The Fuzzy and Compartment System Concept for the Communication System taking account of the Handicapped situation

Masahiro Aruga

Department of Human and Information Science, School of Information Science and Technology , Tokai University

Kitakaname 4-1-1, Hiratsuka-shi, Kanagawa-ken, 259-1292, Japan

Institute of Intelligent Communications (corporative NPO, Japan)

Suehiro-cho 6-12 Kashiwa-shi, Chiba-ken, 277-0842, Japan

Department of Information Systems, Faculty of Engineering, Saitama Institute of Technology

Fusaiji 1690, Fukaya-shi, Saitama-ken, 369-0293, Japan

and

Masayuki Aruga

Culture and Information Sciences, Interdisciplinary Cultural Sciences Program,

Graduate School of Arts and Sciences,

The School of Graduate Studies,

The Open University of Japan

Wakaba 2-11, Mihama-ku, Chiba-ken, 261-8586, Japan

ABSTRACT

In the previous papers the process of structuring the Life support system to consider the essential meaning of the ubiquitous system has been presented. There the Life support system is shown as it is synthesized from the Expanded EMR and on the basis of such an essential concept of the ubiquitous system as it is in the recovery of lost functions of ordinary persons. The Life support system has been described to be synthesized with embedding the communication system for the handicapped people as a module, and as such an example of the embedded communication system as a module the "YUBITSUKIYI" system has been described. Considering the synthesis of the Life support system the transmission structure of information of this system has been needed to be studied, and there some concepts over the ordinary Shannon's information theory are needed to be introduced into analysis of the information itself and the information system structure with regard to this Life support system. In this paper, there are described the expansion concepts of information theory to the consideration of the compartment system taking account of the Fuzzy information amounts over the discussion which was already described in the authors' previous papers.

Keywords: the dementia situation, the information amounts, the Fuzzy Compartment system, Markov's information source.

1. INTRODUCTION

In the previous papers authors have reported the essential meaning of the ubiquitous concept. That is; there is the essential significance of the ubiquitous idea in the recovery of lost functions of ordinary persons. Although in the recent years the concept of ubiquitous system has been popular and popular the consideration of its negative phase has not enough been

discussed. Therefore authors have made a fundamental element of the essential significance of the ubiquitous concept so clear as the above description. On this essential meaning the Life support system has been structured and proposed involving the communication system able to be used among the handicapped and ordinary persons as a module. This Life support system has been developed from the expanded EMR (the EMR is the initial word of the Electric or Electronic Medical Record, and such a name as the Expanded EMR has now been adapted in author's papers as the word to be different from the ordinary EMR or Electronic Health Record, but in the future if more appropriate name appears its name will be able to be adapted.). And now as the communication system and device for the handicapped persons the YUBITSUKIYI (which is the name of communication device for blind deaf persons. See Fig.3) system has been used with being embedded in the Life support system. Of course, this Life Support System itself has been developed now, and of course this communication device and other devices have been developed until now and they have been discussed to be embedded into the Life support system as other modules, but in this paper the development and synthesizing process of those other modules are omitted. These development process and results will be presented in other papers. Here, the most fundamental and important view points on dynamical situation of such system are on the information structures and the information amounts while such system working. Until now there have been discussed three cases of study on this view points in parallel; that is, The first case of them is the consideration of entirely new information concepts different from the ordinary information theory, and the second case of them is the consideration of information concepts on some philosophical view points (for instance, Peirce's semiotics and its interpretants etc.), and the third case of them is the consideration of information concepts on the basis of Fuzzy concepts and expanded from the ordinary Shannon's information theory to the Fuzzy system's idea. In this paper the third case is mainly discussed, and in it the outline to introduce the Fuzzy system for analyzing and synthesizing the information system model is described, and there are described the expansion concepts of information theory to the consideration of the compartment system taking account of the Fuzzy information amounts over the discussion which was already described in the authors' previous papers. Therefore in this paper firstly the brief description of synthesis of the Life support system is described, there at same time the communication system for blind deaf persons needed to study the new information theory taking account of the Fuzzy concepts is briefly described. Secondly the Fuzzy idea with regard to such communication system is described, and there the Fuzzy concept is introduced to be applied to dementia situation and the characters of its model are derived. And furthermore, there, it is described that when considering the Fuzzy concepts and relations derived from the Fuzzy system theory expanded from the ordinary Shannon's information theory the Markov's information source is able to be considered as a kind of Fuzzy information source. Especially it is shown that even if the most simple example of the Fuzzy concepts taking account of the Markov's information source it is able to become a simple model of such handicapped and dementia situations. Thirdly the outline of the compartment system and the introduction method of the Fuzzy concepts into this compartment system concepts are described. And finally the conclusion and further works are described.

