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Knowledge Extraction for Infomation Fusion

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***Abstract*—The important thing in doing planning and mission execution is to gain data and information from observation result. From data and the information which have been collected, can be design an appropriate strategy, reviewed from various perspectives to minimize the loss in mission execution. Therefore an appropriate method should be used to perform Knowldege Extraction for any information obtained from these observations. Fusion Information based on Cognitive Artificial Intelligence (CAI) is intended to produce a complete information processing and fast as a basis for planning and mission execution. This paper will explain the process of infomation fusion based on CAI, for doing Knowledge Extraction, so it can take appropriate conclusions for the results of observations made .**

***Keywords*— Information Fusion, Knowledge Extraction, Cognitive Artificial Intelligence**

I. Introduction

Decision-making in the execution of a mission or operation requires several stages of information processing. Such information is usually obtained from a variety of sources that can support the course of operation or mission . For example, in military missions , the decision to carry out military operations normally be taken by a local security conditions , weather conditions, availability of ammunition , etc . Another example is in medical operation , making the diagnosis of disease and medical solution according from diagnosis result, are usually obtained from the medical records of the patients , the results of laboratory tests , the condition of the body when handling , etc .

Along with the development of Artificial Intelligence (AI) , some AI-based decision making method has also growing rapidly. Most of the existing method uses the concept of agents to help decision-making. AI learning method's which is commonnly use is : Fuzzy Logic , Neural Network (NN), and Genetic Algorithm (GA). Each method is basically trying to emulate how humans process any data and information obtained to generate new knowledge .

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Fuzzy overcome the limitations of logic ' 1 ' and ' 0' on the system logic , and often used in intelligent control systems , NN introducing unsupervised and supervised learning methods , while GA emulation of biological evolution and is often used for process optimization .

The most appropriate model in designing a method of decision making is the process of the human brain in learning something to gain knowledge. In processing the information received, the human brain gain input from the five senses. Each sensory system receives the information based on its function. Eyes to see, ears to hear, noses to smell, etc. Each information combined (fusion) into a single unified knowledge. Based on the mechanism of the human brain in processing information, in 2009, Science in Artificial Intelligence gained a new direction, that is, not only mimicry behaviors and ways of thinking but also explores how humans process knowledge growth. The concept was developed by Adang and Arwin and called ***Information Fusion*** method. In contrast to the existing methods of AI this method focuses on learning and growing knowledge of the learning outcomes. Therefore, this method hereinafter referred to as Cognitive Artificial Intelligence.

This paper will explain how to perform the extraction of knowledge for Information Fusion , so that it can produce results that can be used as a reference for decision making. Starting at Section I which delivered a background of this research, then followed by Section II which describes theoretical background about information fusion. Section III will present the development of Information fusion. This paper will be closed by section IV which will deliver some part of our research result and future work for this research.

II. Theoretical Background

A. *Information Fusion*

What is information fusion ? Basically Information Fusion is the combination process of information from various sources that generate a single information . For example , humans can know an apple by shape , flavor , texture and color. The more complete the information received , the more accurate single information obtained . This single update information hereinafter referred to as the Ultimate Knowledge. Figure 1. Illustrate the process of Fusion Information

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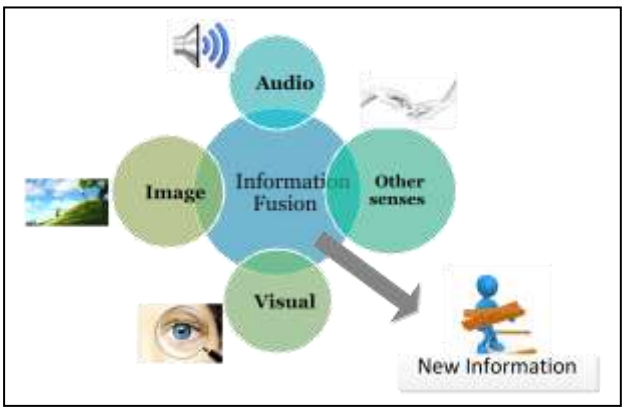

Figure 1. Fusion Information Process inside Human being

In the next process , the new information will be fused with the knowledge that has been owned previously (this is called *Prior Knowledge*) . The outcome of this process is new knowledge that is more complete, which is called *Posterior Knowledge*. This knowledge is then compared with the knowledge that has been stored in the brain to produce results (inferencing) . This inferencing result will be used as the basic for the decision making to perform an action. [1]. This process to gain inferencing result is illustrated at Figure 2

