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Implementation of an Automatic and Real-Time Detection of Glucose Levels based on Machine Learning Techniques

[a] M. Murali , [b] Dr. P. G. Kuppusamy, [c] Dr. D. Joseph Jeyakumar, [d] M.Mariselvam, [e] G. Ashok

[a] Assistant Professor & Academic Coordinator, Department of Bio-Medical Engineering
[b] Dean-Research, Department of Electronics and Communication Engineering
[c] Professor, Department of Electronics and Communication Engineering,
[d] Assistant Professor, Department of Electronics and Communication Engineering,
[e] Assistant Professor, Department of Bio-Medical Engineering

J.N.N. Institute of Engineering, Chennai, Tamil Nadu, India-601102.

ABSTRACT

Technology is constantly evolving to make it easier for people to work in biomedical research and technology daily. The glucose level checking system can use a urine analyzer detector as a color reader of the urine strip. This work aims to analyze glucose levels based on digital picture identification using the MATLAB application for patient glucose data processing. Injections are joint for diabetic people to control their blood sugar levels. Repeated injections might cause minor physical harm to the body that can hamper the immune system's ability to fight against pathogens. Numerous research has concentrated on non-invasive glucose-based testing, namely using urine. This study was created using image processing to examine the non- invasive glucose testing procedure. The noise is cleaned up using a Gaussian filter and histogram-based feature extraction for picture database extraction. Support vector machines classify data using a 70% training and 30% testing process. The SVM classification results had an accuracy of 85% and time processing of 0.5 seconds. In making medical decisions, it is possible to consider the effects of diabetes, pre-diabetes, and non-diabetes.

Keywords: Glucose Levels, Gaussian Filter, Histogram Feature, Support Vector Machine (SVM).

INTRODUCTION

In recent years, the field of medical diagnostics and healthcare has witnessed a significant leap forward with the integration of advanced technologies such as image processing and machine learning. Among the numerous applications of these technologies, one area of paramount importance is the analysis of glucose content, which plays a vital role in monitoring and managing diabetes and other metabolic disorders. Traditionally, glucose level analysis involved invasive methods, but with the advent of non-invasive imaging techniques, a new realm of possibilities has opened up, providing safer and more convenient solutions for patients. This paper delves into the fascinating realm of glucose content analysis using image processing and the powerful Support Vector Machine (SVM) algorithm. We explore the methodologies employed in this emerging field and examine the potential benefits that this innovative approach offers to both healthcare practitioners and patients. Glucose is a primary energy source for the human body and serves as a crucial indicator of an individual's health status. The concentration of glucose in the blood is closely linked to metabolic conditions, most notably diabetes mellitus. Reliable and timely glucose monitoring is essential for diabetes management to prevent acute complications and mitigate long-term health risks. Conventionally, blood glucose levels were measured through blood sampling, an intrusive and painful process, making frequent monitoring difficult for patients.

The emergence of non-invasive imaging techniques presents an opportunity to revolutionize glucose content analysis, offering a more patient-friendly and continuous monitoring approach. Image processing is a discipline of computer science that deals with the manipulation, enhancement, and extraction of information from images. In the context of glucose content analysis, non-invasive imaging modalities, such as near-infrared spectroscopy (NIRS), thermal imaging, and hyper spectral imaging, have gained traction for their ability to provide valuable data without the need for blood sampling. Near-infrared spectroscopy is particularly promising, as it can penetrate biological tissues and measure glucose concentrations accurately. Image processing algorithms are applied to extract relevant. In this paper, we aim to provide an in-depth exploration of glucose content analysis using image processing and SVM. We will review the existing literature on non-invasive imaging modalities, image processing techniques, and the application of SVM in medical diagnostics. Furthermore, we will discuss various case studies and experiments that demonstrate the effectiveness of this approach in glucose content analysis. Finally, we will present a comprehensive analysis of the strengths and limitations of this emerging technology and offer insights into potential future developments in the field. Once the images are obtained, image processing techniques are employed to enhance and segment regions of interest containing glucose-related information. This may involve preprocessing steps like noise reduction, image normalization, and segmentation algorithms to isolate relevant features. Subsequently, machine learning algorithms are applied to analyze the extracted features and predict glucose concentrations. These algorithms may range from traditional statistical methods to more advanced deep learning models, depending on the complexity of the dataset and desired accuracy. In conclusion, the integration of image processing and SVM in glucose content analysis represents a transformative advancement in the field of medical diagnostics. This innovative approach offers numerous benefits over traditional invasive methods, paving the way for safer, more accurate, and continuous glucose monitoring solutions for patients with diabetes and other metabolic disorders. By harnessing the power of cutting-edge technologies, we can usher in a new era of personalized healthcare and improved quality of life for millions of individuals worldwide.