2. THE SYNTHESIS OF THE LIFE SUPPORT SYSTEM AND THE COMMUNICATION SYSTEM FOR THE BLIND DEAF PERSONS

In recent years the popular ubiquitous concept have been promoted mainly on the view point of its merit issues. But this easy promotion has very dangerous problems because the one who use the ubiquitous system is humankind to have not only the positive mind but also the negative mind. Therefore considering the negative phase of the ubiquitous idea the essential significance of the ubiquitous concept was made so clear as the recovery of lost functions of the human being and the handicapped situations. On this essential concept the Life support system has been synthesized embedding the

communication system for the blind deaf persons. The Life support system has been developed from the expanded EMR on the base of Linux OS, and as the communication system and device to be embedded in the Life support system the YUBITSUKYI system has now been used. This YUBITSUKYI system was developed and is now developed for the communication among the blind deaf persons and the ordinary people. In today's Japan it is estimated that there are about 20,000 blind deaf persons, and it is able to be conjectured that the number of the blind deaf persons in the present whole world is greater than several times of the number of Japan's blind deaf persons of today. Therefore the Life Support System into which the "YUBITSUKYI" system is embedded as a module has been useful not only for the communication among the handicapped and ordinary persons, but also for the diagnosis of dementia, especially the diagnosis of the blind deaf persons. For as an ontology the dementia situation is able to be treated as a kind of handicapped situation. That is; as the dementia situation is able to be understood as the state of the lost functions of ordinary persons, authors have considered and defined that the dementia situation is a kind of handicapped situation. In this paper such consideration is adapted as same as authors' previous papers. Now the outline of the "YUBITSUKYI" system is briefly described at the following. It is the system with which the blind deaf persons are able to communicate among themselves and others. The word "YUBITSUKYI" (see Fig.3) is the name of device of this communication system. And this device has been designed on the basis of the Finger Braille that is structured on the Braille patterns (see Fig.1, Fig.2). Of course, though such techniques are able to satisfy user's needs to some extent, the "YUBITSUKYI" system is useful to not only such communication process but also information processing. For as the "YUBITUKYI" is the electrical tool (at present having been improved), the signals of this tool are able to be treated by electrical signal processing techniques and this data are able to be treated directly as the information processing data. The finger Braille technique is structured on the Braille system in which two sorts of point patterns (that is; Convex and Concave sides) have been used. The Fig.1 shows a Braille pattern of

Japanese character "ka", and its symmetrical expression patterns of the Braille and the finger Braille corresponding number of the character. As a result the "YUBITUKYI" system uses such finger Braille patterns, and using the touch sense of the six vibrating points the character patterns are able to be understood among the users of this system, and the mutual communications of users of this system are performed. [1],[2]
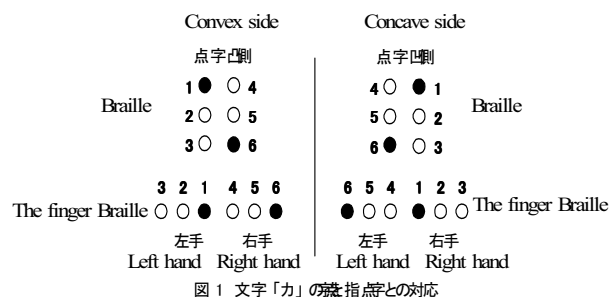

