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# A Monitoring Device for Blood Glucose Concentration and regulate the Insulin Injection Rate using Fuzzy Logic Controller

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**ABSTRACT:** To maintain the good health is a biggest challenge of this generation, to stay fit and healthy one needs to make efforts, as the eating habits and the environment we are living is not only polluted but itsto hard to find good healthy food everywhere. One of the most dangerous disease is diabetes, it is incurable and affects the whole body in many ways. The motivation behind this research is to enable the doctor's community and deliver them an enough precise system whose precision will be the best of all the earlier versions that are so far considered for the classification of diabetes disease. Decision making has its own role in all the regions. Particularly in the field of drug, diagnosis is very much important to disperse the patients at any of group (not at risk, less risk, at risk). In this research, the emphasis is on developing a system which not only monitors the glucose concentration level but also regulates the insulin injection rate to control the glucose concentration level, the designed simulink model will regulate the glucose concentration level between the minimum and maximum threshold i.e. between 50mg/l to 120mg/l. To control the blood glucose concentration level fuzzy logic controller has been implemented.

**KEYWORDS:**Glucose, Diabetes, Insulin, PID Controller, System Security.

## I.INTRODUCTION

Glucose is the main type of sugar in the blood and is the foremostinput of energy for the body's cells. Glucose comes from the dietsthat we eat or the human body can make it from other substances. Several hormones, including insulin, control glucose levels in the blood[1]. It is also well-known as dextrose. Glucose is saved as a polymer, in animals as glycogen and in plants as starch. Insulin is a hormone made by the pancreas that permitshuman body to use sugar from carbohydrates in the diet that you consume for energy or to store glucose for future use[7]. Insulin benefitsretains your blood sugar level to get too high (hyperglycemia) or too low (hypoglycemia)[6]. Fuzzy logic is a method of many-valued logic that shows approximate, rather than fixed and exact reasoning. Compared to old-style binary rationality (where variables can take on true or false values), fuzzy logic variables can have a truth value that ranges in degree between 0 and 1[18]. After understanding the working of the glucose and insulin and their irregularities in a diabetic patient, a model has been considered using the data having base as a glucose insulin chart and fuzzy logic controller to control the diabetes or the blood glucose absorption[.

Thegoal of this learning is to calculate how well a closed loop control scheme could perform for diabetic patients. Research on long-term diabetic complications concludes that dropping the regular blood glucose has a beneficial effect, and this shall be the performance objective of the implemented controller algorithm. Though, minimizingusual blood glucose concentrations comes with the danger of cumulative hypoglycemic incidents, so performance of the regulator algorithm should also be tightly connected to its ability to avoid hypoglycemia. A mathematical prototype of the human glucose homeostasis has been established in an earlier project.

Earlier so much work has been done on type1 diabetes Maryam,et al. (2012) has proposed that the Diabetes mellitus is aillness due to the insufficiency of the pancreas in dealing plasma glucose level [1]. D. U. Campos-Delgado, et al.

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(2006) shows extensive closed-loop simulations are illustrated, using a detailed compartmental model of the insulin-glucose dynamics in a TIDM patient with meal intake[7]. Al-Fandi, et al. (2011) the performance of a closed-loop Proportional-Integral-Derivative (PID) fuzzy logic controller (FLC) is evaluated as an computerization scheme for an implantable insulin delivery system in type I diabetes therapy[10] Ahmed Y, et al.(2013) worked on discrete insulin infusion based on long-time interval measurement is the classic technique for diabetes treatment [14].

R. HariKumar, et al. (2012) Shows the primary importance where the processes are too complex to be analyzed using the conventional one. The designed controller is implemented with low power multiplier and Fuzzy controller architecture. In case of non-linear inputs, Fuzzy PD Controller performs better compared to the conventional controller and consumes lesser power[4].

## II. EXPERIMENTATION

As discussed in the above section about controlling the insulin for blood glucose level, here we have designed a substantial model which will not only regulate and monitor the glucose level but also maintain its value between the up threshold and lower threshold.
MATLAB model such designed is modeled in such a way that it takes the outside supply and also it takes the constant supply of meal after every 7 hours.

