shafer, so it is also called the D-S evidence theory. Trust function, introduced the theory, to a certain extend, the Bayesian estimation method does not need to determine the probability of accurate, can distinguish between uncertainty and don't know, meet the weaker than probability of justice, for multi-sensor and platform, application of D-S evidence theory is helpful to the fuzziness and randomness of uncertainty information representation and reasoning. However, this method also has its obvious disadvantages: (1) it cannot solve the problem of evidence conflict, and it is difficult to focus on the weight because it cannot determine the size of the subset; (2) the combination of evidence will cause the growth of the focal element index, which leads to the large computation; (3) the conditions of evidence reasoning are harsh and require independent evidence.

The Fusion Method Based on Expert System and the Fusion Method Based on Neural Network. Expert system (Expert Systems) to imitate people's perception of multi-source information fusion system mechanism, from the eyes, ears, Canon. Son, hands and feet, sensory organs so as to obtain the data information of comprehensive physical identification and prediction, that is to say, this is a similar experts forecast and decision-making ability of information system. Expert systems generally pass If… Then…The generation of inference rules and patterns realize logical reasoning, information and integration. The fusion method based on expert system has the advantages of adaptability and flexibility, composite expert knowledge, long and short supply, stability and reliability. However, the expert system relies on knowledge representation, as the knowledge rule increases, the problem domain increases, the reasoning search becomes more difficult, and even the combination explosion; Therefore, it is difficult to design and develop the expert system for information fusion.

Neural network to simulate the biology information processing process and methods achieve information processing, its basic processing unit for neurons, the related knowledge on the connection weights between neurons layered said. Through the training of the neural network learning, and constantly modify the weights, progressively closer to the desired output and the output and optimize it, it can be said that the neural network learning process, is the organization of the neural network weights between neurons in the modification process. Unlike neural network information fusion system based on epistemology that need domain knowledge or to form certain rules, it does not rely on basic expert knowledge, using the training set data information network, application testing set for validation, the result of the fusion processing and then use trained neural network to deal with a lot of information fusion problem. The information fusion process based on neural network is as follows:

Step 1. Select appropriate neural network models based on the data information and system characteristics obtained, such as BP model, RBF model, ART model and Hopfield model; The most commonly used model is BP neural network, which can be logically divided into input layer, hidden layer and output layer. The establishment of a BP neural network includes the determination of the number of input layer neurons, the determination of the number of output neurons, the determination of the number of hidden layer neurons, and the selection of activation functions.

Step 2. Data information correlation, alignment and transformation, feature extraction. Data alignment and transformation is primarily for data preprocessing, to coordinate alignment calibration, timing, unified measurement units, such as operation, observation and the information associated with measured target classification operation, in order to effectively obtain eigenvector, sometimes still need to some kind of transformation of data information, such as fast Fourier transform (i.e., the observed signals do between the time domain a frequency domain transform). Then, the feature extraction is carried out on the data information of alignment and transformation to extract feature vectors.

Step 3. Normalization processing. The eigenvectors extracted from the previous step are normalized to make the input data information, mapping to [0,1] or smaller.

Step 4. Conduct neural network learning and testing. Neural network training process actually is a process of modifying connection weights between neurons, starting from the existing data information characteristics, connotation and law of

learning which, continuously adjust and optimize the network connection weights, makes the configuration of the neural network and the actual situation constantly close to reflect the real situation, it is also a neural network is competent for the root causes of uncertainty reasoning and information fusion, especially when mixed with noise data in the data processing more showed the advantage of neural network.

Step 5. Use the neural network obtained in training for practical information and fusion. Neural network to simulate biological decision-making function, and make full use of in the application of self-learning and self-organization ability, according to the actual situation of constantly learning new knowledge, information fusion, optimize network structure, the cumulative value generally can improve the reliability of information and integration.