Fig.1 The correspondence of Braille and the Finger Braille

Fig.2 The Finger Braille

Fig.3 The " YUBITUKYI"(Left:Ver.1, Right: Ver.2)

3. THE FUZZY INFORMATION SOURCE AND CONSIDERATION OF MODEL FOR THE HANDICAPPED AND DEMENTIA SITUATION

In the Life support system the joysticks of the " YUBITUKYI" terminals have been used as devices of the communication system among the blind deaf persons and ordinary people, and through the touch sense of the total 8 vibrating points of those devices the communication is performed. The 2 points in the 8 points are for the function of transmission of signals and the patterns of Japanese characters are structured by the 6 points that are left. Therefore the character patterns are made by these 6 points, and those patterns are considered as the fundamental information elements. Here, from the Shannon's theory the active state of vibrating points means to arise the events of ON or OFF., and the information amounts of 6 bit show that the set of total $2^6 =$ 64 patterns of Japanese character is the fundamental pattern set. But the handicapped and dementia situations are not enough able to be identified only by such information theory. Therefore the examination of new information idea over the Shannon's theory has been needed for the analysis of information system of the handicapped and dementia situations. Then on the third case described in the above chapter 1 the Fuzzy concepts have been introduced for such analysis. In this paper, expanding the Fuzzy concepts in the author's previous papers the compartment system and its Fuzzy idea are proposed to be introduced as an analyzing and identifying technique of such situations. As shown in author's previous papers with regard to SF (the sign of Fundamental Set), FA (the sign of the Fuzzy Set), x_i (i=1,2,~64, the elements of SF) and $m_{FA}(x_i)$ (i=1,2,~64, the membership function of each x_i) are the following relations. There each different membership function is applied to each different handicapped and dementia situation.

And each Fuzzy Set (FB,FC,...) is made from each membership function ($m_{FB}(x_i)$, $m_{FC}(x_i)$, ...). When the membership function $m_{FA}(x_i)$ (i=1,2,~64) , and the Probability of the element x_i (i=1,2,~64) is $p_i=P(x_i)$ (i=1,2,~64), here p is a set of p={ p_i }, then the probability of the Fuzzy event P(FA)

becomes

$$P(FA)=\sum_{i=1\sim64} m_{FA}(x_i)P(x_i) \ \ldots\ldots\ldots\ldots (1)$$

As a result, the information content , I(FA | p) with regard to Fuzzy set FA becomes

$$I(FA \mid p) =(1/P(FA)) \sum_{i=1\sim64} P(x_i)m_{FA}(x_i) \log m_{FA}(x_i) + \log(1/P(FA)), (i=1,2,\sim64) \ \ldots\ldots\ldots\ldots (2)$$

And the Fuzzy content is

$$F(FA \mid p) = I(FA)-I(FA \mid p) \ \ldots\ldots\ldots\ldots(3)$$

and this is able to be used as an index of such situation. Here I(FA) is the information amount in such case as the set FA is a ordinary set, and at this time the values of the membership function to derive the set FA are 0 or 1. Furthermore the Markov's information sources with regard to the Fuzzy set have been introduced into discussion. There the Fuzzy Markov's information sources are defined by the Fuzzy conditional probability to be derived from the Fuzzy set. Here, the Fuzzy concept is introduced firstly considering the Ergodic character for the space of ordinary Markov's information source and secondly considering that this fundamental elements have the membership functions corresponding to the elements of the space. As a result, considering the conditional probabilities of the Markov's information source, the space of {($s_{j1},s_{j2}...,s_{jm}$, s_i) } which defines

$$P(s_{j1},s_{j2}...,s_{jm}, s_i) = P(s_i/s_{j1},s_{j2}...,s_{jm}) \times P(s_{j1},s_{j2}...,s_{jm}) \ \ldots\ldots\ldots(4)$$

derives the Fuzzy conditional probabilities. Here the membership functions are given to s_{jk} and ($s_{j1},s_{j2}...,s_{jm}$, s_i), and the Fuzzy Markov's information source is introduced as the function of the given membership function and the contents derived from the Fuzzy set. These Fuzzy concepts are able to synthesize the models of the handicapped and dementia situations. [1]-[3]

