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Automatic System for Calculating Dose of Thiopentone Based on Static Physiological Parameters

Dipti S. Diwase*
Research Scholar, Department of Comp Sci & Engg
G. H. Raisoni College of Engineering,
Nagpur, India
diptidiwase18@gmail.com

Prof. R. W. Jasutkar
Assistant Professor, Department of Comp Sci & Engg
G. H. Raisoni College of Engineering,
Nagpur, India
r_jasutkar@yahoo.com

Abstract: The main objective behind the development of proposed system is to introduce an automatic system based on fuzzy controller that utilizes linguistic fuzzy rules for simulating dose of anesthesia levels and adjusts the infusion rate with respect to input parameter. Here we are using Thiopentone as anesthetic agent. Dose of Thiopentone is calculated on the basis of parameters like Age, weight, height of a patient. The method is based on the analysis of these variables by giving membership function, evaluation of rule based system and defuzzification process to control the depth of Thiopentone and decide required dose of Thiopentone. The major advantage of proposed system is to provide ease to anaesthesiologist so that he/she can attention to other physiological variables which they have to keep under control.

Keywords: Thiopentone, fuzzy controller, If...then rule base, membership function designing, static physiological parameters.

I. INTRODUCTION

Anesthesia is described as a part of medical profession, which ensure that the patient's body remain insensitive to pain and other stimuli during surgical operation. It includes muscle relaxation, unconsciousness and analgesia [1]. The actual anesthetic procedure is a two step process. Drugs are initially given to "induce" anesthesia and later maintaining anesthesia during surgery [2][3] . Generally initial dose of anesthesia is given by considering physiological parameters like height, weight and age. In critical situation this analysis become more difficult and anesthetic makes empirical decisions for dose of anesthesia. It creates a lot of pressure on the anesthesiologist and becomes very difficult to monitor other physiological factor. So an expert system for calculating dose of anesthesia according to value of the input physiological parameters (age, weight and height) is always welcome.

Few fuzzy based systems are developed to monitor the dose of anesthesia. A.Yardimci [4] designed microcontroller based fuzzy logic system for sevoflurane. On the other hand M. Logesh Kumar [5] emphasizes on a fuzzy controller to control mean arterial blood pressure and cardiac output by administering three drugs dopamine, Sodium Nitro Prusside and Phenylephrine which perform the function of increasing heartbeat rate, decreases, and increases blood pressure respectively. Prof. H. T. Kashipara, Mr. T. V. Bhatt [6] preferred isoflurane as an anesthetic agent and regulate the dose of anesthesia on the basis of real time varying physiological parameters.

In [7] we have implemented fuzzy controller for regulating dose for regulating dose of isoflurane by considering physiological parameters like systolic pressure, diastolic pressure and heart rate. This system is useful for maintaining dose of anesthesia during surgery. Now we are considering other physiological parameter like age, height and weight for calculating initial dose of Thiopentone. The main objective is to develop a system based on fuzzy controller that utilizes linguistic fuzzy rules for simulating anesthesia levels and adjusts the infusion rate with respect to input variables. For the modeling purpose fuzzy input variables such as age, height and weight are obtained from the patient before the surgery start. According to the value of these variables, fuzzy controller decides the initial dose of Thiopentone. The controlling and controlled variables are set for their respective membership values and that membership function represents intermediate conditions with respect to classical two valued logic [8][9].

Rule based system of fuzzy controller establishes relationship among different variables [9][10][11]. MATLAB fuzzy logic tool box is used to visualize the performance and the design of fuzzy controller [7][12].

II. SYSTEM OVERVIEW

A. Controlling and Controlled variable:

Dose of Thiopentone has a direct relationship with age and body surface area. For many clinical purposes body surface area is a better indicator of metabolic mass than body weight because it is less affected by abnormal adipose mass. Here body surface area can be calculated by using Dubois & Dubois formula which is given as

Body-sur-Area(m^2) = (weight(kg)0.425*height(cm)0.725) / 139.2

Thus Fuzzy based system for administering initial dose of anesthesia has two input variables and one output variable. Input variables such as body surface area and age are called controlling variable and output variable that is dose of Thiopentone is called controlled variable. This particular fuzzy controller, controlling variables are generally called as static variable because value of age and body surface area does not change during the surgery and there values are always collected during pre-processing of surgery.