For agricultural Internet information fusion, neural network is one of the biggest advantages is the processing of uncertainty information fusion, the fusion of uncertainty information processing ability of expert system based on knowledge or rules such as information processing system is difficult to compare. Agriculture, for example, in the Internet of things, the pressure sensor applications broader sense (weight) of livestock and poultry, the sensor values (pressure) in addition to the affected by the target parameter m, tends to suffer from a temperature t, power source current fluctuation coefficient of target parameters, the influence of the pressure sensor output voltage U actually affected by these three parameters, can be said with a ternary function, namely, U = f (m, t, a), in which t available measured temperature sensor, and current fluctuation coefficient of a sensor data from the current sensing. Therefore, the voltage value that best reflects the actual pressure should be fused by the data information obtained by the pressure sensor, the temperature sensor and the current sensor. Based on the information fusion method based on neural network, it is very effective to eliminate the uncertain influence of the non-target parameters in the process of Internet of things, such as sensor, etc.

Of course. the information fusion method based on neural network has its disadvantages. For example, its network structure is not easy to set up, which often leads to local extremum (optimal) problem. Its network parameters (such as initial offset value, learning speed, etc.) can easily cause problems such as too fast convergence when the setting is not suitable. In addition, it is difficult to obtain the extensive representative and typical training sets of neural networks.

To sum up, all kinds of information fusion each has his strong point, each has a number of shortcomings, the solution can have two kinds: one is to strengthen a certain algorithm to improve research, try to improve the algorithm, and avoid its shortcomings; Second, integrated the advantages of each algorithm, the combination of two or more than two algorithm used, foster strengths and circumvent weaknesses, promoting stability, real-time information, fusion, this approach is more commonly used.

4 Research on the Integration of Agricultural Internet of Things Based on Ontology

In terms of goods information coding, EPC (electronic item code) and UID (generic code) standards emphasize the unification of the information coding format, and follow certain communication protocols, but a given information, exactly how concepts or terms to express, these standards are not unified or imposed, which affect the Internet of things human, machine and a correct understanding, interaction and sharing of information. If the information is allowed to follow the common semantic rules in terms of expression, information sharing and system interoperability can be promoted.), on the other hand, OGC (development of geographic information alliance organization based on the W3C standards developed SWE iot standard solution (sensor networks), provides a distributed infrastructure services platform, to publish, discover and access sensor resources, but SWE lack definite concept model, it is difficult to realize the semantic understanding and interoperability, is unfavorable to the fusion of different granularity of time and space information, and help. Formal representation of ontology in the information, knowledge and promote information sharing and interoperability aspects advantage significantly, and USES ontology to describe and said agricultural network information, including the context of agricultural Internet access information and knowledge of related areas. It can be seen that ontology based information fusion research is the key link to improve the reliable perception ability and system intelligence level of agricultural Internet of things.

4.1 Ontology Based Information Fusion Method

There are three kinds of ontologies from information fusion participation: a single ontology based agricultural Internet information fusion method, multi-ontology-based agricultural Internet information, fusion method and hybrid method.

(1) the former is the use of a global ontology is formal and semantic information fusion to provide a common vocabulary (term) library, this method, all the information and the local ontology is related to the vocabulary.
(2) based on multi-ontological information and fusion method, the semantics of each sensor (data source) are described by its own ontology; Among various sensors (data sources) and no definition of common global words, in the information fusion, a combination of ontology mapping, etc. to complete different between heterogeneous sensor (data source)/semantic annotation, classification and terminology. Among them, the core is the ontology mapping, which is still based on the calculation of the similarity degree of the ontology, thus obtaining the aggregation and dispersion degree of ontology concept and other conditions of concern.
(3) hybrid method. Multiple ontologies are used to describe the information source semantics, but the information concept described by ontology is based on a global Shared vocabulary (term) library.

In general, the information fusion method based on single ontology is relatively simple, but often not easy to build the global ontology, especially the agricultural

information in Internet of things is often with uncertainty, the more increased the difficulty of the global ontology construction. The disadvantage of the multi-ontology-based information fusion method is that there is no global vocabulary (term) library, which requires the mapping and operation of ontology. However, the advantages of this method are very convenient in the addition and removal of the sensor (information source). A hybrid approach is a tradeoff between the two approaches, but a global vocabulary (term) library is also needed. In general, for the Internet of things of agriculture, aiming at the characteristics of the information, in the three basic methods of information fusion method based on ontology is often the first choice, mainly through ontology mapping and ontology integration calculation with the model of transformation operations to achieve semantic fusion. Ontology mapping algorithm with two or more ontology for the input, find out the input ontology by calculation of the corresponding element-that is, the concept, the connection between the concept, attribute and instance-the semantic relationships between, including equivalent relation, similarity relation and opposite relationship, the relationship between the whole and part, etc. The purpose is to synthesize a new ontology by calculating the semantic relation between corresponding ontology elements by calculating the existing ontology (input quantity). Of course, the ontology mapping is often based on similarity mapping, which is mainly the calculation of the similarity of the ontology, which is a large calculation.

