IoT Based System for Classification of Diabetes Using Convolutional Neural Network Algorithm

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Abstract **- The Internet of Things is the most preferable technology in medical applications. Diabetes is a persistent disorder that impacts hundreds of thousands of humans in the world. Early detection and accurate diagnosis of diabetes are crucial for the effective management and prevention of complications. Deep Learning (DL) has emerged as a promising technique for the classification of diabetes effectively using medical data. Implemented an Internet of Things-based system to predict the diabetes of patients by taking retinal images of the patient. Then compared the patient retina image with the predefined dataset and classified diabetes using the Convolutional Neural Network algorithm. Results are displayed on Liquid Crystal Display, which sends an alert message to the doctor as well as patients about the result through IoT.**

Keywords: **Diabetes, Convolutional Neural Network algorithm (Deep Learning), Retinal images, Liquid Crystal Display (LCD), Internet of Things (IoT).**

I. INTRODUCTION

Diabetes is a continual scientific situation that influences how the frame approaches blood sugar (glucose). Glucose is a vital source of energy for the cells in the body, and insulin is a hormone that helps regulate the amount of glucose in the bloodstream. In people with diabetes, the body either doesn't produce enough insulin or can't use it effectively, leading to high blood sugar levels. As of 2021, it is estimated that there are 463 million adults (age 20-79) living with diabetes worldwide, which represents 9.3% of the global population in that age group. In India, 77 million adults (aged 20-79) living with diabetes as of 2021.

There are essential kinds of diabetes: Type 1 diabetes and Type 2 diabetes. Type 1 diabetes happens whilst the body's immune machine assaults and destroys the cells withinside the pancreas that produce insulin. Type 2 diabetes, on the other hand, occurs when the body becomes resistant to insulin or doesn't produce enough insulin to maintain normal blood sugar levels. Other types of diabetes include gestational diabetes, which can develop during pregnancy, and prediabetes, a condition in which blood sugar levels are higher than normal but not yet high enough to be diagnosed as diabetes. Diabetes can cause a wide range of health problems if left untreated, including heart disease, stroke, kidney damage, nerve damage, and vision loss. However, with proper management, including medication, lifestyle changes, and regular monitoring, people with diabetes can live healthy and fulfilling lives. The traditional procedure is to prick a finger, which is painful for the patient. Microvascular issues of diabetes, which includes diabetic retinopathy and macular edema, may be visible in the eye's retina, and the retinal pix are getting used to display and diagnose the infection manually. Using deep studying to automate this time-eating procedure is probably pretty beneficial.

II. LITERATURE SURVEY

There is significant research that is going on in the area of developing deep-learning algorithms for medical applications. All of these studies use a diabetes database either the PID dataset or some other database.

In [1] study used a collected database from the Conventional Neural Network (CNN), Long Short-Term Memory (LSTM), Artificial Neural Network (ANN), and Deep Learning algorithm to help healthcare specialists in the early detection of diabetes with more accuracy. The authors in [2] used the Long Short-Term Memory (LSTM), Convolutional Neural Network (CNN). The classification system proposed can help clinicians to diagnose diabetes using ECG (Electro Cardio Graphy) signals with a very high accuracy of 95.7%. All of these studies use a diabetes database either the PID dataset or some other database. The author in [3] used Parkinson's Dataset for the classification of Parkinson's disease (PD) using MLFNN with a backpropagation algorithm. The performance metrics used in the paper are sensitivity, specificity, and accuracy. They achieved 83.3% for sensitivity, 63.3% for specificity, and 80% for accuracy in diagnosing and detecting PD using an MLFN. The author [4] uses Deep Neural Network (DNN) for diabetes prediction. The accuracy obtained by the system is 98.35% using a deep neural network for five-fold cross-validation which is better than the state. In this paper [5] author presented the Multilayer perceptron (MLP) to predict diabetes disease in patients, performance and accuracy of each algorithm that has been used by deep learning data mining techniques are applied in the medical data domain to predict diabetes and to find out efficient ways to treat them as well. The author [6] presented a novel method for diabetes diagnosis that works using Deep Neural Network (DNN). Different studies have used DL networks efficiently for Diabetic Retinopathy (DR) detection and grading. These use the human eye image to process the prediction of diabetes. In [7] the model was trained on a large dataset of fundus images and achieved high accuracy in classifying five DR severity levels. They also used Grad-CAM to generate heatmaps that highlight the regions of the fundus image that the model deemed most important for its predictions. In the [8] study that model was trained on a large dataset of fundus images and achieved high accuracy in classifying five DR severity levels. They also used Grad-CAM to generate heatmaps that highlight the regions of the fundus image that the model deemed most important for its predictions. In [9] that integrates a weight initialization method and a momentum term to accelerate

the training process and improve the model's performance. The model was trained on a large dataset of fundus images and achieved high accuracy in classifying four DR severity levels. They also compared the performance of the improved BP neural network with other ANN models. In [10] provides an overview of deep learning techniques used for diabetic retinopathy classification, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and hybrid models and the system gets more accuracy.

