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Application of Early Diagnosis of Diabetes Mellitus (DM) Equipped with Calorie Needs for DM Sufferers Using the Fuzzy Mamdani Method

Humaidillah Kurniadi Wardana[1], Imamatul Ummah[2], Lina Arifah Fitriyah[3]

[1,2]Electrical Engineering Department, Faculty of Engineering,
Universitas Hasyim Asy'ari Tebuireng Jombang, Indonesia
[3]Natural Science Department, Faculty of Science Education,
Universitas Hasyim Asy'ari Tebuireng Jombang, Indonesia
Email: [1]bhindere.adi3@gmail.com, [2]ima_ummah@yahoo.co.id, [3]muna_arifah@yahoo.co.id

Abstract

Diabetes Mellitus (DM) is one of the deadliest degenerative diseases in the world. The prevalence of DM in Indonesia from year to year shows a significant increase. The high number of these causes the need for appropriate action and anticipation for health workers, DM families and DM people themselves. In this study, a system application model was created by using informatics techniques in health for early diagnosis of DM and what calorie needs needed for DM sufferers. This system was created using a GUI application and the Mamdani fuzzy method. The purpose of creating this system is to help in making an initial decision for DM diagnosis.

Keywords: Diabetes Mellitus, Calorie, Fuzzy Mamdani, GUI

1. INTRODUCTION

Diabetes Mellitus (DM), also known as diabetes, is a group of metabolic diseases characterized by hyperglycemia, which is an increase in blood glucose levels that exceeds normal limits [1], [2]. Hyperglycemia occurs because the pancreas does not produce beta cells that produce both absolute and relative insulin hormones in which play a role in glucose metabolism in body cells [3], [4]. There are two types of diabetes that often occur in a person, namely diabetes of type I or known as Insulin Dependent Diabetes Mellitus (IDDM) which is a type of diabetes that depends on insulin and diabetes of type II or known as Non Insulin Dependent Diabetes Mellitus (NDDM) which is diabetes that does not depend on insulin [5].

According to the WHO (World Health Organization), the number of people with DM in Indonesia are predicted to get an increase. WHO predicts the increase of the number of DM sufferers in Indonesia from 8.4 million in 2000 to 21.3 million in 2030. The 2013 Basic Health Research reported that DM sufferers in Indonesia was 6.9%. There was an increase for about 8.5% in 2018[6]. These data show that the number of people with DM in Indonesia is very many. DM is one of the most dangerous diseases in the world of health because this disease will be carried for a

lifetime for sufferers and there is still no cure for it. DM treatment is used only to control or control blood sugar levels in order to remain normal.

The development of science and technology, especially computers in the field of expert systems, can be utilized by the world of health to make easier in making decision quickly and appropriate [7]. Expert systems can be easily implemented in fuzzy logic. The foundation of fuzzy logic is fuzzy set theory. It is very important to use Fuzzy set theory of membership degree as a determinant of the existence of elements in a set. The value of membership or the degree of membership or membership function becomes the main characteristic of reasoning with the fuzzy logic [8].

Previous studies that have been carried out by utilizing the fuzzy system are such as using the Sugeno system in determining the level of risk of DM with 8 input variables [9], diagnosis of DM using the Mamdani and Sugeno method [10], using the Mamdani method for the detection of DM disease with 3 input variables [11], prediction and classification of DM by using aplication of adaptive neuro [12], determining the type of DM using the Sugeno method with 3 input variables [13]. Based on the descriptions above, this study created an early diagnosis application of DM completed by the calorie needs needed by DM sufferers by implementing the Mamdani fuzzy logic method.

2. METHODS

The application of early diagnosis of DM and calorie needs for sufferers uses a fuzzy inference system based on the Mamdani method. The diagnosis process in this expert system is based on laboratory results at Jombang District Hospital. Input or input from the following system are:

1. Patients' identity consisting of name, gender, age, height, weight.
2. Data of Laboratory results comprising of: systole, diastole, glucose, total cholesterol, HDL levels, LDL levels, triglyceride levels.