PID controller is also includes as it is required to keep the blood glucose level under the range of 50-120. PID, proportional integral derivative loop feedback mechanism it is which continuously calculates the blood glucose level and keep it under the range however when the supply meal glucose rises suddenly and abruptly PID shows a slow progress and at the range which is constantly above the 200 mark PID fails partially to maintain the range hence the process is transferred to the S-Reactor block which regulates the body blood glucose level using the insulin and to maintain the system stability, as S-reactor do provides the assistance to PID in maintaining the blood glucose level range but it doesn't helps the system to maintain its stability for that Fuzzy Logic has been introduced and it helps the system to maintain its stability.

Fuzzy Logic helps the system to constantly maintain the blood glucose level however it maintains the system with precision but there are variations but very less as compared with the PID and S-Reactor based model. Fuzzy Logic works over the linguistic values and it can be seen in its rules view in figures.

Author has presented the proposed design in Figure 1.

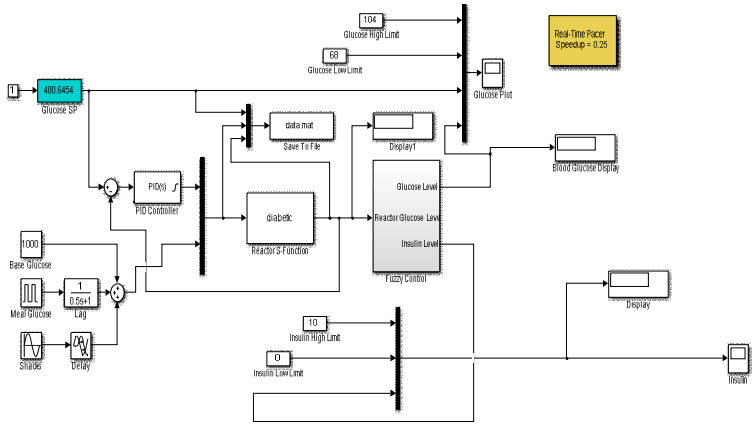


Figure 1: Fuzzy Enabled Insulin Regulation and glucose monitoring Simulink Model (Check Page 6)

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Motive behind developing this model using Fuzzy logic is to control the variable and high concentration of glucose present in the human blood. To design it there are three levels or we can say that there are three sections which operates the whole system and enable the system to auto regulate the glucose concentration level.
Fuzzy Logic design has been demostrated in figure 2.

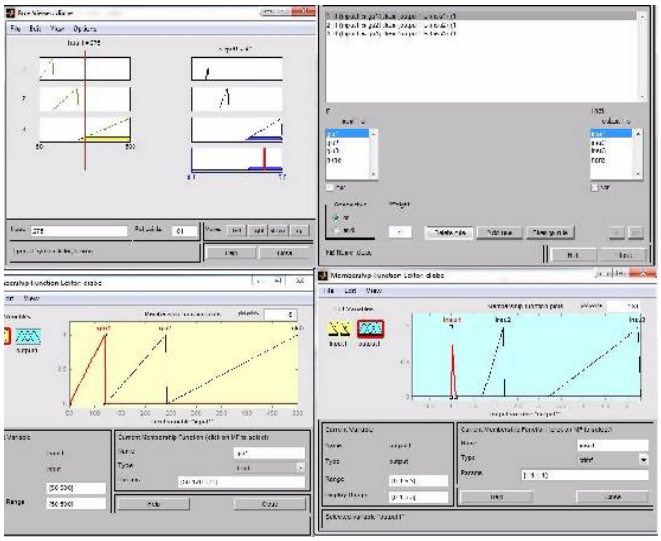

Figure 2: Fuzzy Logic Controller Design for Insulin Regulation

From the above described theory and models shown it can be seen that the insulin and glucose level monitoring can be done using the artificial intelligence, however to make system more advanced and accurate one needs to train the data and then it should be analyzed thoroughly before implementing it over the humans.

## III. RESULT

From the designed models and architectures, simulation result shows the monitoring of glucose level and the injection of insulin, system is auto operated, however if the user wants to set some particular value the offers the flexibility for the same. Simulation result some time may also depend upon the system configuration and if the system performance is slow it may lead to slow response time.
MATLAB tool can be prove a bit handy in order to achieve the same. MATLAB Simulink model will be required to design and also it will be needed to be simulated.
In this section MATLAB model simulated results have been shown. From the result obtained it can be deduced that the previous models which were not enabled with the Artificial Intelligence only monitors the glucose and the insulin level of the body, after the inclusion of Fuzzy Logic in association with PID controller system becomes more reliable and is now enable to pump or regulate the insulin according to the body requirements.