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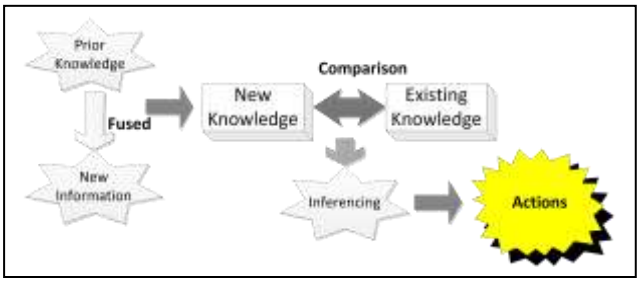

Figure 2. Process to gain inferencing result

B. *Information Fusion's Computation*

In the field of Artificial Intelligent (AI) , the method of decision-making (inference method) is the most commonly used method for decision –making (Inference-method) is Bayesian Inference Method (BIM), where the method is based on *Bayes Probability* rules as formulated as follows :

$$P(Bj \mid A) = \frac{P(A \mid Bj)P(Bj)}{\Sigma jP(A \mid Bj)P(Bj)} \qquad (1)$$

Where :

P(Bj|A) : *posterior probability*, the probability of hypothesis B when A is occured
P(A|Bj) : *prior probabiliy* , the probability of indication A when B is occured
P(Bj) : *prior probability* when B is occured.

And then to obtain process of information fusion, formula (1) is enhanced become (2) :

$$P(A_i \oplus B_j) = \max_{j=1,\ldots,m} \frac{\sum_{i=1}^{n}(P(B_j \mid A_i))}{n} \qquad (2)\ [1,2]$$

Where n is number of sensor.

if $P(V^i_j) = P(B_j|A_i)$ and $P(\psi^i_t) = P(B_j \oplus A_i)$, n = δ, formula (2) can be writen as (3) :

$$P(\psi_t^i) = \frac{\sum_{i=1}^{\delta}(V_j^i)}{\delta} \qquad (3)[1,2]$$

Where :

V^i_j : sensor respond to hypothesis
δ : number of sensor
$P(\psi_t^j)$: best value of hypothesis at each observation time

Formula at (3) is called A3S 's equation (Arwin Adang Acik Sembiring). Calculation result from (3) is accumulate to gain the value of *Degree of Certainty* (DoC)[2][3]. DoC basically is a value representing the most possibilities hypothesis among all alternatif hypothesis. Therefore DoC value also state the ultimate knowledge.

In order to understand the course of A3s equation in equation (3) above , then made the following illustration :

TABLE I. TABLE ILLUSTRATED INFORMATION FOR OF A3S EQUATION

t (observation time)	Sensors	Hypotesis			
		H_1	H_2	H_3	H_4
t1	S_1	**1**	**0**	**0**	**0**
	S_2	**1**	**0**	**0**	**0**
	S_3	**0**	**0**	**0**	**0**
	S_4	**0**	**0**	**0**	**0**
t2	S_1	**0**	**0**	**0**	**0**
	S_2	**0**	**1**	**0**	**0**
	S_3	**0**	**1**	**0**	**0**
	S_4	**0**	**1**	**0**	**0**
t3	S_1	**0**	**0**	**0**	**0**
	S_2	**0**	**1**	**0**	**0**
	S_3	**0**	**1**	**0**	**0**
	S_4	**0**	**1**	**0**	**0**

Table 1 illustrated the receive information for A3S equation. The observation of the information represented by a logic '1' indicating that the hypothesis is accordance with the results of sensor observations , logic ' 0' state otherwise .

A3S computation according to the set of information at Table 1, is shown in Table 2.

TABLE II. TABLE RESULT OF A3S FROM TABLE 1

t	Hypotesis			
	H_1	H_2	H_3	H_4
t_1	**1**	**0**	**0**	**0**
t2	**0.5**	**0.5**	**0**	**0**
t3	**0.333**	**0.667**	**0**	**0**

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From the result from Table II, it can be seen that H_2 is the best Hyphotesis from all observation from time to time. The result from H_2 at t3, is called DoC from this observation. The results of this DoC declare that the information can be used as a new knowledge .

III. The Development of Information Fusion for Knowledge Extraction

A3S has been tested on the construction of the software on one of the government agencies of the Republic of Indonesia . This software is used to help making decisions according on input from the indications and possible events which may occure , related to duties of the agency. The program is created using programming language Visual C.

The course of this program can be explained as follows : The input of this program is indicative of field observations and hypotheses , which is a probability of occurrence (or action) which is experienced by the object being observed. Information from observations and hypotheses are then fused with A3S equation , to see the possibility of events being experienced . The results of this program is in the form of graphs, showing aspects of the probability of occurrence based on the observation that observed in a certain time .

