ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 2, February 2016

SIMULATION OF FUZZY BASED AUTOMATIC INSULIN PUMP DESIGN SYSTEM

P. Elakkiyapriya[1], Dr. D. Kumar[2], K. Bazilraj[3], U. Saravanakumar[4]

1-PG Student, Dept. of ECE, PeriyarManiammai University, Thanjavur, Tamilnadu, India.
2- *Prof in ECEand Head of NanotechnologyPeriyarManiammai University, Thanjavur, Tamilnadu, India.*
3-Associate Prof in Defense Institute of Advance Technology, Pune,India.

4.prof in Dept. of ECE, PeriyarManiammai University, Thanjavur, Tamilnadu, India.

ABSTRACT -Diabetes analysis is commonlyestablished on various insulin infusions that application long-time interval evaluations. The goal is to longing a totaldone, resourceful and autonomous insulin transferscheme. suggestingschememeasures the volume of insulin by formulation established upon two linguistic determinants i.e. weight and blood glucose stages. These determinants have been used to develop a rule established fuzzy scheme in java. The fuzziness transfers anexceptional regulation into the regime than a non fuzzyscheme as limitedalterations in quantities of insulin can transfer about effective command on the glucose stages. A convenient interactive has been longwinded that inculcates the fuzzy scheme for providing consultation. The insulin transfer has been simulated in java where the quantity of insulin brought to the patient can be mastery led by the doctor. The scheme has been verified by taking a random exemplary of hundred insulin dependent individuals to test the effectiveness of the scheme. The developed fuzzy scheme was found to be more precise than a non fuzzyscheme. This modeling is suitable for soluble human insulin type. The implementation of this scheme in real time with insulin pump will enable those in inaccessible areas and intensive care units to mastery the glucose stages in an efficient manner.

Keywords

Glucose, insulin, fuzzy scheme, insulin pump, Simulation.

1.INTRODUCTION

India has become the diabetic capital of the world with 4 cores Indians agony from diabetes as of 2006 and the number is expected to rise to 7 cores by the year 2025. Diabetes may compromise insignificant morbidity, leading to conditions such as blindness, cardiovascular disease, kidney disease and premature death. Most of the diabetic patients are insulin dependent and effective monitoring is necessary for keeping the glucose stages under mastery (Dudde and Vering, 2003). Insulin is a “High Alert” Cure, due to interact individualized dosing and administration regimens; insulin is not a “one size-fits-all” cure.

Curewrongs associated with insulin use have the potential to cause patient harm and are responsible for 80% of inpatient wrongs caused by glucose lowering agents and 10% of all harmful drug wrongs. These human established insulin transferschemes can be replaced by adone insulin transferschemes, which are time efficient, convenient with no human wrongs and thus compromises in easier and exceptionalmastery of insulin for patients. Bed ridden patients require human assistance and these schemes would eliminate the need for it if implemented in real time. Diabetes is a lifelong disease and it is best to maintain proper mastery to suppress its negative impact on the quality of life.

Diabetes is a metabolic disorder compromising from the permanent lack of insulin result from the pancreas (type 1 diabetes) or the chronic degradation of the functionality of endogenous insulin (type 2 diabetes),

whichcompromises in raising the glucose concentration in blood because without insulin, the cellular scheme cannot properly change carbohydrates such as sugars, starches, or other foods into strength usable by the human body. These determinants eventually compromise in several complications, such as cardiovascular disease, chronic renal failure, retinal damage, nerve damage, and micro vascular damage**.**

In the human body, only insulin and glucagon play a role of regulating blood glucose stages within a very narrow range by barring it from blood to the most cells, such as muscles and adipose tissues, turning it to strength. Typically, either excess or shortage of glucose in blood is known as a metabolic disorder.

If you have more sugar in your human body than it needs, insulin helps store the sugar in your liver and releases it when your blood sugar stage is low or if you need more sugar, such as in between meals or during physical activity. Therefore, insulin helps equity out blood sugar stages and keeps them in a normal range. As blood sugar stages rise, the pancreas secretes more insulin.

If your human body does not produce enough insulin or your cells are resistant to the effects of insulin, you may develop hyperglycemia (high blood sugar), which can cause long-term complications if the blood sugar stages stay elevated for long periods of time.

Many researchers have attempted to find methods for diagnosing and treating diabetes disease. One of the approaches is to longing an automated closed-loop insulin transferscheme. A fully automated insulin transferscheme (also known as an artificial pancreas) could potentially be the ultimate answer for blood glucose (BG) mastery in diabetic patients. This scheme can mimic the activity of a normal pancreas and is capable of maintaining physiological BG stages for insulin dependent diabetic patients.