In this paper, progressing the step more forward, the Fuzzy concepts are applied to the compartment system theory to make the models of the handicapped and dementia situations more useful.

4. THE COMPARTMENT SYSTEM AND THE FUZZY CONCEPTS

The outline of compartment system and its characters are the followings. Ordinary compartment system is expressed with a transfer matrix A and the state variable vector x as the following formulas. And the Bu in this expression and the t are the controllable term and the time.

$$\mathrm{d}\,x./\mathrm{d}t = \mathrm{A}\,x. \quad \text{or} \quad \mathrm{d}\,x./\mathrm{d}t = \mathrm{A}\,x + \mathrm{B}u \quad \ldots\ldots..(5)$$

Each Laplace transformation of them is the following.

$$X(s) = [sI\text{-}A]X(s) \text{ or } X(s) = [sI\text{-}A]X(s) + BU(s) \ldots(6)$$

Here considering such compartment system as a model of the handicapped and dementia situations the Fuzzy concepts are applied to the compartment system. Then the compartment system concepts are expanded from the ordinary passive meaning of definition to its active meaning of definition, after that on the active meaning the Fuzzy elements are distributed to that active compartment system characters. As a result the total compartment system models involving the original objective events above described are expanded to the Fuzzy compartment system models. Here a part of the second case to be described in the above chapter 1 is considered for these objective events and the Fuzzy concepts of them. That is; when considering the compartment system models the concepts of the interpretants of Peirce's Semiotics are fundamentally introduced into a part of such models. And the Fuzzy concepts are introduced on following order. Firstly these interpretants of Peirce's Semiotics are treated as the ordinary compartment system elements and secondly this compartment system elements are extended to the Fuzzy elements. The following Fig 4's compartment systems are two typical and simple compartment systems, which are named the Catenary system and the Mammillary system.
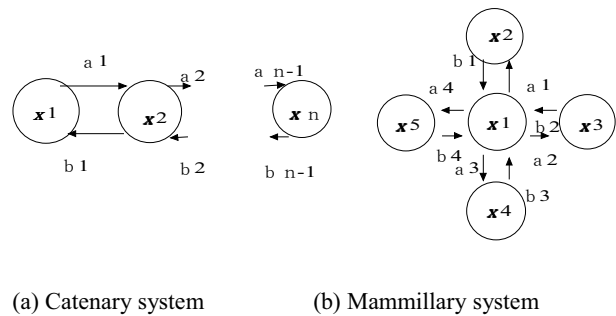

(a) Catenary system   (b) Mammillary system

Fig.4 The Catenary and Mammillary system

And these system expressions with matrixes and vectors are the followings. But the Fig 4's transfer factors a_i, b_i are so explained as the usual expression a_{ij}. That is; an expression

$$\begin{bmatrix} dx_1/dt \\ dx_2/dt \\ \cdot \\ \cdot \\ dx_n/dt \end{bmatrix} = \begin{bmatrix} -\sum_{i=1}^{n} a_{i1} & a_{12} & a_{13} & \cdot & a_{1n} \\ a_{21} & -a_{12} & 0 & \cdot & 0 \\ a_{31} & 0 & -a_{13} & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n1} & 0 & 0 & \cdot & -a_{1n} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ x_n \end{bmatrix} + Bu$$

$$\ldots\ldots.(7)$$

is the Mammillary system with matrixes and vectors.