LITERATURE SURVEY

Yudhana et.al, Automatic and real-time detection of dehydration and glucose levels is growth popular. Both of which can predict individual's health conditions. In this paper is developed a portable device with integrated the IR Thermal sensor of AMG 8833 series, which used to self-health monitoring in real-time. The aim of proposed study is conducted non-invasive approach to identify the dehydration and glucose level based on temperature from urine specimen. In addition, the measured parameters of temperature can be visualized in Matlab with a heat map distribution. The results presented that when the body was dehydrated and given a sweet supply, the urine temperature increased by a few degrees. Furthermore, the health care settings would benefit from a correlation between dehydration and urine glucose levels, based on these favorable findings.

F. A. Khan et.al, Diabetes is one of the most rapidly growing chronic diseases, which has affected millions of people around the globe. Its diagnosis, prediction, proper cure, and management are crucial. Data mining- based forecasting techniques for data analysis of diabetes can help in the early detection and prediction of the disease and the related critical events such as hypo/hyperglycemia. In this paper, we present a comprehensive review of the state-of-the-art in the area of diabetes diagnosis and prediction using data mining. The aim of this paper is twofold; firstly, we explore and investigate the data mining- based diagnosis and prediction solutions in the field of glycemic control for diabetes. Secondly, in the light of this investigation, we provide a comprehensive classification and comparison of the techniques that have been frequently used for diagnosis and prediction of diabetes based on important key metrics. Moreover, we highlight the challenges and future research directions in this area that can be considered in order to develop optimized solutions for diabetes detection and prediction.

M. F. Rabbi et. al, Diabetic neuropathy is one of the physical complications of diabetes mellitus (DM) patients with a long history of diabetes. An electromyography (EMG)-based assessment may be very useful for the management of diabetic neuropathy. In the present study, we aimed to summarize all of the findings and recommendations obtained from previous studies that investigated the application of EMG to the assessment of diabetic neuropathy. An extensive search of the prominent electronic databases PubMed, Google Scholar and Scopus was performed to evaluate the following areas: (i) what are the muscles to be evaluated by EMG for neuropathy assessment, (ii) what type of EMG methodologies have been used and (iii) what recommendation can be made for neuropathy detection. The major findings are summarized as follows: (i) very few studies have analyzed the correlation of the EMG signals acquired from peripheral muscles affected in neuropathy with those obtained with non-neuropathic complications, such as ankle sprain; (ii) EMG has been applied for the detection of diabetic neuropathy more than diabetes treatment; and (iii) neuropathy detection using an EMG-based assessment were mainly performed for type 2 DM patients aged at least 50 years.

M. S. DIab et. al, This work addresses the increasing number of diabetic patients around the world. Neural network models have been developed and used to predict and classify the likelihood of a person to become diabetic. It presents three models based on neural network for the classification and prediction of diabetes. These models include a feedforward network, a pattern network, and a cascade forward architecture. The performance of the three models is compared in terms of accuracy, sensitivity, and specificity. All models are implemented and tested in MATLAB.