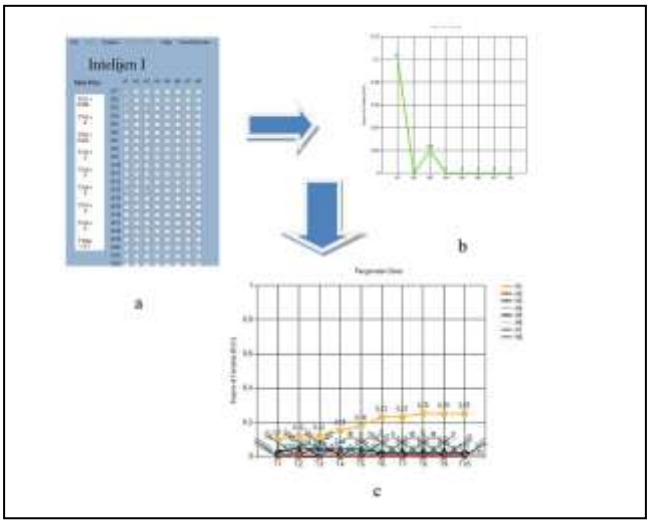

Figure 3. Output Result of A3S method (a) data input (b) graphical representation of one observation time (c) Graphical representation of all observation time

In each observation time , the user enters the data in the associate table (Figure 3a) . Entered data is indicative of the potential fit between the hypothesis according to the information available. In each observation time , the program will calculate the probability the greatest value of each hypothesis (Figure 3b) . The end result of this program is the graph of the overall observations , which demonstrate the greatest possible relationship hypotheses and indications occur .

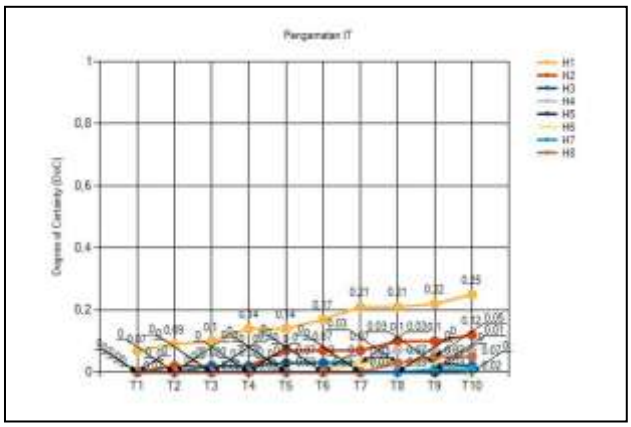

Figure 4. Details observation result

Figure 4 show the details of observation result from A3S computation for this software. Observations conducted over 10 times . The observations show that the value of the DoC in H_1 rose significantly during the observation period . So it can be said that in these observations H_1 is the best hypothesis generated in this observation .

IV. Concluding Remark

This paper delivered how fusion information can be used as Knowledge Extraction. From test result, it can be shown that Information Fusion offering a new method for development in Artificial Intelligence, to help making decision according information which have been receive from observation environment. Because its ability to doing information fusion and grow its knowledge, A3S methods which is used in Information Fusion can be said as Cognitive Artificial Intelligence (CAI).

After applying this A3S algorithm in form of software for decision-maker's tools, currenty we are doing research to design a kind of processor which equipped with algorithm of A3S, called Cognitive Processor. With A3S algorithm, cognitive processor can be used as a main control for an autonomous system, which have ability to grow it knowledge continuously, as time passes. Because this system come in form of SoC, cognitive processor able to support the development of autonomous-*mobile* electronic instrumentation.

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References

[1] A.P. Engelbrecht, *Computational Intelligence: An Introduction*, 2nd ed., L. Faussett, *Fundamentals of Neural Networks: Architectures, Algorithms, and Applications*, Prentice-Hall, USA: New Jersey, 1994.

[2] Sumari, A.D.W., Ahmad, A.S., Wuryandari, A.I. dan Sembiring, J. ," Brain-inspired Knowledge Growing-System: Towards A True Cognitive Agent, *International Journal of Computer Science &*

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Artificial Intelligence (IJCSAI). Vol. 2, No. 1, World Academic Publishing, 26-36,. 2012.

[3] A.D.W. Sumari and A.S. Ahmad, "Design and implementation of multi agent-based information fusion system for supporting decision making (a case study on military operation)," *ITB Journal of Information and Communication Technology*, Vol. 2, No. 1, May 2009, Institut Teknologi Bandung, Bandung, pp. 42-63.

