

# Diabetes Risk Analysis using IoT and Deep Learning

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**Abstract**—Internet of Things is an upcoming technology which is applied in solving problems involved in areas like banking, healthcare, security and transport etc. In the proposed system, IoT and machine learning techniques such as classification and regression techniques are applied on diabetes database to decide the risk of diabetic patients and suggest patients with lifestyle modifications and proper medication in order to improve their health condition and reduce adverse reactions in other parts of body or preventing to cause psychological effects. IoT devices and cloud technologies are connected to transfer data and to execute the decisions on well-defined rules.

**Keywords**--Diabetes, Deep Learning, Internet of Things(IoT), lifestyle modifications

## I. INTRODUCTION

Diabetes is also referred to as diabetes mellitus that belongs to a group of diseases in which a person's glucose rate goes high and his body's insulin level decreases. Their symptoms are polyuria-frequent urination and have increased appetite-polyphagia and consumption of water - polydipsia. Almost 382 million people has diabetes over the world. Diabetes are classified into Type-1 and Type-2.

Type-1 is said to be insulin influenced diabetes where insulin levels will be decreased due to inability for the body to produce insulin or due to damaged pancreas, it involves body attacking its pancreas with medicines. This type of pancreas is genetic i.e. one person has diabetes due to other person belonging to same family. Sometimes it may lead to damage to the blood vessels of the eyes and its diagnosis is known as diabetic retinopathy and diagnosis of damaged nerves is called diabetic neuropathy, diagnosis of damaged kidneys is called diabetic nephropathy. If situation in diabetes becomes more severe then it may lead to heart disease or affects kidneys and can cause stroke. Treatments involve taking insulin injected into skin either stomach or hands or legs. Methods are syringes, prefilled cartridges injected into insulin pens or jet injectors use high pressure air sprayed on skin etc.

Most common occurring disease is Type 2 diabetes almost 95% of them face with it and it is called adult on-set diabetes nowadays even kids and teenagers suffer from diabetes due to obesity and sedentary lifestyle etc. It is called non-insulin diabetes and mild one than the first one but then still cause adverse effects on the health can lead to stroke and increase of coronary diseases. In type 2 production of insulin is somewhat higher than type 1 but amount produced is less than a normal person which requires it due to resistance on the organs etc.

People, who are obese than their normal weight, are highly subjected to type 2 diabetes as they could have insulin resistance. With this resistance it may lead to pancreas for it to work over harder production of insulin is very less and no cure for diabetes but can be controlled through weight management, exercise, proper food control or can assist patients to lead better life through technologies.

## II. LITERATURE SURVEY

Pérez et al developed a system which monitors temperature in patient's feet and other health condition using smart sock sensors and is sent to mobile, desktop or PDA. The system helps patients to maintain proper diet and medications[1]

Aljumah, Abdullah A et.al, had design the system which predicts the existence of diabetes using regression technique of data mining. Existence of Diabetes is analyzed with help of Oracle Data Miner Software and provides suggestions for doctors to use different modes to treat diabetes. The source of dataset is from NCD(Non Communicable Disease) in Saudi Arabia from World Health Organization and also used in analyzing different treatment which can be applied and effective for various ranges of age groups based on different factors. Age groups were classified as younger and older. The result obtained as drug treatment is ineffective for younger groups as compared to older groups[2].

Poorejbari, S.et al; had designed a system which aims to treat and manage diabetes by using cloud computing approach. This system is designed for patients for making it usable at home as well as hospital for diagnosing type-2 diabetes. Survey suggests that type-2 diabetes can get cured with help of lifestyle changes. It uses three main components: - Home Context Manager-gathers necessary information from patients along with responds patient's requests, Hospital Environment-accessed by nurse or doctors in hospital and Cloud Infrastructure[3].

Kazemi, M et al; designed system details of health status of patients using convenience sampling methods. Later on NDS(Neuropathy Disability Score) was administered on six hundred patients. Based upon the score severity was classified. With SVM method, one-against-all, one-against-one, three-kernel functions and radial basis were used to predict class of dataset. Synthetic minority oversampling technique is used to improve the outcome[4].