Calculation of the number of calories needed for diabetics is also related to Body Mass Index (BMI) which is calculated using the BMI formula:

$$BMI = \frac{W(Kg)}{(H(m) \times H(m))} \tag{1}$$

With :
BMI = Body Mass Index
W   = Weight in meters
H   = Height in meters.

The BMR formula according to Harris and Benedict is distinguished between men and women:

$$BMR\ Men = 66,473 + 13,752\ W + 5,003 S - 6,755\ A \tag{2}$$

$$BMR\ Women = 65,5096 + 9,563\ W + 1,850 S - 4,676\ A \tag{3}$$

With : 12
H   = Heat production in 24 hours (calories)
W   = Weight (kg)
S   = Height (cm)
A   = Age (years)

The model used in the implementation of application of early diagnosis of the DM disease is the fuzzy logic model with the Mamdani method. Figure 1 below shows the steps used in the Mamdani method.
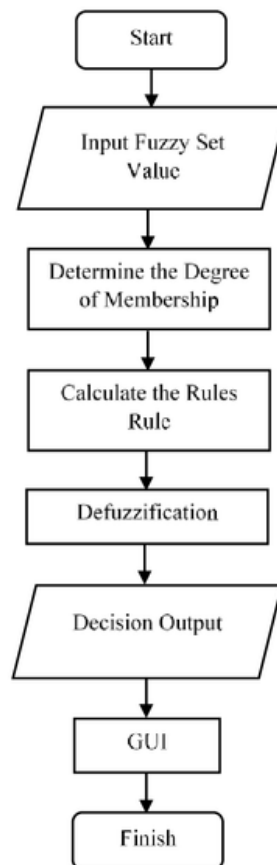
Figure 1. Flowchart of Fuzzy Mamdani Method

3. RESULTS AND DISCUSSION

The application made in this study consists of four menus, namely; home, program, info and exit. The display of home menu is shown in the Figure 2 below.

Figure 2. Menu of Home

While the program menu contains the main program of the application as shown in the Figure 3, consisting of 3 parts, such as diagnostic results, fuzzy rule view and types of DM diits. The diagnosis results consist of:

1. Calculating BMI using the formula (1) with input of weight and height.
2. Diagnosing normal, prediabetes or diabetes using FIS Mamdani with input of systole, diastole, at time glucose, total cholesterol, HDL levels, LDL levels, triglyceride levels.
3. Calculating BMR using the formula (2), (3) with input of age, height and weight.

Figure 3. Menu of Program

The fuzzy rule view has two buttons. The first button displays the diagnosis of normal, prediabetes or diabetes as shown in the Figure 4. The second button displays the calculation of BMI and BMR using fuzzy input of weight and height, as shown in the Figure 5 and Figure 6.
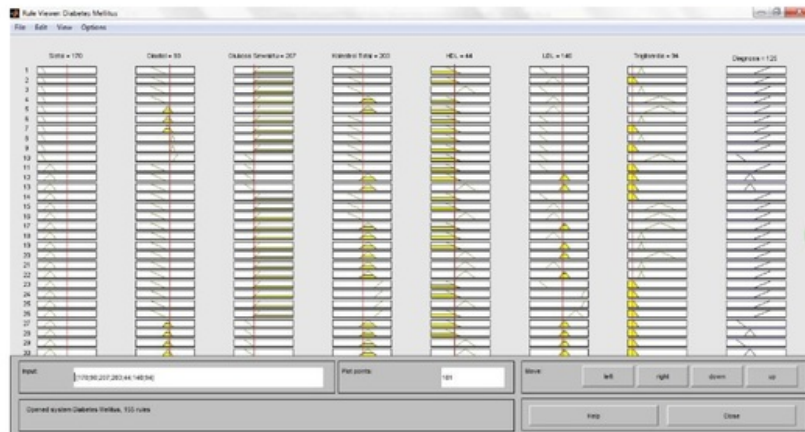

