# AMPEROMETRIC DETECTION OF GLUCOSE AND FRUCTOSE LEVEL IN BEVERAGES USING IOMT

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**Abstract—-. *D*iabetes mellitus, one of the root cause of demise and infirmity in the world and is extremely responsible for kidney failure, cardiac disease and blindness. Uncertain talks on social media about taking beverages may take the patient to confusion in the amount they have consumed. In this paper, we propose a smart detection of beverage glucose level consumption by the patients. This helps them in maintaining the blood glucose level. An amperometric sensor measures the current response to detect the fructose and glucose level. The output obtained from the transducer is converted to voltage, amplified and is given to filter and finally, the glucose and fructose level in the sample was obtained. This system is practiced and evaluated in a real-time environment by taking data from the beverages. The information is accumulated, passed on and put away in the cloud. STM32407 Microcontroller assumes a part IOMT and answers the refreshment glucose and fructose level to diabetic patients through the versatile application. It encourages us to aid constant seeing of the degree of glucose and fructose in the drink early along these lines attracting dangers to wellbeing. This framework chugs insignificant energy despite the fact that working progressively climate.**

**Keywords—diabetes mellitus, glucose biosensor, point-of-care testing, performance**

## I. INTRODUCTION

The degree of glucose and fructose is significant in synthetic, organic and clinical just as in food preparing and maturation. Diabetes is a persistent illness signalized by the sequential blood glucose levels, which results from the inappropriate working of the pancreas and helpless creation of insulin or when the phones of the react inappropriately. Diabetes are characterized three sorts. 1. Type1 diabetes is otherwise called adolescent diabetes. It is ordinarily analyzed in youngsters and youthful grown-ups. In type 1 diabetes, the individual's body doesn't create any insulin. 5% of the populace had this kind of diabetes and sickness. 2. Type2 diabetes implies absence of creation of insulin or the cells doesn't utilizing insulin appropriately. This is the normal type of diabetes in universe. 90% of the populace influenced with this diabetes type. A portion of the danger factors are no active work, overweight, hereditary qualities, age over 45 and identity. 3. Type3 is gestational diabetes. It is high blood glucose level which is first analyzed during pregnancy. This isn't that the ladies get diabetes after labor or she had before her pregnancy, yet it is a danger factor for type2 diabetes later on,.

Since keeping a typical glucose level is exhorted, a progression of appropriate glucose biosensors have been created. All things considered, specialized enhancements in glucose biosensors, normalization of the scientific objectives for their presentation, and persistently evaluating and preparing lay clients are required.

This article surveys the concise history, fundamental standards, logical execution, and subsequently the current status of glucose biosensors inside the clinical practice.

An amperometric transducer is an electrochemical transducer which measures current response to detect the concentration of an analyte at a fixed potential. This transducer aids to control and maintain the required amount of blood sugar level. Various chemical reactions are determined by the level of glucose and fructose level. It is converted to an electrical signal from the sample.

At the point when the Internet of Things (IoT) was actualized to clinical gadgets it is known as the Internet of Medical Things (IoMT). It includes keen on-body sensors, shrewd contraptions, brilliant framework, savvy houses, and keen emergency clinics that speak with each other through the IoT. IoMT assumes a vital part continuously checking. Better crisis reaction, simple admittance to patient's information, far off admittance to medical care and partners network is better in the brilliant medical services system.

This paper is summed up as Section II talks about the Innovative commitments of this paper. Segment III examines existing related exploration. A nitty gritty clarification of the proposed research is given in Section IV. Segment V examines the proposed novel methodology for a precise examination of the state level. Area VII has the finish of this paper.

## II. GLUCOSE DETECTION

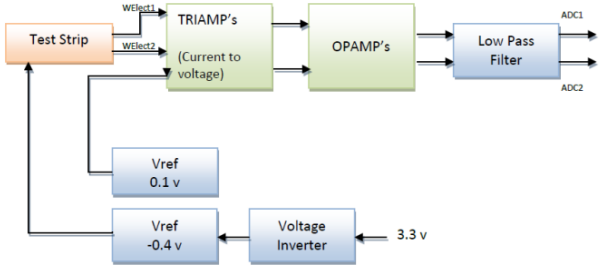
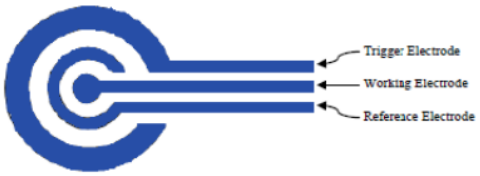