Al Jarullah et al; designed a system and provides result of prediction for diabetic neuropathy, a classifier built from a balanced dataset and the RBF kernel function with a one-

against-one strategy on a patient was about 76%. The system collects information and generated a pattern defining effective diagnosis of Diabetes, which is generated using decision tree technique. This technique is applied on Pima Indian Dataset analysis is done using WEKA tool with J48 decision tree technique. Accuracy came out to be 78.17% properly classified of total records and improperly classified is 21.82% [5].

Huang, C., Jiang et al, designed a system using SVM model in order to analyze the detection of diabetes in the body and has assumed that the model can classify more than 2000 clinical data on comparing three functions such as AUC, ROC and RBF, RBF provides best performance with 90% accuracy[6].

Kasbekar et al, designed system based on classification techniques and involved in detection of how dangerous is diabetic neuropathy on comparing with diseases, various techniques has been applied in terms of injuries and ulcer identification. Decision tree technique was applied on system using R and CARET package was used based on parameters hemoglobin levels, serum creatinine, glucose levels etc. Initially a single C5.0 tree is generated using Doppler flow and ulcer levels provides coarseness existed in the foot[7].

Senthil Kumar et al, has designed system for decision making based on medical datasets-heart disease, diabetes and hepatitis diabetes retrieved from UC-Irvine and objective of system is to generalize and differentiate the values provided by various algorithms such as ID3, C4.5 and CART. In terms of complexity, C4.5 performs better than ID3 and CART performs better than all in terms of efficiency[8].

Kamble et al, developed a system for diabetes detection using Restricted Boltzmann machine approach a deep learning technique which detects whether patient has diabetes or not and in case if diabetes exists then its classification is done using decision tree[9]. They had generated result for 300 data points. The system aims for correct walking posture.

### III. SYSTEM ARCHITECTURE

There are many systems designed for diabetic patients nowadays from checking out blood glucose till providing an assistance for leading better life. In this system, data will be gathered using blood pressure sensor, glucometer sensor, ECG sensor and Foot pressure sensor attached with temperature sensor. The above sensor values will be used in symptom assessment which contains queries about whether patients have any other symptoms or bad habits.

The symptom assessment data will be stored in a cloud server. A decision is made on the data stored in the cloud and retrieved values are proceed over analysis in order to make patients to visit doctor or need to visit dietician.

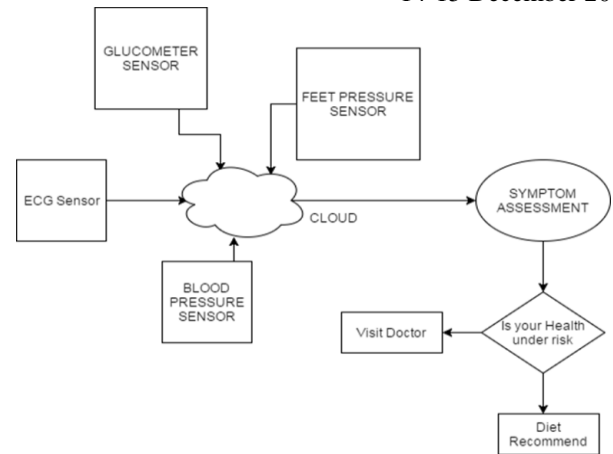


Fig. 1. Diabetes Risk Analysis-Flow

The system is designed using Raspberry-Pi 3 with OS enabled 1.4GHz 64-bit quad-core processor, dual-band wireless LAN, Bluetooth 4.2 and Power-over-Ethernet support.

#### A. Sensors

- Sensors used are glucometer sensor, blood pressure sensors, ECG sensors, Feet Pressure Sensors.
- Glucometer Sensor: Glucometer Sensor allows user to monitor their sugar levels either in fasting or post-lunch.
- Blood Pressure Sensor: Blood Pressure Sensor allows to gather reading blood pressure of user in order to determine existence of high blood pressure.
- Feet Pressure Sensor: Feet Pressure Sensor allows to determine pressure in feet with respect to increased level of swelling and it is embedded with temperature sensor which monitors temperature of feet.
- ECG Sensor: ECG sensor monitors the heartbeat of diabetic patient.