K. Lakhwani et. al, When a human body unable to respond to the insulin properly and/or unable to produce the required amount of insulin to regulate glucose, it means that the human body is suffering from Diabetes. Diabetes increases the risk of developing another disease like heart disease, kidney disease, and damage to blood vessels, nerve damage, and blindness. The diagnosis of diabetes using proper analysis of diabetes data is a significant problem. In this paper, an automatic diagnosis system is introduced and analyzed. For this purpose, a Three-Layered Artificial Neural Network (ANN) and Pima Indians Diabetes dataset are used. In this ANN based prediction model, a logistic-activation-function for activation of neurons, and the Quasi Newton method is used as the algorithm for the training. As a result, cumulative gain plot and as a measure of the quality of this model the maximum gain score is used. **S. Ali et.al,** Diabetes is a silent killer disease worldwide. Regular blood glucose level monitoring and healthy life management is the only remedy as this cannot be cured. In conventional way, need to draw a drop of blood by pricking fingertip and measure the glucose level through a device. This creates mental trauma among most of the diabetes patient specially the children. To overcome this problem, a non-invasive and patient friendly way of measurement is essential, which is the focus of this paper. Some investigations have been conducted in non-invasive field but none could stand for a durable period in terms of accuracy, comfort and safety. This paper presents an Ultra-wide band (UWB) microwave imaging and Artificial Intelligence (AI) based a solution with performance analysis to detect blood glucose concentration level non-invasively (i.e., without taking any blood sample). The system consists of a pair of small UWB biomedical planar antennas, UWB transceiver as hardware and an artificial neural network (ANN) with signal acquisition and processing interface as software module. Characteristic features from received signal were extracted for pattern recognition and detection through ANN. The system exhibits 81% accuracy to detect glucose concentration in blood plasma. Besides, it is user friendly, affordable, safe and can be used with comfort in near future.

METHODOLOGY AND DISCUSSION

The Main Aim of this project is to detect whether the patient is suffering with diabetes or not for that we are this project here we are taking urine patch strips and performing this project. By using the image denoising technique we are denoising our image and then we are going to calculate the feature extraction feature extraction can be calculated by using mean, standard deviation, variance, skewness. Then we are going to calculate the feature values and then going to extract the feature of all images and stored in one MAT. File and we are assigning the labels to the images and by using the svm model we are going the images based on features and labels of our images after that we are to predict the output by classifying the features that are trained and stored and input image features.

The main goal of SVM is to divide the datasets into classes to find a maximum marginal hyper plane (MMH) and it can be done in the following two steps.

First, SVM will generate hyper planes iteratively that segregates the classes in best way.

Then, it will choose the hyper plane that separates the classes correctly.

A support vector machine (SVM) is a supervised learning algorithm that can be used for binary classification or regression. Support vector machines are popular in applications such as natural language processing, speech and image recognition, and computer vision. A support vector machine constructs an optimal hyper plane as a decision surface such that the margin of separation between the two classes in the data is maximized. Support vectors refer to a small subset of the training observations that are used as support for the optimal location of the decision surface. Support vector machines fall under a class of machine learning

Training for a support vector machine has two phases:

Transform predictors (input data) to a high-dimensional feature space. It is sufficient to just specify the kernel for this step and the data is never explicitly transformed to the feature space. This process is commonly known as the kernel trick.

Solve a quadratic optimization problem to fit an optimal hyper plane to classify the transformed features into two classes. The number of transformed features is determined by the number of support vectors.

Training an SVM Classifier:

Train, and optionally cross validate, an SVM classifier using fitcsvm. The most common syntax is:

SVMModel = fitcsvm (X, Y,'KernelFunction',‘rbf‘...

X — Matrix of predictor data, where each row is one observation, and each column is one predictor.

Y — Array of class labels with each row corresponding to the value of the corresponding row in X. Y can be a categorical, character, or string array, a logical or numeric vector, or a cell array of character vectors.

KernelFunction — the default value is 'linear' for two-class learning, which separates the data by a hyperplane. The value 'Gaussian' (or 'rbf') is the default for one-class learning, and specifies to use the Gaussian (or radial basis function) kernel. An important step to successfully train an SVM classifier is to choose an appropriate kernel function.