B. Road-Map for Fuzzy Controller Designing:

Figure 1 shows the overview of fuzzy based system for regulating initial dose of Thiopentone. System development plan consists of various steps such as to analyse the system in terms of input variables, to convert these inputs into fuzzy values define membership functions for outputs and inputs, to define rules for the change in output with respect to changes in inputs (these are called as fuzzy logic rules) and finally to specify dose of Thiopentone as per the value of age and body surface area [7][12]. All these steps are explained as follows:

Step 1. Controlling and Controlled Variable Analysis:

Analysis of controlled and controlling variable is the most important step in the development of fuzzy controller. Analysis of the system is done in terms of which are the input and output variables, what are the upper and lower limit values for each variables and what is the valid range of value for each predicate.

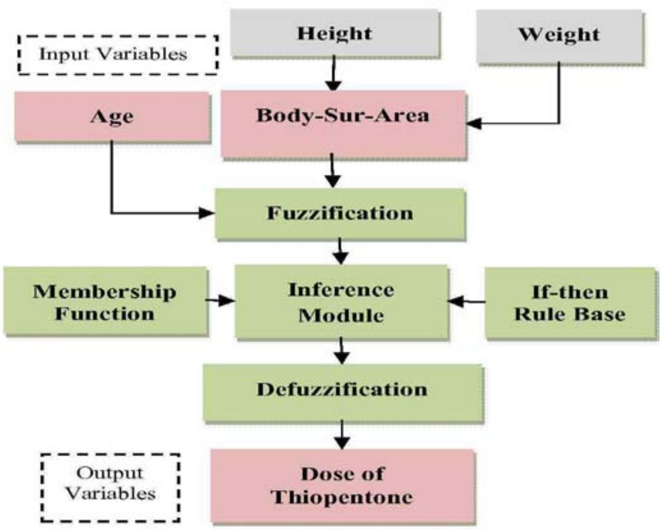

Figure 1. Overview of System Architecture [13]

Step 2. Crisp to fuzzy value conversion of variables:

Input variable's values are the crisp values. So first we have to convert these crisps value into fuzzy value. This process is called fuzzification [6][13]. System contains input and output variables with different predicates for the age and body surface area (body-Sur-Area) and dose of Thiopentone. Fuzzification takes a real time input value and compares with membership function information to produce fuzzy input value. Thus defining membership function is important step in fuzzification process [9][10][11].

Step 3. Designing Membership functions:

A membership function (MF) states the degree of belongings of object to a fuzzy set. As specified earlier fuzzification takes a real time input value and compares with membership function information to produce fuzzy input value. Here Trapezoid membership function is used for declaration of membership function for input and output variable. Trapezoidal curve is a vector function whose value depends upon four scalar parameters. So for declaring trapezoidal curve for each predicate, we have to specify four values [7] [11].

Figure 2, 3 and 4 shows trapezoidal membership function for age, body surface area and dose of Thiopentone. IL, ILN, IN, IH is the predicates for input variable while ILNM, ILN, INB, IH, IN are predicates for output variable.

