Abstract

Diabetes is a metabolic disease that causes high blood sugar. It is the most
predominating condition in population between 45 and 64. In this population,
periodic glucose monitoring is crucial to keep blood glucose levels under control
and take appropriate medication. The traditional method for monitoring blood
glucose involves the use of a glucometer that requires a blood sample obtained
from the person’s finger after being pricked. One cannot deny the fact that this
method causes discomfort and stress at the sight of puncture. In this research, We
propose a Non-Invasive Glucose Monitoring System, which is easy to use,
inexpensive and most importantly, does not require any blood samples. Patients
will have a simple and effective way to keep Diabetes in control without
discomfort. The use of optical sensors has gained much attention in recent years.
Taking those sensors and leveraging the capabilities of small cameras, we create
a prototype that is connected to a Raspberry Pi. The prototype captures images of
the fingertip when a laser beam is directed to human tissue. Blood glucose
concentration can be estimated by studying the absorption, reflection properties,
and analyzing how the light is transmitted along the finger. An artificial neural
network model is proposed to be built and trained by the image dataset obtained
to predict blood glucose level. The design includes a smartphone app which will
be able to send an alert to the physician if needed. This idea will help the diabetes
community and make a blueprint for future research.

Introduction & Motivation

• Diabetes is an illness that can affect a person in many ways, both physically and
  emotionally, if it is not handled properly.
• It is important to keep blood glucose in check. Using traditional invasive method
  often causes discomfort especially at the site of puncture.
• As mentioned earlier, the use of invasive glucometer can elicit pain. Due to this
  pain, patients might develop a psychological barrier that can keep them from
  checking their blood glucose regularly.[1]
• The goal of non-invasive glucose monitoring technology is to make the process as
easy and painless as possible so that diabetics can do it as prescribed, even up to 5
times a day. [2]

Related Work

• To avoid this problem, minimal invasive glucose monitoring systems have been
developed. One such system which is commercially available is Dexcom. Even
though it is minimally invasive a skin-patch with needle like sensor is placed on
human tissue with the help of a transmitter, and the needle is inside human body
which aids in continuous glucose monitoring. This system must be replaced every
10-12 days and is still painful, uncomfortable, and invasive.
• GlucoTrak is another such system which uses ultrasonic and thermal technologies
to measure glucose concentration from the earlobe. But a big disadvantage with
this is it requires individual calibrations.
• Google X smart lens is a new contact lens that can measure glucose levels
using tear fluid. Engineers have created tiny, miniscule electronics that fit between
two soft lenses, with a small pin hole that allows for the collection of tears [3]

Proposed System

To limit these stress and discomfort caused by using the invasive glucose
monitoring systems, our research idea is to build an inexpensive and easy to use
non-invasive glucose monitoring system which doesn’t need any blood sample.

Components:
• Internet of Things architecture allows different devices to send and receive
data simply by connecting to the internet. With the help of machine learning
and artificial intelligence, the data collected from these devices may be used
to recognize trends and make choices.
• Raspberry Pi is a low-cost computer that runs Linux and has a set of GPIO
(general purpose input/output) ports for controlling electronic components
and experimenting with the Internet of Things (IoT).
• Raspberry Pi camera has a ribbon cable and can be fixed in the camera port
of Raspberry Pi. Raspberry Pi camera is useful in many areas like vision
inspection, image processing and more.

Process:
• The first step is to take 12 images using the prototype and
• The next step is to do a finger prick test and make a note of the readings.

Dataset

• Histograms are a type of data distribution measure that are used for enhancing
  photographs and used to analyze data dispersion in a variety of ways.
• histogram is used as a descriptor of the acquired images, which indicates the
  intensity values of the light that has been transmitted through the human tissue.
• An artificial neural network model using OpenCV and TensorFlow libraries with
  ReLu activation function will be built using python for training the model with this
  image dataset. The histograms will be associated with their corresponding finger
  prick test value to train the model.
• Inconsistencies between the reference glucose values and estimated glucose values
  will be studied to evaluate models’ performance.

Conclusion

Non-invasive glucose monitoring systems are still in their early stages of
development and this research would help the diabetes community by introducing
them to an inexpensive and easy to use system and have a pain-free experience for
monitoring their health.

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