A Fuzzy Aggregative Clustering Control Model of Information Appliances

Huey-Ming Lee[1] **, Ching-Hao Mao**[1] **, Shu-Yen Lee**[2]

[1] Department of Information Management, Chinese Culture University
55, Hwa-Kung Road, Yang-Ming-San, Taipei (11114), TAIWAN

[2] Dep. of Private Participation in Infrastructures, China Engineering Consultants, Inc.,
2nd Fl., No. 1, Ln. 240, Kiang Fu S. Road, Taipei, TAIWAN

Abstract:- In this paper, we propose a fuzzy aggregative clustering control model of information appliances (FACIA). This model is capable to cluster the information appliances (IAs), filter and extract the message of IAs automatically. Via the proposed model, the intelligent agent of information appliances (IAIA) not only can be more convenient and humanity for user, but also can be more efficient and accurate for IAIA's processing.

Key-word:- Fuzzy Cluster, Information Appliance

1 Introduction

Along with the prosperity of internet, information appliances (IAs), play an important role for the future. The IA devices can be expanded to related products of information. A satisfactory IA control mechanism can promote the integrity IA facilities, also, it enable the home network system more comfortable and convenience.

Lee and Huang [7] proposed an IA controlling model (IACM), which can control IA devices through home management broker. Lee et al. [6] presented IA intelligent agents (IAIA) to ensure the security and convenience of home environment. Wu and Jan [9] proposed home network management system integrity WAP and SMS by mobile communication devices. We can have that the home network has been expanded from local control to remote control, and from physical control to wireless control.

Information appliances control mechanism can make a decision according to the message of IAs [6, 7].If the control mechanism can filter the chaos messages and extract the useful characteristics of the messages, then it will be more effective and accurate.

Cluster analysis has been a fundamental research area in data analysis. Due to the fuzzy nature of many practical problems, a number of fuzzy clustering methods have been developed following the general fuzzy set theory strategies outlined by Zadeh [12]. In the fuzzy clustering literature, the fuzzy c-means clustering, proposed by Dunn [12] and extended by Bezdek [1] is the most used and discussed. FCM has become the most well-known and powerful method in cluster analysis [11].

In this study, we apply FCM algorithm [5] to simplify and filter the messages of IAs. We also apply the Maximum Tree algorithm [10] to obtain the cluster of IAs. Via the proposed model, the IAIA not only can be more convenient and humanity for user, but also can be more efficient and accurate.

2 FACIA

Lee et al. [8] proposed the fuzzy cluster model of information appliances (FCIA) in information appliance control model (IACM). FCIA can promote the group capability of IA intelligent agent for managing IA devices to receive the user's requests to cluster IA devices and response the results. However, the FCIA is short of the ability to process the messages of IA. As above, we proposed a fuzzy aggregative clustering control model of information appliance (FACIA),as shown in Figure 1.

There are three sub-models, saying IA clustering engine (IACE), IA message clustering engine (IAMCE) and user interaction model (UIM) in FACIA, as showing Figure 2. Also, there is an IA device database (IADD). The functions of these components are as the followings:
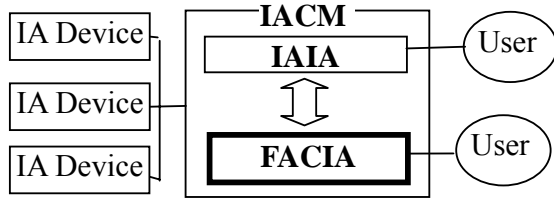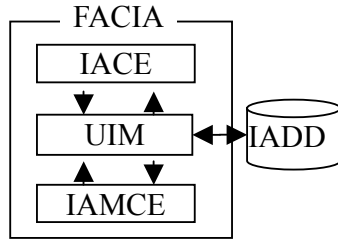
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Figure1 IA controlling model

Figure2 Fuzzy aggregative clustering control model of IA (FACIA)

- ■ IACE: IACE is the core of this model. The users' recognitions of IA device are clustered through fuzzy cluster.
- ■ *IAMCE: IAMCE can not only simplify the complicated IA message, but also filter the contradiction values.*
- ■ UIM: UIM plays the interface among users, IAIA, and IACE. The various operating parameters of IACE can be defined via UIM.
- ■ IADD: IADD stores the individual user's recognitions of IA devices, clustering results of IACE and the IA devices' message.