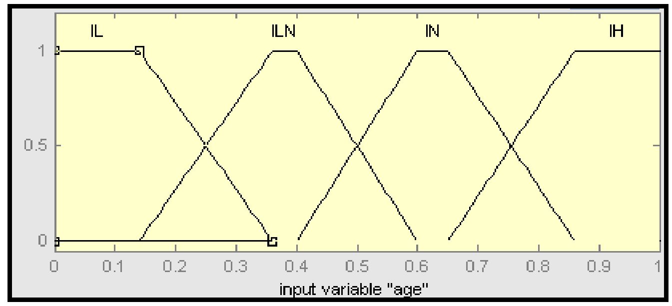

Figure 2. Membership Function for AGE

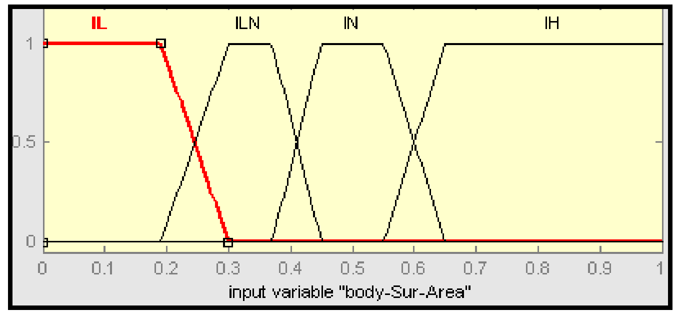

Figure 3. Membership Function for Body Surface Area

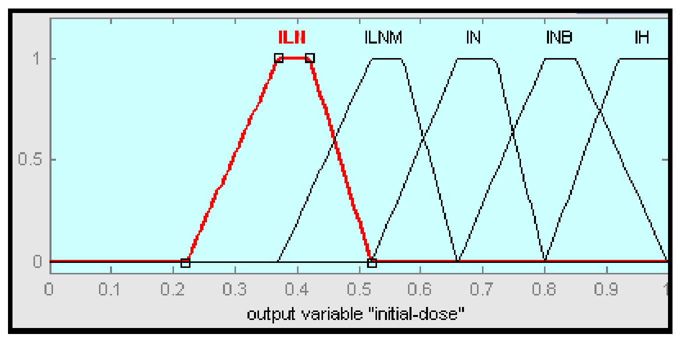

Figure 4. Membership Function Dose of thiopentone

Step 4. Define fuzzy rule base:

It is a set of IF-THEN rules and membership functions. The fuzzy rule is:

If <antecedent 1> Θ ... Θ <antecedent N> then <consequent 1> Θ ....Θ <consequent N>

Antecedent shows condition, consequent shows conclusion and Θ represents the logical operator. By attaching a set of fuzzy value inputs to the rule that correspond to actual values for the antecedents, a set of actual conclusions can be determined by executing the rule [6][9][11][12].

Rule base table for controlling initial dose of Thiopentone is given in Table 1.

Table I. Fuzzy Rule Base For Controlling Dose of Thiopentone

		Body-Sur-Area			
		IL	***ILN***	***IN***	***IH***
AGE	***IL***	ILNM	ILNM	IN	IH
	ILN	ILNM	ILNM	IN	INB
	IN	ILN	ILNM	ILNM	IN
	IH	ILN	ILNM	IN	IN

With reference to the rule base table, there are total sixteen rules. The fuzzy rule can be stated as

If (AGE is IL) and (DP is IL) then (Initial-dose is ILNM), If (AGE is IH) and (DP is IN) then (Initial-dose is IN)..etc

Figure 5 shows the rule editor. On the basis descriptions of the input and output variables defined with the FIS Editor, the Rule Editor allows you to construct the rule statements.The output of each rule is a fuzzy set. The output fuzzy sets for each rule are then aggregated into a single output fuzzy set. Finally the resulting set is defuzzified or resolved to a single number [6] [12][13].

Step 5. Calculate the dose of Thiopentone

As per the value of age and body surface area, the rule base is evaluated and depending upon that fuzzy value for dose of Thiopentone is specified. The value of dose of Thiopentone is a fuzzy value. This fuzzy value is converted into crisp value by the process called defuzzification[5][12][14]. Here centroid method is used for defuzzification process which is given by a formula

Crisp value=∑Multiplication of members value at particular Position / ∑ Membership value