Such an artificial pancreas scheme can theoretically produce tight glucose mastery without finger-stick BG evaluations, subcutaneous insulin injections, or hypoglycemic/hyperglycemic events, thereby, dramatically improves the quality of life for an insulin-dependent diabetic patient. The artificial pancreas is a scheme of integrated devices containing only synthetic materials, which substitutes for a pancreas by sensing plasma glucose concentration, calculating the volume of insulin needed, and then delivering the correct volume of insulin. Typically, such a device is comprised of a neither glucose monitoring sensor, an insulin pump, and a mastery algorithm to regulate the pump to deliver the neither insulin in order to maintain moglycemia in presence of sensor evaluations.

1. Literature survey

1.1 Application of GMR Sensors to Liquid Flow Sensing

This paper presents a feasibility study of the application of giant magneto resistive (GMR) sensors in detecting motion of slow moving fluids. A motivating application for the exiting effort is the development of a smart catheter capable of monitoring the volume of human body fluid drained from the ventricles of the brain. Micro fabricated ferromagnetic flaps are used to detect motion of the surrounding fluid. The deflection of the flaps is detected by an ultrasensitive GMR sensor placed outside of the lumen of the catheter.

Numerical and experimental compromises are provided demonstrating a resolution of 1.4 mL/h. Numerical analysis of the fluid past the sensing element show an optimal hinge length of the flexible flaps, as well as a significant increase in sensitivity with reduction of the by-pass gap to ~50 μm. The effect of electro-magnetic interference and other sources of low-frequency noise (drift) have also been investigated. The compromises from the study are used to derive a set of longing rules that may lead to the successful development of a smart catheter.

Maturation of micro-electromechanical scheme technology over the last 3 decades has brought about technological advances that make this problem solvable. Early examples of micro-flow sensors were established on hot-wire anemometry. Subsequently, differential thermal anemometers with largersensitivity and resolution have been developed,reaching a resolution of 300 nl/min. In parallel, micromechanicalcantilever flow sensors detecting Stokes drag have also been developed using piezoresistive and optical detection schemes. The later have demonstrated detection limits of 0.08 ml/hr and perhaps the most sensitive flow sensor. Despite their high resolution, optical detectors in these

sensors are bulky, require fiber-optic waveguide, a light source, an optical spectrum analyzer, and are therefore more suitable for bench-top applications.

A typical micropump is a MEMS device; it is the actuation source through which a fluid exemplary (drugs and therapeutic agents) is transferred with precision,accuracy and reliability from a reservoir to the target. Typical applications include drug transfer and biomedical pharmaceutical, environmental monitoring and even homeland security applications such as Micro Total Analysis Schemes (μTAS) or Lab-on-a-Chip (LoC) and Point of Care Testing Schemes (POCT); reliability and robustness of the micro pump are thus essential

1.2 PSECMAC Resourceful Insulin Schedule for Diabetic Blood Glucose Management

Therapeutically, the closed-loop blood glucose–insulin regulation paradigm via a masterylable insulin pump offers a potential solution to the management of diabetes. However, the development of such a closed-loop regulatory scheme to date has been hampered by two main issues: 1) the limited knowledge on the interact human physiological process of glucose–insulin metabolism that prevents a precise exemplarying of the biological blood glucose mastery loop; and 2) the vast metabolic biodiversity of the diabetic population due to varying exogneous and endogenous disturbances such as food intake, exercise, stress, and hormonal determinants, etc.

In addition, current attempts of closed-loop glucose regulatory techniques generally require some form of prior meal announcement and this constitutes a severe limitation to the applicability of such schemes. In this paper, they present a novel resourceful insulin schedule established on the pseudo self-evolving cerebellar exemplary articulation masteryler (PSECMAC) associative learning memory exemplary that emulates the healthy human insulin response to food ingestion.

The exiting PSECMAC resourceful insulin schedule requires no prior meal announcement and delivers the necessary insulin dosage established only on the observed blood glucose fluctuations. Using a simulated healthy subject, the suggested PSECMAC insulin schedule is demonstrated to be able to precisely capture the interact human glucose–insulin dynamics and robustly addresses the intraperson metabolic variability.