According to user's submission, UIM will request the clustering demands to IACE and IAMCE, then, IACE and IAMCE will response the clustering results to UIM.

2.1 IACE

The IACE is responsible for clustering works of IAs. It processes user's recognitions of IA to cluster IA devices, and it facilitates the management of remote control. The Figure 3 illustrates the operation flow of IACE. As the user's recognitions are put into the IACE, the input and output will be transmitted to user through UIM.

After IACE receiving data, the step of entering IACE is – message received. The data received in the message format will be analyzed at this step, and then the command will be transmitted to the

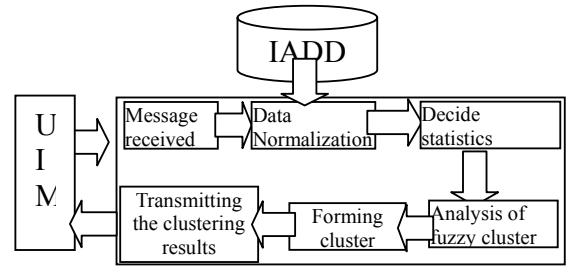data normalization. The data will

Figure 3 The operation flow of IACE

be acquired from IADD according to the command received. After acquiring the user's data from IADD, the procedure will enter into the step of data standardized, the data acquired from IADD will be standardized. For the data normalization, we employ the formula (1) [7] to proceed normalization:

$$X_{ij} = \frac{X_{ij} - \{X_{ij}\}Min}{\{X_{ij}\}Max - \{X_{ij}\}Min} \qquad (1)$$

$\{X_{ij}\}$ Min represents the minimum of actual measurement value in row j
$\{X_{ij}\}$ Max represents the maximum of actual measurement value in row j

After normalization, the data will be transmitted to the step of deciding statistics. The normalized data will be used to calculate the similarity of respective measurement attribute among IAs, consequently the fuzzy similar matrix is generated. For the IACE's deciding statistics, we apply the max-min method [7] as shown in (2):

$$r_{ij} = \frac{\sum_{k=1}^{n} Min(X_{ik}, X_{jk})}{\sum_{k=1}^{m} Max(X_{ik}, S_{jk})} \qquad (2)$$

The fuzzy similar matrix is transmitted to the step of analysis of fuzzy clustering. The fuzzy similar matrix is clustered via the fuzzy clustering. We apply the netting method [7] and the maximum number method [7] for fuzzy clustering.

Finally, the clustering results are transmitted to UIM via transmitting procedure. IACE will generate the cluster of IAs.

2.2 The weighing factors of IACE

This research incorporates the recognition conditions of security, entertainment, information acquiring, necessity for life, communication, comfort and convenience of devices and the recognitions of individual user of IA devices. The clustering information is acquired via IACE. Due to the different recognitions of individual user, the clustering results are different.

We ranged the user's recognitions of IA into seven grades. In many cases, we cannot express uncertainty problems simple by using the concept of probability. With the availability of concept of fuzzy set theory, we can solve the problem under fuzzy circumstances. Moreover, fuzziness can be quantified by using the properties of fuzzy numbers. We made the linguistic values 1,2, … , 7 into corresponding reasonable fuzzy numbers with triangular membership functions.

2.3 IAMCE

We apply the algorithm of FCM [5] to contract the IAMCE. IAMCE can not only simplify the chaos messages of IAs, but also filter the contradiction messages. There are two components, saying filter component and extract component, as shown in Figure 4 in IAMCE. The clustering, filter component is capable to filter the contradiction or chaos messages of IAs. Extracting Components can extract the characteristics messages of IAs.
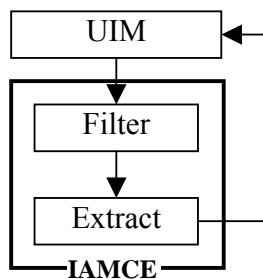

Figure 4 Information Appliance Message Clustering Engine

2.4 UIM

UIM plays the interface among users, IAIA, and IACE. The various operating parameters of IACE and IAMCE can be defined via UIM. Furthermore, UIM get the result of IACE or IAMCE, and saved the to IADD.