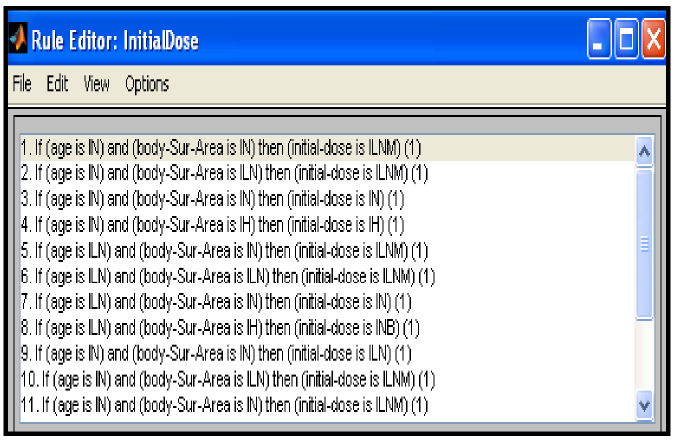

Figure 5. Designing Fuzzy Rules using Rule Editor

III. SIMULATION RESULT OF FUZZY CONTROLLER

Figure 6 shows rule viewer for the proposed system. Rule viewer displays the behavior of the whole fuzzy inference process. As mentioned before, fuzzy rule base system consists of fuzzy rules, in rule viewer each rule is a row of plots, and each column is a variable. Figure 7 shows surface viewer for dose of Thiopentone.

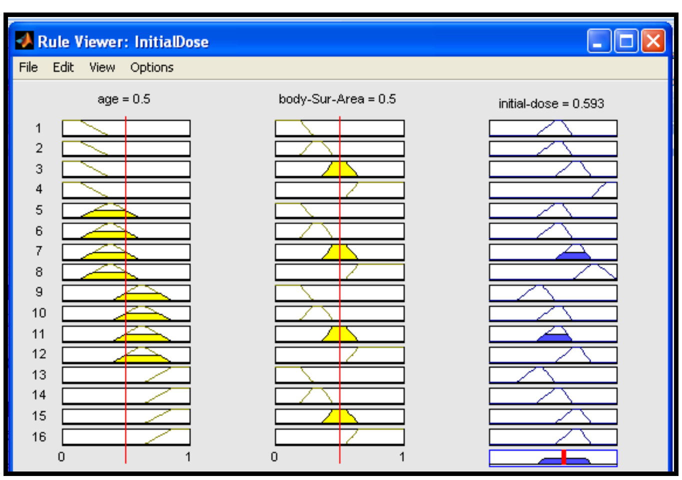

Figure 6.Simulation Result: Rule Veiwer

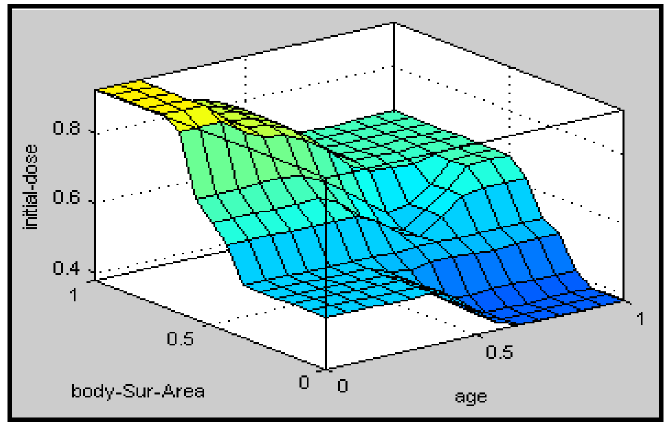

Figure 7: Simulation Result: Surface Veiwer Initial Dose of Thiopentone

Table II gives different values of dose of Thiopentone for different values of input variables. By using the proposed fuzzy controller dose of Thiopentone can be very easily calculated for different values of input variable.

Table II. Dose of Thiopentone For Different input variables

Sr. No	Age	Weight (Kg)	Height (cm)	Thiopentone Dose (mg)
1	26	56	125	2.6178
2	30	60	130	2.6287
3	33	54	135	2.6355
4	40	75	135	2.6404
5	50	50	160	2.6802

IV. POTENTIAL BENEFITS OF PROPOSED SYSTEM

The potential benefits of the system are given as follows:

a. The proposed Fuzzy Based system will help to increase patient's safety and comfort.
b. Provide ease to direct anesthesiologist's attention to other physiological variables which they have to keep under control.
c. Use of the proposed system results into the reduction in the costs of an operation.
d. This system also leads to reduce the pressure on the anaesthesiologist.
e. Thus this system will serve as a guide in developing new anesthesia control systems for patients based on physiological parameters of the patient.