Subsequently, the PSECMAC resourceful insulin schedule is employed on a group of type-1 diabetic patients to regulate their impaired blood glucose stages. The work reported in this paper represents a major paradigm shift in the management of diabetes where patient compliance is poor and the need for prior meal announcement under current treatment regimes poses a significant challenge to an active lifestyle.

2.3 A Comprehensive Study of Micropumps Technologies

This paper emphasis on physical principles and fabrication of micropump, state-of-the-art micropumping technologies developed over the past fifteen years, highlighting their advantages. Micropump features such as miniaturization potential, actuation voltage and ease and cost of fabrication are compared and application-determining performance characteristics discussed.

When studying a class of devices it is always useful to have a good understanding of potential target applications. In the case of microfluidic schemes, common target applications include chemical and biological analyses, biological and chemical sensing, drug transfer, molecular separation, amplification, sequencing and synthesis for environmental monitoring. A microfluidic scheme is one where fluid flows in miniature devices.

It makes biological assays more effective through reduced reagent quantities and shorter reaction time. It is relatively inexpensive and can be integrated with other functional miniaturized components. It can contribute to the precision masteryschemes of industries such as automotive,aerospace and machine tools. Most microfluidic schemes have two or three-dimensional microchannels through which fluid exemplarys are pumped (often concurrently and in various mechanisms), masteryled and manipulated.

Most microfluidic schemes need a self-contained active pump of a size comparable with the volume of fluid to be pumped. The key considerations for them include their reliability, power consumption, actuation voltage, ease and cost of fabrication, biocompatibility and a dosing accuracy comparable with that of a fuel pump.

2.4 Problems with Insulin Therapy

The type and volume of insulin to be given is decided by wide range of determinants including type of diabetes, age, gender, human body mass index and

other diseases the patient may suffer from. The insulin analysis needs to be supplemented by lifestyle and diet alterations so as to lead an active and healthy life. Insulin dosing is individualized and interacts. Administration of too much or not enough insulin application dire consequences. The Institute for Safe Cure Practices (ISMP) placed insulin, subcutaneous and Intravenous (IV), on a list of "High alert Cures" due to its potential to cause serious patient harm if given in wrong.

Too much insulin intake may lead to hypoglycemia and then loss of consciousness and seizures. International diabetes care centre has recognized the numerous reports of serious wrongs associated with the misadministration of insulin. These wrongs involve human wrong and wrongs occurring in the prescribing of insulin volume. It should not be assumed that all healthcare practitioners are knowledgeable and skilled with measuring doses and recognizing doses that exceed safe limits. So these curewrongs involving insulin is responsible for disproportionate number of serious adverse events.

2. PROPOSED SYSTEM

2.1 Importance of Fuzzy System

The above inveracities have contributed to a plethora of insulin wrongs at every step of the prescribing, dispensing and administration. A solution for all the above insulin analysis problems can be given by a fuzzy establisheddone insulin transferscheme. Precisevolumes of insulin dosage can be measured or prescribed from the fuzzy scheme. The fuzzy scheme is more precise than the normal masteries because instead of being either true or false, a partial true case can also be declared. Thus exact number of units of insulin can be brought to the patient thus aiding efficient mastery of glucose stage.

3.2MATHEMATICAL MODEL

This exemplary describes the interactions between glucose and insulin in human subjects, in order to realize an adequate exemplary for ill patients, agony from Diabetes Mellitus(DM) Type 2.

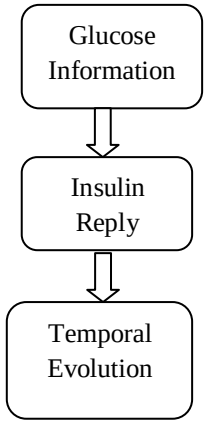

Fig.1 MathematicalExemplary

4. MATERIALS AND METHODS

4.1. Patients

The patients have been randomly selected from populations of southern states of Tamil Nadu and Andhra Pradesh. The analysis was performed by collecting data from hundred patients of varying ages and gender agony from diabetes. The patients were informed about the specific use of the data collected from them. All patients provided their consent for usage and publication of the data obtained from them.

4.2. Instrumentation

The software used for the development and analysis is java coding. The insulin quantity is measured by alonging in fuzzy schemelonging in java. Thelinguistic changing are weight and blood glucose stages.The insulin quantity is the output of the observed scheme. Theinput and output changing are divided into membershipfunctions according to their ranges.

