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USE OF MULTIVARIATE FUNCTION FOR RAPID IDENTIFICATION OF CHRONIC DIABETIC PATIENTS OF TYPE1 FROM HEALTH DATABASE

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Abstract

In recent years the use of technology has become very common and popular. By the use of technology, we can easily accessed correct and useful information of a diabetic patient. However, finding such information of those patients who really need urgent medical treatment is limited and challenging.

One method is to use technology that has strong mathematical functions, to extract the beneficial information about diabetic patients. Therefore, the integration of technology that have strong mathematical functions with health can identify serious diabetic patients from big health database of patients.

This paper presents a mathematical function by which serous diabetic patients can be identified from health database.

This research can be materialised in any country for any disease provided all relative patients and Health Care Units are on line inter-linked. The pre-requisite for his research is the existence of Health Care Data base and constant liaison with diabetic patients through any social health society.

The objective of this research is to provide quick, precise and accurate medical aid to any respondent as a result to reduce the fast transformation of diabetic Type 1 to Type 2.

The one of primary reason is the overconsumption of food and very less amount of exercise to burn the calories. Once a person suffers with this disease, there does not exist any on line regular medical record with General Physician (GP) as a result the patient has to describe the whole history right from the beginning each time to a different GP. At state level, any health network is not available. In many cases, it takes a lot of time for a GP to reach at right diagnosis for any patient.

This very research paper aims to provide quick response to any diabetic patient on a phone call. This is only possible if record of patient already exits with GP or with Diabetic Society. How this all will work and what to do is the concept of this research paper.

This research paper provides a complete particle approach for both patients and Health Care Departments.

Keywords: Multi Variate Function, Partial Derivative, Diabetics, Telehealth, Health Database, Type 1(T1DM) and Type 2 (T2DM).

1. Introduction

The growing population of diabetic patients will continue to increase pressure on healthcare systems. Multidisciplinary research fields that integrate both Information and Communication Technologies (ICT) and healthcare disciplines are thus looking at advances to transform our personalized healthcare. Significant advances in the field of technology deliver cost-effective solutions to patient health management, anyone, anywhere, and anytime (Kikuno, 2005).

With rapid growth in technology, the development and management of patient's database is gaining more importance. This is to support doctors or medical practitioners to find chronic patient details from the big data of patients. Software developments have made the system to store such crucial data however to identify chronic patient details from billions of records is still a challenge. In this paper, we come up with new mathematical function by which we can identify chronic patient's details

2. Literature Review

Diabetes Mellitus is a complex condition caused by either lack of production of Insulin in the beta cells of the Islets of Langerhans in the pancreas or the body cells fail to respond to the Insulin so that there is excess glucose in the blood. Glucose, is a 'simple' sugar, obtained from the enzymatic breakdown of starch and carbohydrates.

It is an essential energy source required by the body cells to function. Since there is a lack of Insulin or insulin resistance, the cells begin to starve due to lack of glucose. Diabetes is often called 'starvation in plenty'. There is excess glucose in the blood circulation, but not available to the cells to facilitate optimal function. Since the cells are not functioning at optimal capacity, critical tissue and organs are adversely affected. In the case of the eye, due to poor retinal blood vessel intercellular adhesion integrity there is a tendency in poorly controlled Diabetes Mellitus, for retinal bleeding to occur.

If left untreated, this can lead to blindness. Similar haemorrhage in the brain and heart can lead to stroke (Cerebrovascular accident) and Myocardial Infarcts (Heart Attacks), respectively. In the case of the lower limb peripheries, this can lead to gangrene and foot amputations. It must be noted that there is no cell in the body that is immune to the adverse effects of Diabetes mellitus.

Diabetes mellitus has become quite prevalent at a global level. In Australia, 1.1 million people have been diagnosed with diabetes (Arsand et al., 2008) and is prevalent in the Aboriginal and Torres Island population. There are two types of Diabetes Mellitus, Type 1(T1DM) and Type 2 (T2DM). Australian statistics have revealed that 120,000 people have suffered from Type 1 diabetes and 956,000 have Type 2 diabetes (El-Gayar et al., 2013).
T1DM occurs when the body produces no insulin and is occasionally referred to as Juvenile Diabetes or Early-Onset Diabetes. It mostly occurs during teenage years or before the age of forty.