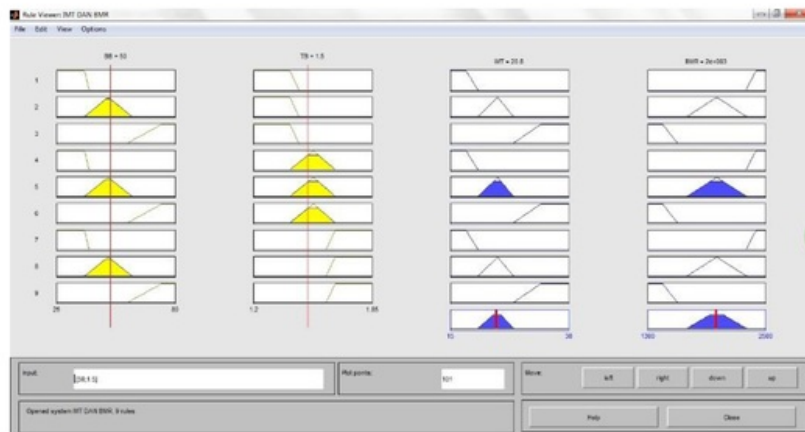Figure 4. Rule View of DM Diagnose

Figure 5. Rule View of BMI and BMR

The info menu shows how to diet for DM sufferers in general, as shown in the Figure 6.
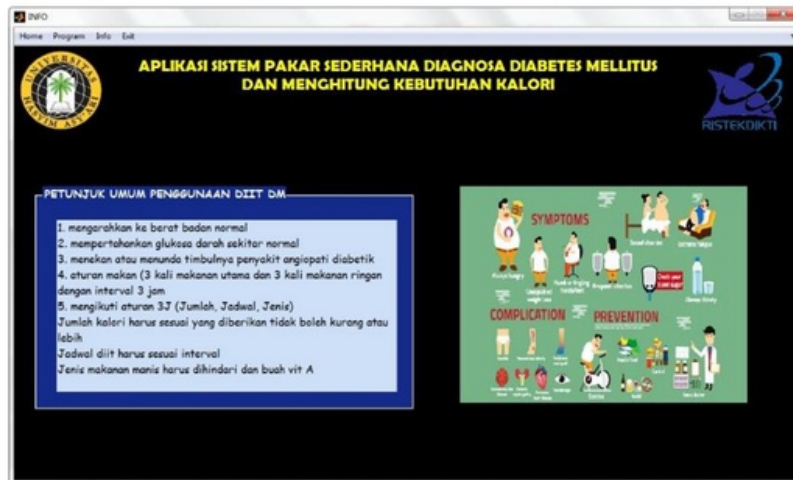

Figure 6. Menu of Info

For example, if a male, in age of 31, height of 1.5 m, body weight of 50 kg, blood pressure of 140/90 mmHg, at time glucose of 207, total cholesterol at 203, HDL of 44, LDL of 140 and triglyceria at 94 then the results of IMT shows normal, diagnose of diabetes and BMR needed is 1295.19 calories. It can be said that it includes the DM diets of type II needed 1300 calories that are divided into 192 g of carbohydrate, 45 g of protein and 35 g of fat, as shown in the Figure 7.

Figure 7. Example of The Program Being Run

4. CONCLUSION

This research designed and made an application of early diagnosis of DM disease completed with calorie needs for DM sufferers using the Mamdani fuzzy method. The system created used the GUI application consisting of 2 systems. The first system is to diagnoses DM with 7 inputs consisting of systole, diastole, glucose, total cholesterol, HDL, LDL and triglyceria as well as 3 outputs namely diabetes, prediabet, normal. The second system aims to determine the calorie needs for DM sufferers with 2 inputs consisting of body weight and height and 2 outputs, namely BMI and BMR.

5. ACKNOWLEDGMENT

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