Fig1.1 shows the complete detection of glucose level in beverages. The sensor utilized here has an electro-enzymatic methodology, i.e., it takes the advantage of glucose oxidation with a glucose oxidase protein. The glucose oxidase present there catalyzes the synthetic response of glucose with oxygen which prompts an increment in pH, decline in the fractional pressing factor of oxygen, and increment of hydrogen peroxide because of the oxidation of glucose to gluconic corrosive. A test strip is utilized to gauge changes in one or a few of the segments to discover the glucose focus. The strip utilized here has three terminals or cathodes. Figure 1.2 shows the test strip terminals that is the Reference anode, working cathode, Trigger anode. A negative voltage of -0.4V is given to the reference cathode. As blood/glucose arrangement is set on the strip, a compound response happens in it. Likewise, it produces some current relative to glucose fixation. The current is consistently observed by setting the strip to empower the gadget to screen the degree of glucose in refreshments.




A) Current to voltage converter

The test strip produces current as of the yield and understood the convergence of glucose level in drinks . The yield got is changed over to voltage so it tends to be separated and changed over. A current to voltage converter is utilized for the transformation. It has a solitary inventory, low info counterbalance voltage, low information balance and predisposition current.

B) Amplification and filtered

This block is isolated into an amplification segment and then a low pass filter with a cut-off frequency of 8Hz to eliminate high-frequency noise.

C) Vref generator 0.1 V

The reference voltage is produced by a simple voltage divisor and an external OP-AMP. The figure 1.3 shows the Vref generator circuit (0.1 V).

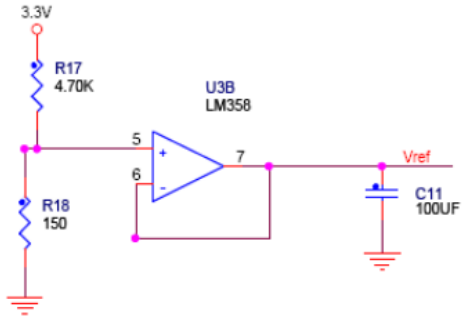



*Fig 1.3*

D) Vref generator –0.4 V

A negative voltage of 0.4V is applied to the reference electrode of the strip.. The fig1.4

shows the generation of -3.3v.Followed by the assistance of a voltage inverter, a charge pump voltage inverter is built with three external 1uF capacitor.

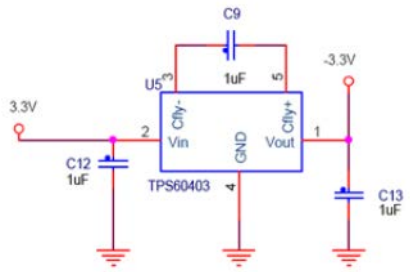



*Fig1.4*

With the negative voltage, the reference voltage, -0.4V, is generated by a simple voltage divisor and an external OP-AMP which is configured as a voltage follower. The following figure1.5 shows the Vref generator circuit, –0.4 V.

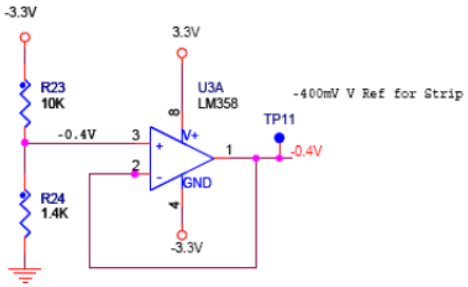
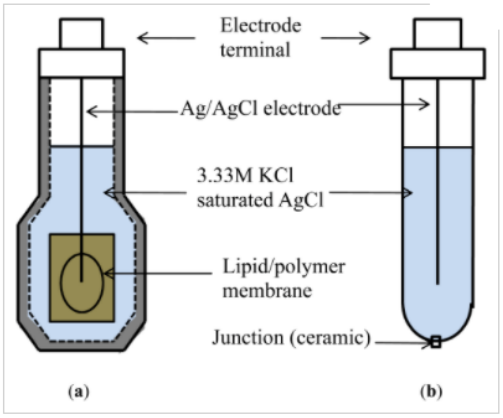



*Fig1.5*

## III. FRUCTOSE DETCTION

Fructose or fructose may be a monosaccharide like glucose is of course found in fruit, honey, agave and most root vegetables. Also, it is regularly added to processed foods in the form of high-fructose corn syrup. It is a key dietary source of carbohydrates. In Western countries, the daily intake of fructose by adults is ∼100 g (1). Due to the specific metabolic properties, fructose develops required metabolic changes, including glucose intolerance, hyperlipidemia, and hyperuricemia. Besides, in light of nonenzymatic fucosylation of proteins , polyol pathway, and carbonyl stress, fructose is inferred to play a specific role in the pathogenesis of complications in diabetic. Thus, the measurement of fructose level in the beverage is clinically significant. It would be most important. Estimating the fructose content of varied drinks would be simple by buying some fructose and making a series of standards of known concentration--say 1%, 5%, 10% then on, and use these to estimate the sweetness of the drinks. Sensing the tastes difference between the fructose and beverages is noted and is completed by sweetness sensor.