#### B. Softwares:

The system is programmed using python scripts to maintain records of tests, recommending for dietary changes or making an appointment for doctor.

#### C. Modules:

- **Data Collection and Storage:** The system involves gathering data from sensors like- ECG, Blood Pressure, Glucometer and Feet Pressure Sensor which will be stored in cloud.
- **Algorithm Formulation:** A model is designed for risk analysis considering previous factors in order to take precautions for patients to face from chronic diseases hence using CART algorithm, risk is predicted and suggestions are provided to patients
- **Need a Diet Recommendation:** If the risk factor is low then the system will suggest patient to go for diet recommendation.

- **Need to fix an Appointment:** If the risk factor is high then system will suggest patient to make a visit to doctor.
- **Feedback:** The system will ask patient about their improvement in health, if the status still remain same then system will provide certain tips to patient.

#### IV. RISK ANALYSIS IN DIABETE

Risk analysis on data helps in monitoring the patient dealing with diabetes and prevent from acute complication. The dataset is biosensor values. This risk analysis model also helps in future reduction of diseases that may arise because of diabetes. Hence it is very importance to predict diabetes in early stage and take precautionary measures such that the blood glucose level and other related diseases are controlled which are more commonly seen in aged people but there are various other techniques used which are developed with Genetic Algorithm. In comparison with second one, first one is selected as it has capability to predict diseases which arise due to diabetes

#### V. CART

CART-Classification and Regression Techniques a data analysis technique used in data mining for discovering supreme relationships and patterns and makes easier study over hidden complex areas within data. Splitting of data is done as per some criteria and increases disjunction of classes leading to hierarchical decision structure. CART doesn't require clue values with respect to distribution of elements and can be programmed normally using decision statements which has made easier in treating diabetes patients by identifying their symptoms. It is known to be using Boolean repeated partitioning-which begins with root and splits sub-nodes and proceeds to successor nodes. The key elements of a CART analysis are a set of rules for:

- **Splitting of nodes-**Before splitting node into child node, decision is made which is based on yes or no-if yes(1) means child node is splitted over left side otherwise right side and process is succeeded over sub nodes. While splitting a node, it looks for problem present in splitting performs in-depth search of it. Decision of tree-Once splitting of node is done, split definitions in nodes are ordered in the using GINI index. Assigning each terminal node to a class-Once a node is defined with rule a quality will be analyzed whether it less or more. If it is less means no more nodes are divided whereas rest will be divided and assures generation of complete decision tree.
- **Pruning of Trees:-** Once a node proceeds with sub-division of sub nodes , without verifying generation of maximal trees, just examines small trees obtained from pruned nodes of maximal tree .Normally it doesn't halt in between the process of tree generation. Pruning is done using Minimal Cost Complexity.
- **Testing:** Once maximal tree is generated; sub-trees are obtained from the maximal tree in order to estimate which one is best for cost or error rate. With generated data, sampling process is done in order to generate training data

and test data Using, Training data an oversized tree can be generated whereas with test data an estimation can be done which sub tree has error or improper classification. The best child tree can be said with the lowest or near-lowest cost.The data has been classified into Highly Diabetic and Less Diabetic which can help in providing better suggestion or improving their treatment.

#### VI. CONCLUSION

Diabetes is an incurable disease which occurs in both adults and young aged people as their symptoms can cause variable reactions in body which might lead to chronic diseases hence for that a risk model is designed for system to predict high and low risk levels in dataset retrieved from biosensors which are used for monitoring health status using electrocardiogram, glucometer, blood pressure sensor and feet pressure sensor and all these data are stored in cloud and can be retrieved as comma separated form. The proposed risk prediction analysis is performed using CART algorithm.

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