V. CONCLUSION

During surgery poorly balanced anesthesia may result in patient's death. That is why exact information about all of the anesthesia modalities is of utmost importance. The proposed system is based on fuzzy controller to administer a proper dose of Thiopentone which is an aesthetic agent. Fuzzy logic simplifies the design of a control strategy by providing an easy to understand and intuitive approach to solve control problems. As the system works independently without the anesthesiologist; it release the pressure and he or she can devote attention to other task. Dose of Thiopentone is calculated on the basis of physiological parameters like age and body surface area of a patient .The method is based on the analysis of these variables by giving membership function, evaluation of rule based system and defuzzification process to specify dose of Thiopentone.

VI. REFERENCES

[1]. Collins, V. J., “General Anesthesia Fundamental Considerations”, 3th Edition, 1993, Philadelphia, Lea&Febiger, pp. 314-359.

[2]. Vickrs, M. D. , Morgan, M., Spencer, P.S.S. ,”General Anaesthetics”, 7th edition, 1991 Butterwurth-Heineman Ltd., Oxford, pp. 118-159.

[3]. Gilbert, H.C., Vender , J.S., “Monitoring the Anesthetized Patient”, Clinical Anesthesia, 1992, pp. 742-743.

[4]. Yardimci, A. Ferikoglu, N. Hadimioglu, “Depth control of sevofluorane anesthesia with microcontroller based fuzzy logic system”, Engineering in Medicine and Biology Society, 2001, in proc. of the 23rd Annual International Conference of the IEEE, Istanbul, TURKEY, Oct. 25-28 , 2001 , Vol. 2, pp. 1649 – 1652, doi: 10.1109/IEMBS.2001.1020531.

[5]. M. Logesh Kumar , R.Harikumar, A. Keerthi Vasan,“Fuzzy Controller for Automatic Drug Infusion in Cardiac Patients”, In Proc. of the International MultiConference of Engineers and Computer Scientists , March 18 - 20, 2009, Hong Kong, Vol I , pp. 76-80.

[6]. Prof. H. T. Kashipara, Mr. T. V. Bhatt, “Fuzzy Modeling and Simulation for Regulating the Dose of Anesthesia” in Proc. Of International Conference on Control, Automation, Communication and Energy Conservation (INCACEC) - 2009, Perundurai, Tamilnadu, 4th-6th june 2009, pp. 1-5.

[7]. D. S. Diwase, R. W. Jasutkar, “Expert Controller for Regulating Dose of Isoflurane”, IJAEST, Vol 9, Issue No.2, pp. 218-221.

[8]. John Yen, Reza Langari, “Fuzzy Logic: Intelligence, Control and Information,” Pearson Education, 2005, pp. 46-77.

[9]. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB," Springer, 2007, pp. 200-204.

[10]. Riza C. Berkan and Sheldon L. Trubatch, “Fuzzy System Design Principles,” IEEE press, 2000, pp. 83-129

[11]. L. A. Zadeh, "The birth and evolution of fuzzy logic " International Journal of General Systems, 1990, vol. 17, pp. 95-105.

[12]. Mirza Mansoor Baig, Hamid Gholamhosseini, Michael Harrison, “Fuzzy Logic based Smart Anesthesia Monitoring System in the Operation Theatre”, WSEAS transaction on Circuit and Systems, January 2012 ,Volume 11, Issue 1, pp. 21-32.

[13]. Xu-Sheng Zhang ,Rob J. Roy,“Derived Fuzzy Knowledge Model for Estimating the Depth of Anesthesia,” IEEE Transactions on Biomedical Engineering, 1994, vol. 48, Issue No. 3, pp. 312-323,doi: 10.1109/10.914794.

[14]. Amod Kumar, Sneh Anand, L N Yaddanapudi, “Fuzzy Model for Estimating induction Dose For General Anesthesia ”, Journal of Scientific and Industrial Research, April 2006, Vol 65, pp. 325-328.