3. Implementation of FACIA

In this section, we will detail the practical environment for the model, and calculate the acquired data describes IACE by steps. Two clustering models are analyzed by maximum trees and netting mode, by substituting different λ interceptive value, different clustering models and the corresponding λ interceptive value can be obtained to represent the relationship between the clustering results. UIM's Web interactive Main interface will be presented at the end of this section.

3.1 Practical environment

For the purpose of ease manipulation, cross-platform, and remote-control capability, we have applied Java Server Page (JSP) and Java Servlet written Web Server structure, and Java 2 Platform Standard Edition v 1.4.2 API Specification is utilized for constructing FACIA's model. This model is constructed upon Tomcat server software that employs browsers as its interface; above mentioned are done with a Pentium III 700GHz Notebook that is powered by OS Windows Professional and Microsoft Access 2002 database.

3.2 Calculating procedure of empirical data

The diversity recognitions based on users' recognition on IA machine that may give a relevant level for machine and assessment factors. After normalizing the data, the similarity between each data would be calculated. This study would employ max-min method for showing the distance between each data, as shown in Table 1.

Table 1 User's recognition of IA device

In addition, we show two fuzzy clustering methods by netting mode and maximum numbers by fuzzy similar matrix $\underset{\sim}{R}$, and substituting different λ interceptive value.
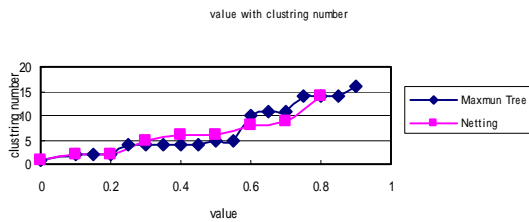
Figure 5 Diagram with different λ interceptive value

With maximum numbers method and λ=0.5, we obtained the cluster result as in Table 2.

Table 2 Max-tree method and λ =0.5
interceptive value

Cluster 1	Digital Washing Machine, Digital Microwave, Digital Fridge, Digital Deco Lamps, Digital Light,
Cluster 2	Home Server, PDA
Cluster 3	Digital TV, Notebook, Set-top Box, mobile phones.
Cluster 4	DVD Player, Game station
Cluster 5	Digital Air Condition
Cluster 6	IR Sensor, Temperature Sensor, Smoke Detector

By Figure 4, the suitable clustering results for two methods are between λ=0.4 and 0.6. Within this range, maximum number method of clustering is more stable than netting clustering method.

3.3 Filtering and Extracting IA message

In order to analyze the extracting ability of IAMCE, we implemented the collected 499 data into the FACIA. We obtained the clustering result as shown in Table 3. This model can not only filter the chaos message, but also extract the representative messages of IA.

Besides, the proposed model can filter the abnormal message of IA automatically, as shown in Table 4. Via the clustering analyzing of IAMCE, it can eliminate these abnormal data.

Table 3

Before Clustering	After Clustering
499	121

(Computing 15 seconds)

Table 4

tem	hum	AC	Description
90	0	0	Tem is too high
150	20	100000	Tem and hum is unusual

where tem: temperature; hum: humidity;
AC: Air_ Condition

4. Conclusion

This study presents a prototype for FACIA model, and shows its feasibility empirically with the result analytically assessed. We made some comments about this model.

(1) As Figure 5, the suitable clustering results for two methods are between λ=0.4 and 0.6. In this range, maximum number method of clustering is more stable than netting clustering method. Besides, maximum trees method is more economical in terms of calculating system data. Therefore, maximum trees method is preferable in this model.

(2) From Table 3 and Table 4, we have that the FACIA can increase the processing ability of IAIA

As mention above, the FACIA makes IAIA not only be more humanistic and convenient for user, but also can be more efficient and accurate for IAIA's processing.

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