Patients with T1DM need to take insulin injections for life and must ensure that their blood glucose levels stay balanced by eating a healthy diet, an effective exercise programme and carrying out regular monitoring of their blood glucose with blood tests. Whereas in T2DM, there is inadequate insulin and thus, the cell does not work effectively.

In order to manage the blood glucose level, Diabetes patients need to maintain a balance between the quantity of food they eat, their physical activity and insulin medication. People with diabetes were placed on rigid diets and were given a list of dos and don'ts about eating. Some of the food restrictions were advised friends or family, which works sometimes but some of their advices may be out of date and inaccurate. It is difficult for Diabetes patients to find a food in the market which ensures that it not harmful for their health. As mentioned

(Bunma, 2014), poor diet and physical inactivity are the key factors in developing chronic diseases in humans.

For diabetes patients, it is important to assess the consumption of sugar by establishing a link between the diet and disease. However, it is currently challenging as people have moved away from traditional homemade food to more Take-Away food and eating out. Consumption of such food makes it difficult for people to accurately assess their food intake and food composition.

Advancement in ICT has brought essential health related information for Diabetes patients. Parallel to this growth, mobile devices provide different applications in the field of health that improves communication between health practitioners and patients (Rahman, 2012). It provides feedback on individual eating habits, which may enable people with diabetes to better manage their condition (Leader, 2012). Previous research has developed tools that can support dietary management for Type 1 and Type 2 diabetes patients. Findings suggest that greater growth is required for mobile dietary and nutritional support in Diabetes patients.

Mobile applications that support healthy eating habits should be integrated with applications for managing blood glucose and physical activity data, as well as medication data (Rahman et al., 2012; Bunma, 2014). However, mobile applications-based self-management is not a quick solution for the problem and it is critical to understand that its effect is based on strong behavioural change by the patient. Some patients encounter difficulties managing technical problems and others cannot afford the cost. Therefore, the adoption and use of user-centred and socio-technical design principles is highly needed to improve usability, perceived usefulness, and, ultimately, adoption of the technology (Arsand et al., 2008).

There are many features that are discussed in (Chomutare et al., 2011; Valdez et al., 2011; Demidowich et al., 2012; El-Gayar et al., 2013; Anthimopoulos et al., 2014; Arnhold, Quade & Kirch, 2014) but we only select those features which have importance and are still under research. Following are the features that are extracted from the literature 2008 till now, which includes: Real time, User Centred Sociotech Design, Functionalities, Augmented Reality, Usability, User, Estimate CHO, Measure meal composition, Independent Life Style and Clinically Accurate. We plotted all these features in the graph where X-axis is the time and Y-axis is the importance of these features. The plus sign indicates the importance and still under research.

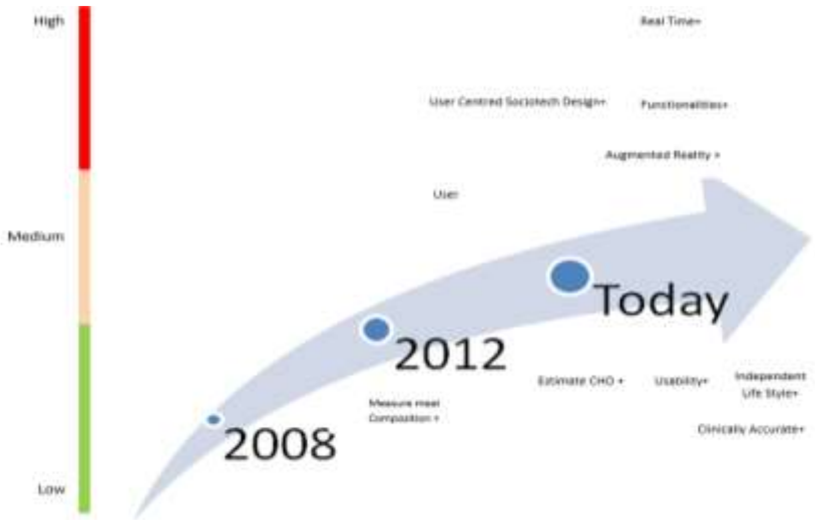

Fig. 1: Time- Graph of most useful features

3. Use of Multivariate Function for Rapid Health Response

To identify high sensitive "diabetes case" instantly we define a "Multivariate Function".