4.3. Membership Functions

The changingis divided established on the range of valuesthey can take. The blood glucose stage is divided into different sinusoidal membership functions ranging from 100 to 400.The weight is divided into twelve membership functionsranging from 0 to 120. The insulin stage is divided into 53membership functions ranging from 0 to 400. Themembership functions of insulin.

4.4. Rules

The rules are formed using if then statements where acertain combination of each of the inputs' membershipfunctions give a particular insulin quantity. The numberof rules depends upon the number of input changing andthe total of membership functions for each inputvariable. All different possible combinations need to beadded to the rules so

as to obtain the exact insulinquantity for the mid values. The total number of rulesbuilt for insulin calculator.

4.5. Program

The program has been coded in java and hencethe user interface and logic behind the program aredeveloped simultaneously. The program is coded to inheritthe already longing fuzzy scheme. The doctor can suggest on the volume of insulin measured by the scheme. The doctors canmastery the volume of insulin injected to the patient by done insulin pump. The patient at the user end will have to enter details like name, age, weight and blood glucose which upon execution displays the insulin quantity to be taken. After analyzing the compromises, the patient can choose to done inject oneself with insulin or ask for further clarifications from the doctor. The doctor can access the program from his end and step in when ever required to give is suggestions.

4.6. Simulation of Insulin Pump

The quantity of insulin from fuzzy analyzer is given as an input to the insulin pump. The required quantity flows from the pump into the injector. The number of units can also be set by the doctor in case it is required. The scheme is simulated in front panel of java in form of two interconnected tanks where the top one is the insulin pump and the bottom is the insulin injector.

5. CONCLUSIONS AND FUTURE WORK

The fuzzy scheme was found to provide more precisecompromises as compared to normal scheme. The validity of the equation is verified by comparison with the actual volume of insulin that is being taken by the patient. A nanometer resolution displacement is the primary requirement for constructing an insulin injection pump motion pre size transfer specified quantity with least possible wrong. Thus work made an elaborate survey for transfer insulin.In the future work going to be implemented using the insulin pump is to be longing for the displacement purpose for the liquid flow is going to be demonstrated.

6. REFERENCES

1. A. Makroglou, J. Li, and Y. Kuang. Mathematical models and software tools for the glucose-insulin regulatory system and diabetes: an overview. Appl. Numer. Math., 56(3):559–573, 2006

2. G. Baratta, F. Barcellona, G. Lucidi, A.M. Bersani, M. Coli, Stability and equilibrium points in MINMOD for glucose, Proc. VI CongressoNazionale SIMAI 2002

3. G.M. Grodsky, A threshold distribution hypothesis for packet storage of insulin and its mathematical modeling, J. Cli. Inv., 51, (1972), pp. 2047, 2059.

4. C. Bustamanate, C. L. Peterson, B. R. Cairns, S. B. Smith, S. Mihardja, S. W. Grill, A. Saha, C. L. Smith, and Y. Zhang, "Dnatransclocation and loop formation mechanism of charomatin remodeling by swi/snf and rsc," Mol. Cell, vol. 24, pp. 559–568, 2006.

5. D. Raccah, "Insulin therapy in patients with type 2 diabetes mellitus: Treatment to target fasting and postprandial blood glucose levels," Insulin, 1(4):158–165, 2006.

6. C. Cobelli and A. Mari, "Validation of mathematical models of complex endocrine-metabolic systems. A case study on a model of glucose regulation," Medical and Biological Engineering and Computing, 21(4):390–399, 1983.

7. D. Takahashi, Y. Xiao, F. Hu, and M. Lewis, "A survey of insulin-dependent diabetes – Part I: therapies and devices", Int. J. of Telemedicine and Applications, Vol. 2008, Article ID 639019, 15 pages, 2008.

8. American Diabetes Association, "Standard of medical care for patients with diabetes mellitus", Diabetes Care, vol. 26, pp. 533-550, 2006.

9. Blood sugar, Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/wiki/blood_sugar.

10. D. Takahashi, Y. Xiao, and F. Hu, "A survey of insulin-dependent diabetes – Part II: Control Methods", Int. J. of Telemedicine and Applications, Vol. 2008, Article ID 739385, 14 pages, 2008.

11. Diabetes Atlas, Third Edition: International Diabetes Federation, 2006.

12. G. Marchetti, M. Barolo, L. Jovanovic, H. Zisser, and D. E. Seborg, "An Improved PID Switching Control Strategy for Type 1 Diabetes," IEEE Transactions on Biomedical Engineering, vol. 55, pp. 857-865, 2008.