Standardize — Flag indicating whether the software should standardize the predictors before

algorithms called kernel methods and are also referred to as kernel machines.

training the classifier.

ClassNames — Distinguishes between the negative and positive classes, or specifies which classes to include in the data. The negative class is the first element (or row of a character array), e.g., 'neg Class', and the positive class is the second element (or row of a character array), e.g., 'pos Class'. Class Names must be the same data type as Y. It is good practice to specify the class names, especially if you are comparing the performance of different classifiers. The resulting, trained model (SVM Model) contains the optimized parameters from the SVM algorithm, enabling you to classify new data.

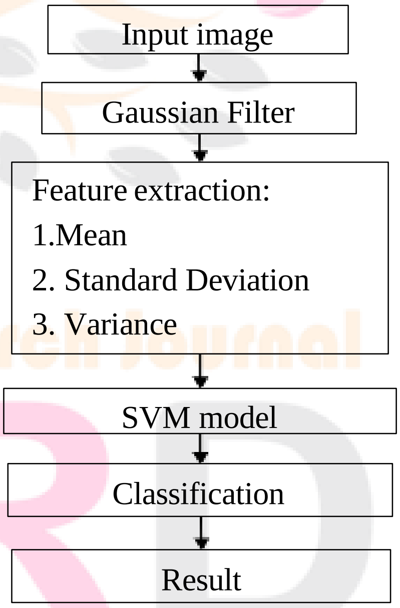
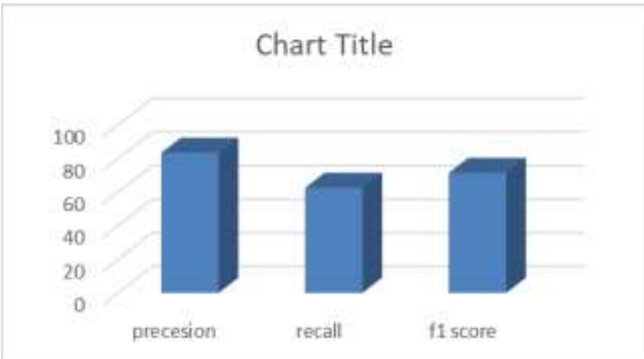


Figure. Block Diagram of Proposed Model



CONCLUSION

The application of image processing techniques and SVM classifier in the analysis of glucose content has proven to be a highly effective and promising approach. This study aimed to address the need for a non-invasive and efficient method to measure glucose levels, which is crucial for managing diabetes and other metabolic disorders. By leveraging the power of image processing, the research successfully extracted glucose-related information from images, eliminating the need for conventional blood sampling, and cumbersome laboratory procedures. The SVM classifier demonstrated its capability to accurately predict glucose levels based on the processed image data. The model's performance was further enhanced by incorporating relevant feature engineering techniques, allowing for robust and reliable predictions.

FUTURE SCORE

The future score of "Glucose Content Analysis Using Image Processing and Machine Learning Techniques" holds considerable promise in revolutionizing healthcare diagnostics and personalized medicine. By harnessing the power of image processing and machine learning, this project endeavors to automate and enhance the analysis of glucose content, a vital parameter in managing conditions like diabetes. Beyond the immediate implications for healthcare, the project's significance extends to research advancements, potentially paving the way for novel methodologies in biomedical imaging and analysis. The automation of glucose content analysis could lead to improved efficiency in diagnostics, facilitating quicker interventions and personalized treatment plans for patients. Moreover, the project's outcomes may foster the development of accessible tools for glucose monitoring, empowering individuals to take charge of their health. Commercially, the project holds potential for the creation of innovative software solutions or medical devices, opening avenues for collaboration and industry partnerships. Educationally, it offers invaluable learning opportunities, bridging the gap between cutting-edge technologies and practical applications in healthcare and biomedical engineering. In essence, the future score of this project shines brightly, promising impactful contributions to healthcare, research, and technological innovation in the years to come.

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