The generalize form of a function is:

$y = f(x)$ and for 'n' variables it is expressed as

$y = f(x_1, x_2, x_3, ..., x_n)$

These 'n' variables are 'n' number of patients.

To identify any particular patient, ***Partial Derivate*** of this polynomial is taken with respect to location of that patient. In other words if a chronic patient symbolize by x_6 i.e. out of a list of, for example, 100 patients we want to focus our attention to 6th patient.

$\frac{\partial y}{\partial x_6} =$ The medical condition of 6th patient (ignoring all other patients).

In this case if we know that this patient has been careless about his medicines, exercises or diet (in that order) then above equations becomes

$\left.\frac{\partial y}{\partial x_6}\right|_{(medicine, exercise, diet)}$ = the medical condition of 6th patient

or $\left.\frac{\partial y}{\partial x_6}\right|_{(m,e,d)} =$ the medical condition of 6th patient

This function is partially derived by substituting three values in form of order triple. In general we can use ordered pair, quadruple or n-tuples depending upon the number of carelessness attitude of the patient.

The gravity of seriousness of this patient is expressed as a function of combination of fractions like

$$y = \frac{1}{m^3} \times \frac{1}{e^2} \times \frac{1}{d^1}$$

For the purpose of solving by substituting values of three different variables m, e and d we take natural logarithm of this equation.

$$\ln y = \ln \frac{1}{m^3} + \ln \frac{1}{e^2} + \ln \frac{1}{d^1}$$

$$\ln y = \ln m^{-3} + \ln e^{-2} + \ln d^{-1}$$

$$\ln y = -3 \ln m - 2 \ln e - \ln d$$

The higher power in dominator indicates a very small value of fraction showing the acute condition of that patient with respect to its attribute.

For simplicity and convenience, we can divide our patient in some groups which at the end generate a numerical value indicating the seriousness of a patient.

Age Group (Years)	Number Value
Infant – 18	1
19 – 37	2
38 – 56	3
57 – 75	4

The database in our system calculates Total Number Value of Patient (TNVP) consisting of three characteristics which can be extended to any number as need arises.

TNVP = (Age Group Value) + (Weight Number) + (Consultation with Parents for age group 1 only)

Case 1:

For example our first patient is of 6years then its TNVP will be calculated as follows:
TNVP = (Age Group Value) + (Weight Number) + (Consultation with Parents for age group 1 only)

$TNVP_1 = (\quad 1 \quad) + (\quad 5 \quad) + (\quad -1 \quad) = 5$

The second term on the right hand side of this equation will start from that number will assume that number which will be after last value of age group.
The third term is -1 indicated highly careful parents of that patient as a result total value of TNVP will decreased and the patient will not be considered seriously compared to the following case.

$TNVP_2 = (1) + (5) + (+1) = 7$
In this case the third term +1 indicates negligence of parent towards patient resulting in highest TNVP value.
In our system for any age group highest value shows a serious case which will reflected on the screen of database containing data of all patients.

Case 2:

TNVP = (Age Group Value) + (Weight Number) + (Behaviour of the patient towards doctor advices)

$TNVP_1 = (2) + (6) + (-2) = 6$
In fact in all these values substitutions a sequel order of integers is being followed.
The first term on the right hand side of above equation shows group value.
The second term is regarding weight of the patient and is after value 5 of case 1.
The third term is for those patients who are very careful about their health and hence their TNVP cannot be maximum in their age group. Therefore these patients do not require immediate attention.

$TNVP_2 = (2) + (6) + (2) = 10$
The similar description stands for this equation as that for $TNVP_1$ expect third term showing casual attitude of the patient toward doctor advice.
As soon as a large number value appears on the screen we can immediately contact that patient for medical assistance.

4. Future Work

Based on the important factors, as mentioned in section 2 and advanced mathematical function in section 3, we proposed an idea called BIG-GLUCON-HERO. This proposed idea is to use "multivariate function" in diabetic's application along with sociotechnical design principles to identify chronic diabetic patients, support their independent lifestyle in order reduce the hospitalization. Further, it can monitor patient food intake to control obesity, provide real time feedback from doctors and parents, support in decision making and interaction with outside world using social media and provide help in case of emergency.