III. COMPONENTS USED IN IMPLEMENTATION

Implementing the classification of diabetes system through IoT need some hardware and software components. The components include retinal images as input, Raspberry Pi 3 Model B+, LCD Display, Buzzer (Piezoelectric Buzzer**)**, GSM Module, and CNN algorithm.

(a) Raspberry Pi 3 Model B+

Raspberry Pi is a small, credit card-sized computer. The Raspberry Pi 3B Model is powered by a 1.2 GHz quad-core ARM Cortex-A53 CPU and has 1GB of RAM**.** It is a microcomputer that carries and utilizes a microprocessor. This help to read inputs like light sensors or a finger on a button and turn them into outputs like activating a motor or led.

Fig.3.1: Raspberry Pi 3 Model B+

(b) LCD Display

Liquid Crystal Display (LCD) is a flat-panel display or any other electronically modulated optical tool that makes use of the light-modulating homes of liquid crystals blended with polarizers. Liquid crystals do now no longer emit mild without delay however instead, use a backlight or reflector to provide photographs in color or monochrome. For display, 16x2 LCD is used, which means it can display 16 characters per line and there are 2 such lines.

Fig.3.2: LCD Display

(c) *GSM*

The Global System for Mobile Communications(GSM) module is a device that allows communication over the GSM cellular network. It provides a way to send and receive data, voice, and text messages from a device or application through SIM. A GSM module can be used in a wide range of applications.

Fig.3.3: GSM Module

(d) Buzzer

Buzzer is an electronic device that produces a continuous or intermittent buzzing sound. It is often used as a signal or warning device in various applications. A piezoelectric buzzer is a type of buzzer that uses a piezoelectric element to produce sound. Piezoelectric buzzers are often preferred for applications that require low power consumption and a compact design.

Fig.3.4: Piezoelectric Buzzer

(e) CNN algorithm

A convolutional neural network is a feed-forward neural network that is generally used to analyze visual images by processing data with a grid-like topology. It's also known as ConvNet. A convolutional neural network is used to detect and classify objects in an image. Below is a neural network that identifies two types of flowers: Orchid and Rose.

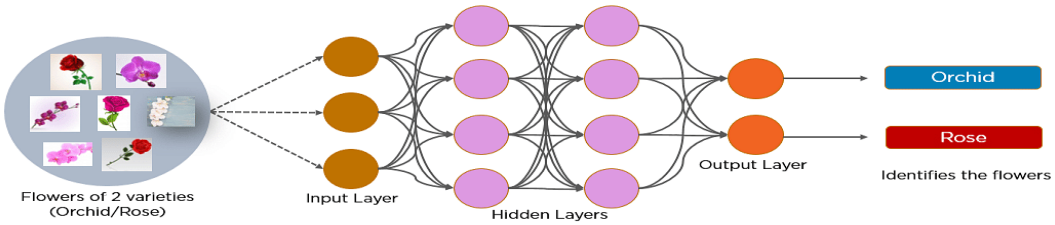

Fig.3.5: CNN Classified the Flowers Into 2 Varieties

A convolution neural network has multiple hidden layers that help in extracting information from an image. The four important layers in CNN are:1.Convolution layer 2.ReLU layer 3.Pooling layer 4. Fully connected layer. Here's how exactly CNN recognizes a bird: The pixels from the image are fed to the convolutional layer that performs the convolution operation. It results in a convolved map. The convolved map is applied to a ReLU function to generate a rectified feature map