A lipid/polymer film, involving a PVC, plasticizer and Liquid. All fills in as an appreciation component likewise as a transducer inside the taste-detecting framework. The reaction of a lipid/polymer layer for each rudimentary taste relies upon the fixations and blend of the plasticizer and lipid.This trademark helps in understanding the taste sensor with worldwide selectivity. The voltage between the sensor terminal and the reference cathode is the film potential (Figure 2.1). The contrast between the film possibilities in a reference arrangement and an example arrangement is the adjustment in the layer potential. In this investigation, deciding reasonable conditions for a lipid/polymer layer to show high affectability and selectivity to positive charge sugars, the amounts and the sorts of the film parts (lipid plasticizer and lipid) are fluctuated to change the hydrophobicity and the electric charge of the layer surface.




Vr, measured by the potentiometry between sensor electrodes and a reference electrode (Ag/AgCl electrode). Followed by, the membrane potential for a sample solution, Vs, is determined. The difference was found between Vr and Vs, written as , Vs-Vr which is defined as a relative value.

## IV.SOFTWARE BASED VALIDATION DETECTION

A new approach using Mamdani fuzzy logic for the accurate intake of beverage level by the patient is measured. It compares the glucose and fructose level of the beverages with the age of the patient, their daily diet, activities and the diabetic level. It analyses the data and recommends the amount of beverage level

intake and insist via the app. A novel IoMT – enables the system for beverage consumption level, thus advancing the state of art in IoMT.

## V . DETECTION APPROACHES: STATE OF ART

The psychological inputs convert to measurable parameters that represents the standing of nutrient levels. wearable sensors with mobile usage like decision, text, etc., ar used [6] to acknowledge aldohexose and levulose level of beverages. The outputs of the linguistic model ar determined by formal logic. It helps in extracting important information from inputs and outputs. it's a high tolerance to uncertainties thus represents the output with excellent accuracy. during this paper, a Mamdani-type fuzzy kind controller is made. There is several inputs however just one output. By exploitation the grid partitioning methodology, the principles associated with the inputs and outputs ar generated [19]. The Mamdani-type managementler could be a system that is nonheritable by synthesizing a group of linguistic control rules obtained from delicate human operators. Implementing machine learning thought helps realize the nutrient level consumption. once detected, the current and former levels ar hold on to the cloud from the system employing a Wi-Fi module.

## VI.RESULT

The fructose and glucose level of various beverages were obtained and tabulated. The table 1.1 shows the beverage consumption level.

Table 1.1

| BEVERAGES | SERVING SIZE | GLUCOSE LEVEL (g/L) | FRUCTOSE LEVEL (g/L) |
|---|---|---|---|
| Pepsi | 500ml | 43.81 | 65.71 |
| Apple Juice | 200ml | 27.20 | 64.85 |
| Iced Tea | 240ml | 39.52 | 59.28 |
| Tropicana apple Juice | 240ml | 24.08 | 28.27 |
| Berry Juice | 240ml | 26.65 | 41.0 |
| Cranberry Juice | 240ml | 18.38 | 21.44 |
| Red Grape juice | 240ml | 30.28 | 32.36 |
| Banana Juice | 240ml | 63.30 | 56.27 |
| Strawberry Juice | 240ml | 62.20 | 56.97 |
| Peach Juice | 240ml | 59.20 | 56.48 |

## VII.CONCLUSION

Fructose and glucose level detection in the beverage is implement using a novel machine learning approach. The consumer electronics implementation uses glucometer and taste sensors for this approach. The recognised value and the patient's age, daily diet, activity and diabetic level are compared. The ease of accessing the information off-line is provided by associate IoT cloud implementation. Cloud access associated verification happens via an on-line cloud package supplier. The results of the planned system show associate accuracy of ninety seven. Besides, the system has developed with minimum quality, low power consumption, would like for user interaction isn't needed and reasonable.

## REFERENCES

[1] S. P. Mohanty, “Everything You Wanted to Know about Internet of Things (IoT),” IEEE Distinguished Lecture, IEEE CE Society, Nov. 2017.