[4] C.O Sereati, A.D.W. Sumari, A.S. Ahmad, and T.Adiono , "Study of Information Fusion Methodology and Knowledge Growing System Algorithm To Design Cognitive Processor ", Int'l Confrence of : "*The 14th International Conference on QiR (Quality in Research) 2015"* – Lombok, Indonesia, 2015.

[5] Sumari, A.D.W., Ahmad, A.S., Wuryandari, A.I. dan Sembiring, J. " Constructing Brain-Inspired KnowledgeGrowing System: A Review and A Design Concept. *International Conference on Distributed Frameworks for Multimedia Applications (DFmA)*. Yogjakarta 2-3 Agustus. pp. 1- 7, ISBN 978-1-4244-9335-7, 2016.

[6] A.D.W. Sumari, A.S. Ahmad, A.I. Wuryandari, and J. Sembiring,"Computational probability for knowledge growing system: a review," submitted to *Seminar Nasional Matematika 2009*, Universitas Katolik Parahyangan, Bandung, 5 September 2009.

[7] H. Henderson, *Artificial Intelligence: Mirrors of Mind*, Chelsea House, USA: New York, 2007.

[8] S.J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 2nd ed., Prentice-Hall, USA: New Jersey, 2002.

[9] L.W. Panjaitan, *Dasar-Dasar Komputasi Cerdas*, Yogyakarta: Andi Offset, 2007.

[10] T. Munakata, London: Spinger-Verlag, 2008. *Fundamentals of the NewArtificial Intelligence: Neural, Evolutionary, Fuzzy, and More 2nd Edition*.

[11] M.W. Eysenck, Principles of Cognitive Psychology 2nd ed., New York: Psychology Press Ltd., 2001.

[12] T.A. Hightower, "Boyd's O.O.D.A Loop and How We Use It". [Online]. Available: http://www.tacticalresponse.com/d/node/226, 2007

[13] Y.Chen and D.M. Pennock, "Information Markets vs. Opinion Pools: an Empirical Comparison". [Online]. Available: http://dpennock.com/papers/chen-ec-2005-market-vs-pool.pdf., 2005.

[14] A.S. Ahmad, *Natural Computation as Future Computation Paradigm to Support Life Quality Enhancement*, Scientific Address in the 47th Anniversary of Institut Teknologi Bandung, 2 March 2006.

[15] A.D.W. Sumari and A.S. Ahmad, "Designing multiagent-based information fusion system", in Proc. 1st MICEEI'08, 2008, paper, pp. 137-143.

[16] A.D.W. Sumari, *the Modeling of A3S (Arwin-Adang-Aciek-Sembiring) Information-Inferencing Fusion Method*, Tech. Rep., Institut Teknologi Bandung, 2008.

[17] A.D.W. Sumari, A.S. Ahmad, A.I. Wuryandari and J. Sembiring, "Brain-inspired knowledge-growing system and its application in biomedical engineering: inferring genes behavior in genetic regulatory system", Journal of eHealth Technology and Application (JETA), Vol. 8, No. 2, pp. 141-151, September 2010.

[18] W. Adiprawita, A.S. Ahmad, J. Sembiring, and B.R. Trilaksono, "New resampling algorithm for particle filter localization for mobile robot with 3 ultrasonic sonar sensor", in 2011 Int. Conf. on Electrical Engineering and Informatics, 17-19 July 2011.

[19] W. Adiprawita, A.S. Ahmad, J. Sembiring, and B.R. Trilaksono, "A Novel resampling method for particle filter for mobile robot localization", Int. Journal on Electrical Engineering and Informatics, Vol. 3, No. 2, pp. 165-177, 2011.

[20] A.D.W. Sumari, "Sistem Berpengetahuan-Tumbuh: Satu Perspektif Baru dalam Kecerdasan Tiruan", Doctor of Electrical Engineering and Informatics Dissertation, School ofElectrical Engineering and Informatics, Institut Teknologi Bandung, Bandung, 2010.

[21] A.S. Ahmad and A.D.W. Sumari, *Multi-Agent Information Inferencing Fusion in Integrated Information System*, ITB Publisher, Republic of Indonesia: Bandung, 2008.

[22] A.D.W. Sumari, "Design and implementation of a multi-agent information fusion system for decision making support in air operation planning," M.T. Thesis, Institut Teknologi Bandung, Bandung, Indonesia, April 2008.

[23] A.S. Ahmad and A.D.W. Sumari, "A novel approach for inferring the genes interaction in genetic regulatory system to obtain genes behavior," submitted to IEEE Conference on Bioinformatics and Biomedicine 2009 (BIBM2009), 2009, paper.

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