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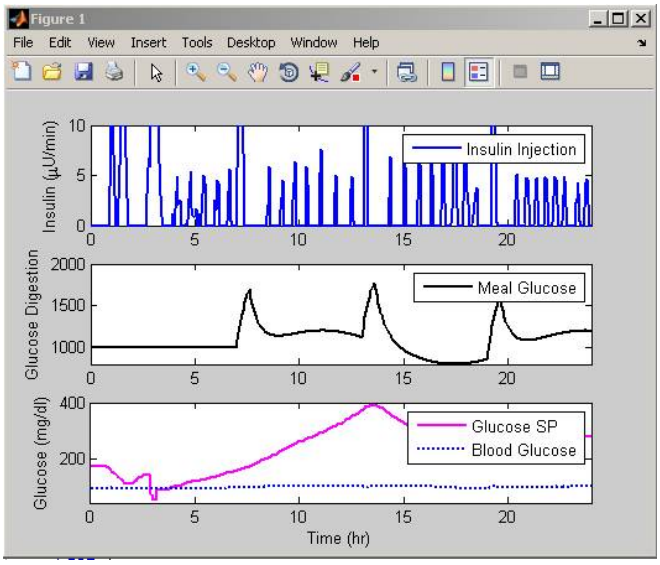


Figure 3: Glucose level before and after digestion

Here in the above figure first part shows the variation in insulin done by the model, with respect to pink line in third section of which indicates the variation of blood glucose done by author. The second section shows meal glucose coming in every 7 hour of interval. The final output is indicated in the third section by the dotted lines in blue color.

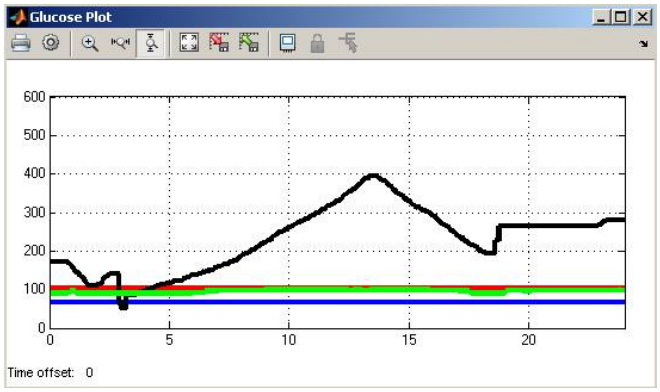


Figure 4: Insulin regulated w.r.t. Glucose level

The above figure shows the output of the model, as mentioned above, black line indicate blood glucose variation done by the author and the green is the final output, as it is between high limit (red line) and low limit (blue line).

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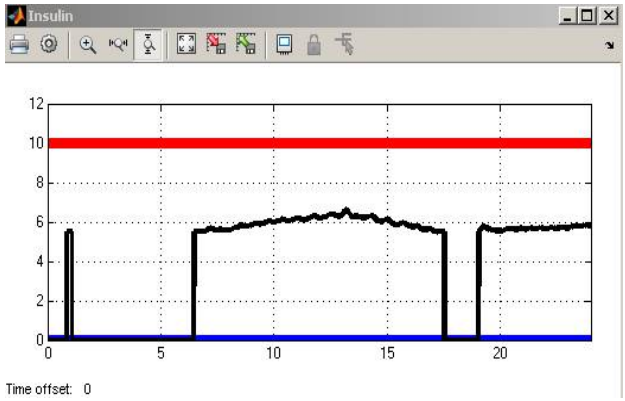


Figure 5: Fuzzy Logic based insulin regulation

The above figure shows the insulin values at different level (black line), and red is the limit of insulin.

## IV.CONCLUSION

During the development of this work, author examine many models and on the basis of the study of different models we have developed a new model or you can say that we have extended an existing model but with a lot more accuracy and complexity the block added are PID controller and fuzzy logic control box. Introduction of AI (Artificial Intelligence) allows the system to examine the previous values and monitors the body glucose and insulin level very well and the process so developed is optimized as well as works under difficult conditions, also digitization of the model makes it more reliable and fast as compared to the previous models.

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