4.2 Information Fusion Based on Ontology and Neural Network

There are some defects in the existing algorithm of similarity calculation.

(1) large computation. If two noumenon Ontology1 and Ontology2 similarity, should calculate the similarity between each pair of concepts in the Ontology: suppose Ontology including x class (concept), Ontology2 contained in a class y (concept), must calculate x*y similarity, form x*y similar matrix. When programming implementation, some ontologies are not similar, that is, the similarity is 0, and time and space are wasted.
(2) the name of ontology can't just according to the similarity of concept similarity or just contact with attributes and concepts of joint distribution to determine, he should include the name of concept similarity, similarity of concept instance, the relationship between the concept similarity (such as is_Part_of relationship between parts and whole, genus relationship is_a or has_a), concept definition of similarity (synonyms, upper concept, a concept) comprehensive analysis.

Agriculture in the Internet of things, about agricultural information through the sensor, intelligent devices such as card reader to obtain or through Internet or other information facilities, including agricultural environment context information, domain knowledge concept, etc. After the access to information, and to transform the unit or analog to digital signal conversion, calibration, associations, such as pretreatment, and then build or integrate ontology, and deposited in the ontology library. Extracted from an ontology in ontology analysis, parsing in OWL ontology (where specific choose OWL DL- a language), extract the information, and the Class (concept, Class), attributes (including data object and attribute), the corresponding instance (also known as

the individual, Individuals), and the corresponding metadata (including basic descriptive definition metadata, metadata, metadata, operation time/position management metadata types) structure types such as temporary storage of information, the similarity calculation needed to for information fusion; The process of ontology parsing can also be regarded as the feature extraction process in information fusion. For name of concept similarity, instance, similarity, the similarity relations, such as concept relations between parts and whole part-whole, inheritance relationship is_a or has_a) and after the definition of similarity calculation, the input of neural network, the result to input information as the neural network computing. Similarities are due to the above four aspects has contribution to the information fusion, but because of the influence of the uncertainty information and noise data, and the agricultural Internet information fusion to comprehensively consider the context information, and related fields of the concept of knowledge integration calculation, thus, the contribution ratio of actual difficulty with artificial or established algorithm, neural network information processing ability strong uncertainty and nonlinear calculation ability, the training by setting the network structure and optimize the network parameters, application described in Sect. 3.2.2 based on neural network information fusion, the basic process and algorithm, calculation, get the new ontology for storage or the new ontology elements (such as the concept, attribute and instance, etc.) is applied to specific issues.

This section proposes the combination of neural network information fusion method based on ontology and framework, and make full use of the semantic description of ontology technology in information expression, fully considered and combined with the neural network method in the uncertainty, incomplete information classification and processing advantages. Because of its openness, the information acquired by the agricultural Internet of things has significant heterogeneity and diversity of expression forms. At the same time because of the complexity of the environmental changes and iot information facilities physical properties limited, measured in terms of time and space limitations, agricultural Internet information with a certain degree of uncertainty and incomplete. Ontology has unique advantages in heterogeneous information description, promotion of information sharing and resource reuse and semantic interoperability. But because of ontology based on description logic, for its uncertainty information, and, with noise data, classification, performance is not strong, nonlinear reasoning and neural network in nonlinear classification, the uncertainty of the information and data information with noise data information processing ability. In a word, combining various methods and optimizing the utilization is the main characteristic of the proposed method and framework.

5 Conclusion

Around the agricultural Internet information fusion method, this paper starts with the basic principle of information fusion, should put forward according to the characteristics of the agricultural Internet information, research suitable information fusion method, based on the analysis summary information fusion method based on Bayesian network, information fusion method based on evidence theory and the information fusion method based on expert system and information fusion method based on neural

network, on the basis of the advantages of ontology technology and neural network is put forward based on ontology and neural network of agricultural network information fusion method and framework.

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