[2] P. Sundaravadivel and E. Kougianos and S. P. Mohanty and M. K. Ganapathiraju,“Everything You Wanted to Know about Smart Health Care: Evaluating the Different Technologies and Components of the Internet of Things for Better Health,” IEEE Consumer Electronics Magazine, vol. 7, no. 1, pp. 18–28, Jan. 2018

[3] Laavanya Rachakonda, Prabha Sundaravadivel, Saraju P. Mohanty, Elias Kougianos, Madhavi Ganapathiraju,” A Smart Sensor in the IoMT for Stress Level Detection

[4] Conductance Analyzing in Function of the Bio-Signals Monitored by Biomedical Sensors,” in Proceedings of International Symposium on Fundamentals of Electrical Engineering (ISFEE), June 2016, pp. 1–4.

[5] P. Rathod, K. George, and N. Shinde, “Bio-Signal Based Emotion Detection Device,” in Proceedings of IEEE 13th International Conference on Wearable and Implantable Body Sensor Networks (BSN), June 2016,pp. 105–108.

[7] E. H¨olzle and F. Bechara, “Pathophysiologie, Klinik und Diagnose der Hyperhidrose,” Der Hautarzt, vol. 63, no. 6, pp. 448–451, Jun 2012. [Online]. Available: https://doi.org/10.1007/s00105-012-2329-8

[8] M.Hund, I.Kinkelin, M.Naumann, and H.Hamm, "Definition of Axillary Hyperhidrosis by Gravimetric Assessment," Archives of Dermatology, vol. 138, no. 4, pp. 539–541, 2002.

[9] S. J. Marshall, "Translating Physical Activity Recommendations into a Pedometer-Based Step Goal," American Journal of Preventive Medicine,vol. 36, no. 5, pp. 410–415, 2017.

[10] V. J. Madhuri, M. R. Mohan, and R. Kaavya, "Stress Management Using Artificial Intelligence," in Proceedings of Third International Conference on Advances in Computing and Communications, 2013, pp. 54–57.

[11] E. El-Samahy, M. Mahfouf, L. A. Torres-Salomao, and J. Anzurez- Marin, "A new Computer Control System for Mental Stress Management using Fuzzy Logic," in Proceedings of IEEE International Conference on Evolving and Adaptive Intelligent Systems (EAIS), 2015.

[12] S. A. Mamdani, E.H., "An experiment in linguistic synthesis with a fuzzy logic controller," International Journal of Man-Machine Studies,vol. 7, no. 1, pp. 1–13, 1975.

[13] D. Sheet, H. Garud, A. Suveer, M. Mahadevappa, and J. Chatterjee, "Brightness Preserving Dynamic Fuzzy Histogram Equalization," IEEE Transactions on Consumer Electronics, vol. 56, no. 4, pp. 2475–2480, 2010.

[14] N. Hasim, M. S. M. Aras, M. Z. A. Rashid, A. M. Kassim, And S. S. Abdullah, "Development of Fuzzy Logic Water Bath Temperature Controller using MATLAB," in Proceedings of IEEE International Conference on Control System, Computing and Engineering, 2012, pp. 11–16.

[15 ] K. Gowrishankar and M. D. M. Khan, "MATLAB Simulink Model of Fuzzy Logic Controller with PSS and its Performance Analysis,"in Proceedings of IEEE- International Conference On Advances In Engineering, Science And Management (ICAESM -2012), 2012, pp. 541– 550.

[16] M. A. Islam, A. B. Talukdar, N. Mohammad, and P. K. S. Khan, "Maximum Power Point Tracking of Photovoltaic Arrays in MATLABusing Fuzzy Logic Controller," in Proceedings of 2010 Annual IEEE India Conference (INDICON), 2010, pp. 1–4.

[17] W. D. Harbour and T. W. Martin, "Development of a Fuzzy Logic Control System in Matlab for an Air Impingement Oven," in Proceedings of 32nd Annual Conference on IEEE Industrial Electronics (IECON), 2006, pp. 319–324.

[18] J. Zhang, H. Tang, D. Chen, and Q. Zhang, "DeStress: Mobile and Remote Stress Monitoring, Alleviation, and Management Platform," in Proceedings of IEEE Global Communications Conference (GLOBECOM),2012, pp. 2036–2041.

[19] K. Plarre, A. Raij, S. M. Hossain, A. A. Ali, M. Nakajima, M. Al'absi,E. Ertin, T. Kamarck, S. Kumar, M. Scott, D. Siewiorek, A. Smailagic,and L. E. Wittmers, "Continuous Inference of Psychological Stress from Sensory Measurements Collected in the Natural Environment," in Proceedings of 10th ACM/IEEE International Conference on Information Processing in Sensor Networks, April 2011, pp. 97–108.