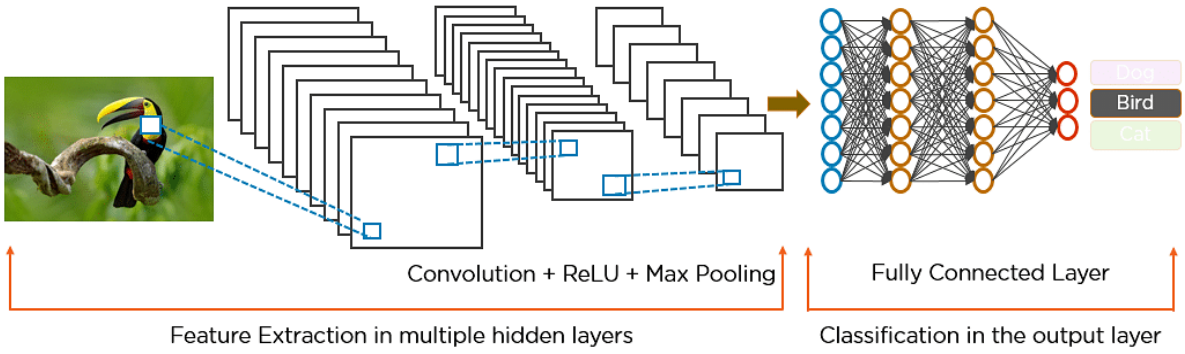

Fig.3.6: Classification Using CNN Algorithm

The image is processed with multiple convolutions and ReLU layers for locating the features. Different pooling layers with various filters are used to identify specific parts of the image. The pooled feature map is flattened and fed to a fully connected layer to get the output.

IV. CLASSIFICATION OF DIABETES USING THE CNN ALGORITHM

An IoT-based system for the classification of the diabetes of a patient using the raspberry pi 3 models B+ with the help of CNN algorithm then compares the actual datasets with predefined datasets for the classification of diabetes and then sends messages about the health condition of a patient to doctors as well as patients about the results either Type-1 or Type-2 and further giving an alert using Buzzer for Type-2 diabetes indication.

The below figure shows the block diagram of the proposed method,

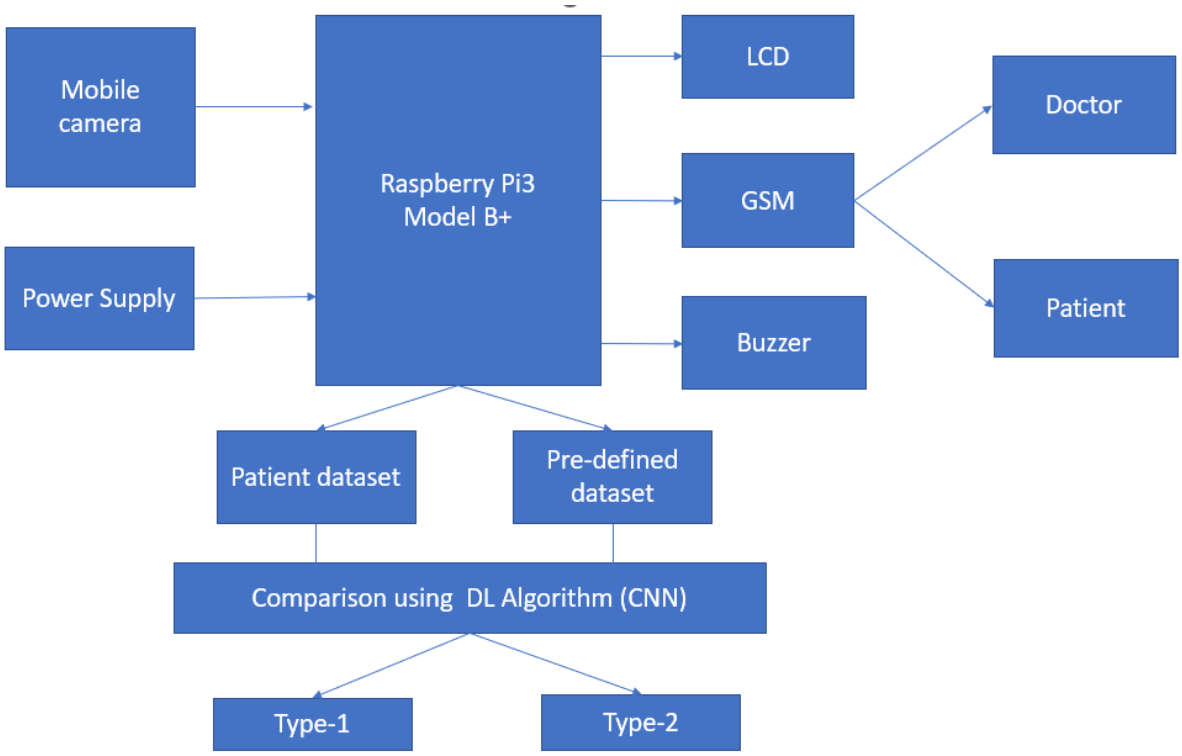

Fig 4.1: Block Diagram for Classification of Diabetes System Using CNN Algorithm

Fig 4.1 represents the block diagram for the classification of the diabetes system using the Internet of Things (IoT). Here, the input is retinal images given to a raspberry pi 3 Model B+ patient along with a power supply. The raspberry pi is the heart of the system which helps with internal processes, using the raspberry pi 3 Model B+. The LCD is used to display the output. The GSM system is used to send messages to the doctor as well as the patient. Thus the hardware implementation of the proposed system is viewed on the block diagram. A deep learning algorithm for the classification of type-1 or type-2 diabetes by using the CNN algorithm and the message is sent to the patient so that they will have an idea about their condition, if the patient has Type-2 the buzzer will ring so that the illiterate can understand easily and know which type they have. So it is very helpful in day-to-day life with good performance of the system.