Fig. 2. BIG-GLUCON-HERO

Conclusion

The paper introduced a mathematical function called multivariate function and how this function can be beneficial in telehealth. Although the use of technology is getting more advanced in many fields especially health and medicine, however, having strong mathematical function inside the technology can be more helpful.

This will helps to extract useful information of diabetes patient from health database. In this paper, we reviewed the literature relating to using technology to help diabetes patient in selecting nutritious food and avoid obesity. From the literature, it seems that some features as mentioned in section 2 are still under research, despite the fact there is rapid growth in technology but identification of chronic patients (based on special parameter likes eating routine, medicine intake and exercise) are still challenging. Whereas usability, real time support, clinically accuracy and interface design are still major concerns in health applications.

Finally, Big-Gulcon-Hero is a proposed idea that use "multivariate function" in diabetic's application along with sociotechnical design principles to identify chronic diabetic patients, support their independent lifestyle in order reduce the hospitalization.

References

i. Anthimopoulos, M. M., Gianola, L., Scarnato, L., Diem, P. & Mougiakakou, S. G., 2014. A Food Recognition System for Diabetic Patients Based on an Optimized Bag-of-Features Model. *IEEE J. Biomed. Heal. Informatics*, 18(4), pp. 1261–1271.

ii. Arnhold, M., Quade, M. & Kirch, W., 2014. Mobile Applications for Diabetics: A Systematic Review and Expert-Based Usability Evaluation considering the Special Requirements of Diabetes Patients age 50 years or older. *Journal of Medical Internet Research*, 16(4).

iii. Arsand, E., Tufano, J. T., Ralston, J. D. & Hjortdahl, P., 2008. Designing Mobile Dietary Management Support Technologies for People with Diabetes. *J. Telemed. Telecare*, 14(7), pp. 329–332.

iv. Bayu, M. Z., Arshad, H. & Ali, N. M., 2013. Nutritional Information Visualization Using Mobile Augmented Reality Technology. *Procedia Technol.*, 11(Iceei), pp. 396–402.

v. Bunma, D., 2014. Using Augment Reality to Increase Capacity in QR Code. *IEEE*, pp. 440-443.

vi. Chomutare, T., Fernandez-Luque, L., Arsand, E. & Hartvigsen, G., 2011. Features of Mobile Diabetes Applications: Review of the Literature and Analysis of Current Applications Compared against Evidence-Based Guidelines. *Journal of Medical Internet Research*, 13(3).

vii. Demidowich, A. P., Lu, K., Tamler, R. & Bloomgarden, Z., 2012. An Evaluation of Diabetes Self-Management Applications for Android Smartphones. *Journal of Telemedicine and Telecare*, 18(4), pp. 235–238.

viii. El-Gayar, O., Timsina, P., Nawar, N. & Eid, W., 2013. Mobile Applications for Diabetes Self-Management: Status and Potential. *J. Diabetes Sci. Technol.*, 7(1), pp. 247–62.

ix. Irshad, S., 2014. *User Experience Evaluation of Mobile AR Services*.

x. Kikuno. 2005. *Why do Software Projects Fail? Reasons and a Solution using a Bayesian Classifier to Predict Potential Risk*. 11th IEEE Pacific Rim International Symposium.

xi. Leader, W. T., 2012. *Designing Mobile Applications to Support Type 1 Diabetes Education*.

xii. Rahman, M. H., Pickering, M., Frater, M., Kerr, D., Bouchey, C. & Delp, E., 2012. Food Volume Estimation in a Mobile Phone Based Dietary Assessment System. *2012 Eighth Int. Conf. Signal Image Technol. Internet Based System*, pp. 988–995.

xiii. Valdez, A. C., Ziefle, M., Horstmann, A. & Herding, D., 2011. Mobile Devices used for Medical Applications: Insights won from a Usability Study with Diabetes patients. *Int. J. Digit. Soc. (IJDS)*, 2(1), pp. 337–346.

xiv. Zhou, F., Dun, H. B. L. & Billinghurst, M., 2008. Trends in Augmented Reality Tracking, Interaction and Display: A Review of Ten Years of ISMAR. In *Proceedings-7th IEEE International Symposium on Mixed and Augmented Reality 2008*, pp. 193–202.