And an expression

$$\begin{bmatrix} dx_1/dt \\ dx_2/dt \\ \cdot \\ \cdot \\ dx_n/dt \end{bmatrix} = \begin{bmatrix} -a_{21} & a_{12} & \cdot & \cdot & 0 \\ a_{21} & -(a_{12}+a_{32}) & a_{23} & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & 0 & a_{n-1n-2} & -(a_{n-2}+a_{n-1}) & a_{n-1n} \\ 0 & 0 & \cdot & a_{n-1} & -a_{n-1n} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ x_n \end{bmatrix} + Bu$$

$$\ldots\ldots..(8)$$

is the Catenary system with matrixes and vectors.

In the compartment system characters there are the circuit analogy model characters, but here the details of them are omitted. They will be presented in other papers. As a model of memory structure of handicapped and dementia situations a simple Fuzzy compartment system model derived from the catenary system is able to be used. As an example such Fuzzy elements as the membership functions $m_A(a_{ij})$ and $m_C(x_i)$

corresponding to the elements of the transfer matrix and the compartments themselves are able to be introduced into the Fuzzy compartment system models, and a relation, $a_{ij} \times m_A(a_{ij}) \times m_C(x_i)$ is able to be used as a kind of Fuzzy element of the Fuzzy compartment system models. As a result a part of the handicapped and dementia situation is able to be expressed as a Fuzzy compartment system model. And when the Fuzzy compartment system model derived from the catenary system is applied to the above example of memory structure of the handicapped and dementia situation the depth *n* of memory or the number *n* of the compartments must be discussed corresponding to the objective situations although the most simple example is *n*=1. Namely it is estimated that this factor *n* of the number of such compartments is able to be applied to the consideration of calling process model of the original memory objects. [2]-[4]

5. THE CONCLUSION AND FURTHER WORKS

In this paper expanding the Fuzzy contents shown in author's previous papers the concepts of the Fuzzy compartment system are developed and introduced for the models of the handicapped and dementia situations and a simple Fuzzy compartment system model of memory structure of them and the examples of its Fuzzy elements are presented And the necessity of discussing the depth or the number of compartments of the model is shown. After this the concrete values of the Fuzzy compartment system elements and some more appropriate Fuzzy compartment system models must be derived corresponding to the individual concrete handicapped and dementia situations.

6. ACKNOWLEDGEMENT

7. REFENCES

[1] Masahiro Aruga, Takashi Takeda, Shuichi Kato: A Communication system taking account of the blind deaf persons and the Life support system to be expanded from Electric Medical Record system, The 10 th World Multi-Conference on Systemics, Cybernetics and Informatics Proceedings Volume 2, pp178-183, July 2006, Orlando Florida

[2] Masahiro Aruga, Takashi Takeda, Shinu Ryu, Shuichi Kato: An Essential Meaning of Ubiquitous Concept and the Expanded Function of the EMR System taking account of the Life Support System, The 11 th World Multi-Conference on Systemics, Cybernetics and Informatics Proceedings Volume V, pp182-187, July 2007, Orlando Florida

[3] Masahiro Aruga, Shuichiro Ono, Kiyotaka Takagi, Shuichi Kato: A kind of discussing method of information contents taking account of the YUBITSUKIYI system embedded into the Life Support System, The 12 th World Multi-Conference on Systemics, Cybernetics and Informatics, Jointly with The 14th International Conference on Information Systems Analysis and Synthesis, Proceedings Volume II, pp202-207, June29th-July2nd 2008, Orlando Florida

[4] Masahiro Aruga, Kiyotaka Takagi, Shuichi Kato: On the expanded information contents for the YUBITSUKIYI system and the Dementia situation taking account of Fuzzy concept of Markov's information source, The 2nd International Multi-Conference on Engineering and Technological Innovation, Proceedings Volume I, pp100-105, July10-13 2009, Orlando Florida