V. RESULTS

The magnificence of diabetes the use of the CNN set of pointers via way of approach of the use of the IoT-primarily based genuinely gadget, the setup of the gadget is hooked up below figure,

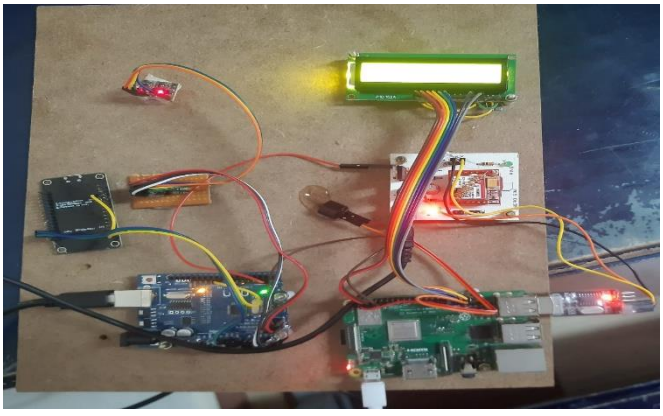

Fig.5.1: Experimental Setup for Classification of Diabetes Using CNN Algorithm

Using the retinal images as input for the classification of diabetes. The output is displayed on the 16*2 LCD. The CNN algorithm is used for the classification of eye images, it is a very efficient & best classifier. Comparison of patient data with predefined data then the outputs as shown below:

Fig.5.2: Output on LCD For Type 1 Diabetes Classification

Fig.5.3: Output on LCD For Type 2 Diabetes Classification

The message notifications are also sent to the doctor as well as the patient's mobile number. That is shown below figures,

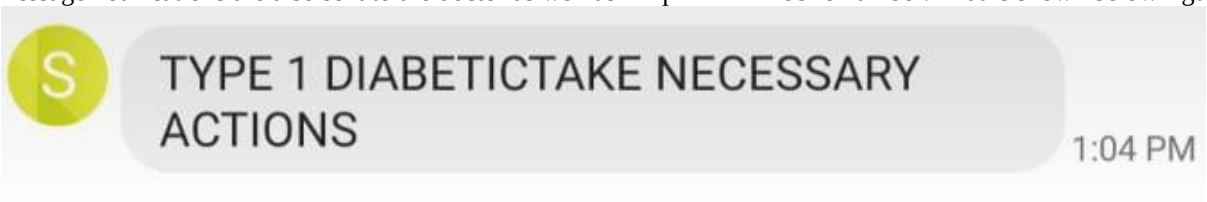

Fig.5.4(a): Messages Sent to Mobile for Classification of Diabetes Using CNN of Type-1

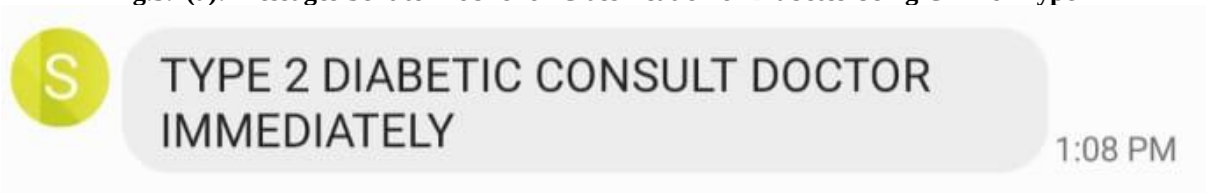

Fig.5.4(b): Messages Sent to Mobile for Classification of Diabetes Using CNN of Type-2

VI. CONCLUSION AND FUTURE SCOPE

The suggested strategy aims to use IoT to provide a more efficient result for better health services. An effective healthcare system is a diabetes classification system that is implemented and is capable of examining diabetes at any time. The system is friendly and simple to use. The system is more accurate by use of the Convolutional Neural Network algorithm. In the future, the prediction and classification can be done by using Artificial intelligence (AI) which can analyze medical records, genetic data, and lifestyle factors to predict the likelihood of developing diabetes easily. Further, two-way communication protocols for IoT can be added to the direct contact between patients and doctors online. Through AI and more datasets can achieve more accuracy in the system.

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