13. P. Dua, F. J. Doyle, and E. N. Pistikopoulos, "Multi-objective Parametric Control of Blood Glucose Concentration for Type 1 Diabetes," presented at 44th IEEE Conference on Decision and
Control, and the European Control Conference 2005, Seville, Spain, 2005.

14. L. Magni, D. M. Raimondo, C. D. Man, G. D. Nicolao, B. Kovatchev, and C. Cobelli, "Model Predictive Control of glucose concentration in
subjects with type 1 diabetes: an in silico trial," presented at IFAC World Congress, 17th, Seoul, 2008.

15 R. S. Parker, E. P. Gatzke, and F. J. Doyle, "Advanced Model Predictive Control (MPC) for Type I Diabetic Patient Blood Glucose Control," presented at American Control Conference, Chicago,
Illinois, 2000.

16. R. Hovorka, V. Canonico, L. J. Chassin, U. Haueter, M. Massi- Benedetti, M. O. Federici, T. R. Pieber, H. C. Schaller, L. Schaupp, T. Vering, and M. EWilinska, "Nonlinear model predictive control of glucose concentration in subjects with type 1 diabetes," Physiol. Meas., vol. 25, pp. 905–920, 2004.
17. F. Chee, A. V. Savkin, T. L. Fernando, and S. Nahavandi, "Optimal H∞Insulin Injection Control for Blood Glucose Regulation in DiabeticPatients," IEEE Transactions on Biomedical Engineering, vol. 52, pp. 1625-1631, 2005.
18. W. Garcis-Gabin, J. Vehi, J. Bondia, C. Tarin, and R. Calm, "RobustSliding Mode Closed-loop Glucose Control with Meal Compensationin Type 1 Diabetes Mellitus," presented at IFAC World Congress,17th, Seoul, 2008.
19. R. N. Bergman, L. S. Phillips, and C. Cobelli, "Physiologic evaluationof factors controlling glucose tolerance in man: measurement ofinsulin sensitivity and beta-cell glucose sensitivity from the responseto intravenous glucose.," The Journal of Clinical Investigation, vol.68, pp. 1456–1467, 1981.
20. M. E. Fisher, "A Semiclosed-Loop Algorithm for the Control of BloodGlucose Levels in Diabetics," IEEE Transactions on BiomedicalEngineering, vol. 38, pp. 57-61, 1991.
21. M. Berger and D. Rodbard, "Computer simulation of plasma insulinand glucose dynamics after subcutaneous insulin injection," DiabetesCare, vol. 12, pp. 725-736, 1989.
22. M. Hernández-Ordonez and D. U. Campos-Delgado, "An extension tothe compartimental model of type 1 diabetic patients to reproduceexercise periods with glycogen depletion and replenishment," Journalof Biomechanics, vol. 41, pp. 744-752, 2008.
23. C. Dalla Man, R. A. Rizza, and C. Cobelli, "Meal Simulation Model ofthe Glucose-Insulin System," IEEE Transactions on BiomedicalEngineering, vol. 54, pp. 1740-1749, 2007.24. J. S. Shamma, The Control Handbook: CRC Press, 1996.
25. L. Magni, D. M. Raimondo, C. D. Man, M. Breton, S. Patek, G. D.Nicalo, C. Cobelli, and B. P. Kovatchev, "Evaluating the Efficiacy ofClosed-Loop Glucose Regulation via Control-Variability GridAnalysis," Journal of Diabetes Science and Technology, vol. 2, 2008.
26. T. Ghys, W. Goedhuys, K. Spincemaille, F. Gorus, and E. Gerlo,"Plasma-equivalent glucose at the point-of-care: evaluation of RoucheAccu-Chek Inform® and Abbot Precision PCx® glucose meters,"ClinicaChimicaActa, vol. 386 pp. 63-68, 2007.

Authour

1.P.ElakkiapriyaM.TechIIyear PG Student, Dept.of.ECE,PeriyarManiammai University, Thanjavur, Tamilnadu, India.

2Dr.D.KumarM.Tech ph.d Prof in ECEand Head of NanotechnologyPeriyarManiammai University, Thanjavur, Tamilnadu, India.

3 K.BazilRaj Associate Prof in Defense Institute of Advance Technology, Pune,India.

4. S.ShanthiAsstProf in ECE,Care Group of Institution, Thiruchirappalli,Tamilnadu, India.

5. Dr.A.BhavaniSankarProf in ECE, AnjalaiAmmalMahalingamEngineering College, Thanjavur, Tamilnadu, India.