[20] V. Sandulescu and R. Dobrescu, "Wearable System for Stress Monitoring of Firefighters in Special Missions," in Proceedings of E- Health and Bioengineering Conference (EHB), Nov 2015, pp. 1–4.

[21] J. Zhai and A. Barreto, "Stress Detection in Computer Users Based on Digital Signal Processing of Noninvasive Physiological Variables," in Proceedings of International Conference of the IEEE Engineering in Medicine and Biology Society, 2006, pp. 1355–1358.

[22] S. Begum, M. U. Ahmed, P. Funk, N. Xiong, B. V. Scheele, M. Linden, and M. Folke, "Diagnosis and Biofeedback System for Stress," in Proceedings of the 6th International Workshop on Wearable, Micro, and Nano Technologies for Personalized Health, 2009, pp. 17–20.

[23 ] A. O. Akmandor and N. Jha, "Keep the Stress Away with SoDA: Stress Detection and Alleviation System,"

IEEE Transactions on Multi-Scale Computing Systems, no. 99, 2017.

[24] Sugar and Sweeteners Team, Market and Trade Economics, Economic Research Service, US Department of Agriculture. US per capita caloric sweeteners estimated deliveries for domestic food and beverage use, by calendar year. Available at: http://www.ers.usda.gov/briefing/Sugar/data/table50.xls. Accessed May 8, 2013.

[25] US Departments of Agriculture and Health and Human Services. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. http://www.cnpp.usda.gov/dgas2010-dgacreport.htm. Accessed May 22, 2014.

[26] Parker K, Salas M, Nwosu VC. High fructose corn syrup: production, uses and public health concerns. Biotech Mol Biol Rev 2010;5:71–8.

[27] ADM. Cornsweet 90. Product database. Available at: http://www.adm. com. Accessed May 8, 2013.

[28] Food chemical codex. 4th ed. Washington DC: National Academy Press; 1996:191–2.

[29] U.S. Corn Refiners Association. Letter to Division of Dockets and Management (HFS-305), Food and Drug Administration. Re: Docket No. FDA-2012– P0904. Washington DC; 2013. Letter. [30] Food and Drug Administration. High fructose corn syrup: questions and answers. Food additives and ingredients. Available at: http://www.fda.gov/. Accessed April 12, 2013. [31] Tappy L, Mittendorfer B. Fructose toxicity: is the science ready for public health actions? Curr Opin Clin Nutr Metab Care 2012;15:357–61.

[32] Han E, Powell LM. Consumption patterns of sugar-sweetened beverages in the United States. J Acad Nutr Diet 2013;113:43–53

[33] Marriott BP, Cole N, Lee E. National estimates of dietary fructose intake increased from 1977 to 2004 in the United States. J Nutr 2009;139:1228.S– 35.S.

[34] Park YK, Yetley EA. Intakes and food sources of fructose in the United States. Am J Clin Nutr 1993;58(Suppl):737.S–47.S.

[35] Bray GA, Nielsen SJ, Popkin BM. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. Am J Clin Nutr 2004;79:537–43.

[36] Vos MB, Kimmons JE, Gillespie C, Welsh J, Blanck HM. Dietary fructose consumption among US children and adults: the Third National Health and Nutrition Examination Survey. Medscape J Med 2008;10:160.

[37] United States Department of Health and Human Services. Direct food substances affirmed as generally recognized as safe; high fructose corn syrup [docket no. 85 N-0548, 21 CFR parts 182 and 184]. Federal Register Vol. 61, No. 165. Available at: www.gpo.gov. Accessed February 12, 2013.

[38] Aydin S, Aksoy A, Aydin S, Kalayci M, Yilmaz M, Kuloglu T, et al. Today's and yesterday's of pathophysiology: biochemistry of metabolic syndrome and animal models. Nutrition 2014;30:1–9.

[39] Livesey G, Taylor R. Fructose consumption and consequences for glycation, plasma triacylglycerol, and body weight: meta-analyses and metaregression models of intervention studies. Am J Clin Nutr 2008;88: 1419–37.

[40] Teff KL, Grudziak J, Townsend RR, Dunn TN, Grant RW, Adams SH, et al. Endocrine and metabolic effects of consuming fructose- and glucosesweetened beverages with meals in obese men and women: Influence of insulin resistance on plasma triglyceride responses. J Clin Endocrinol Metab 2009;94:1562–9.