

# Poster #101: Non-Invasive Glucose Monitoring system using Raspberry Pi

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## 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 a physician if needed. This idea will help the diabetes community and make a blueprint for future research.

## Introduction & Motivation

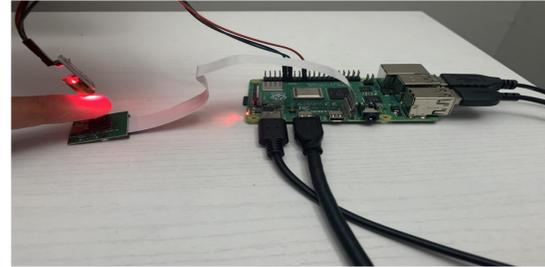
- Diabetes is an illness that can affect a person in many ways, both physically and emotionally, if it is not handled properly.
- It is important to keep blood glucose in check. Using traditional invasive method often causes discomfort especially at the site of puncture.
- As mentioned earlier, the use 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 new smart 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:

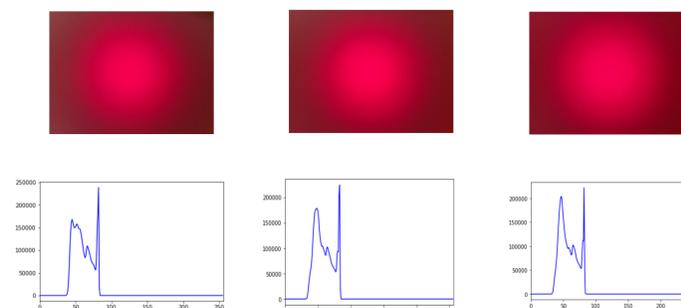
- Internet of Things architecture allows different devices to send and receive data simply by connecting to the internet. With the help of machine learning and artificial intelligence, the data collected from these devices may be used to recognize trends and make choices.
- Raspberry Pi is a low-cost 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.

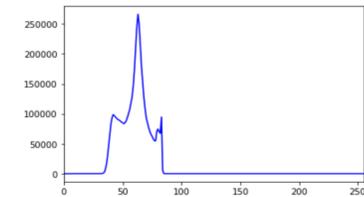
## Dataset

- 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.



### Mean of Histograms:

Mean of these histograms is calculated and only one histogram per subject is considered to train/ test the ANN model.



## Future Work

- As part of this study, we are planning to submit an IRB request which will allow us to obtain the images of fingertip and earlobes of participants. We are going to perform finger prick tests and obtain the results of 45 subjects.
- Each of the subject, with their consent will give the finger prick test and images which will be further split into train and test data for evaluating the Artificial neural network model.
- A smart phone app will be developed as part of the design where a user can install the app on their device, sign up for the first time, and see their glucose readings on the screen of the device.
- Users will be able to see their past readings by choosing appropriate option.
- Also, users are allowed to enter the finger prick test readings whenever they are willing to take test using glucometer or getting a lab test done. This will show the user if there are any discrepancies between the finger prick results and the non-invasive glucose monitoring system results.
- A notification is sent to the healthcare provider when the readings seem abnormal.

## 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.

### REFERENCES

- [1] "GLUCOACTIVE - The Drawbacks of Invasive Glucometer." GLUCOACTIVE, <https://www.facebook.com/GlucoActive/>, 2 Dec. 2019, <https://gluco-active.com/2019/12/02/drawbacks-of-invasive-glucometer/>.
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- [3] "Google X Smart Lens For Diabetes • Geek Insider." Geek Insider, <https://www.facebook.com/geekinsiders>, <https://geekinsider.com/google-x-smart-lens-diabetes/>. Accessed 28 Nov. 2021.