EGR-490 Importance of Food Recognition on Blood Glucose Monitoring: GlucoCheck Context

Abstract

Diabetes, a global health concern, underscores the need for effective management strategies, especially given that over 50\% of type 2 diabetes cases are preventable. Achieving optimal blood sugar control necessitates a multifaceted approach, encompassing a balanced diet, regular exercise, and strict adherence to prescribed medications. However, the challenges inherent in maintaining dietary discipline for diabetic patients, often relying on laborious and unreliable traditional monitoring methods like recollection and manual record-keeping, necessitate exploration into innovative and efficient solutions. In this context, automated technologies have emerged as promising tools, with a particular focus on food image recognition systems that leverage computer vision and mobile cameras. These systems offer a streamlined process for tracking dietary intake, presenting a potential boon for individuals managing chronic health conditions such as diabetes. The present study aims to develop such a system, emphasizing its capacity to automate diet tracking and enhance the overall management of diabetes. The discussion extends to future directions, emphasizing the need for continued research and development to address existing limitations and refine the application.

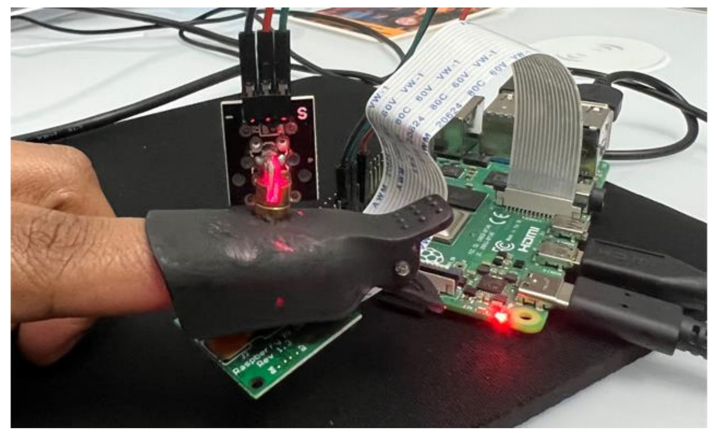
Preliminary Results: Pilot study shows promising results; we achieved an overall accuracy of 93% on five categories of food.

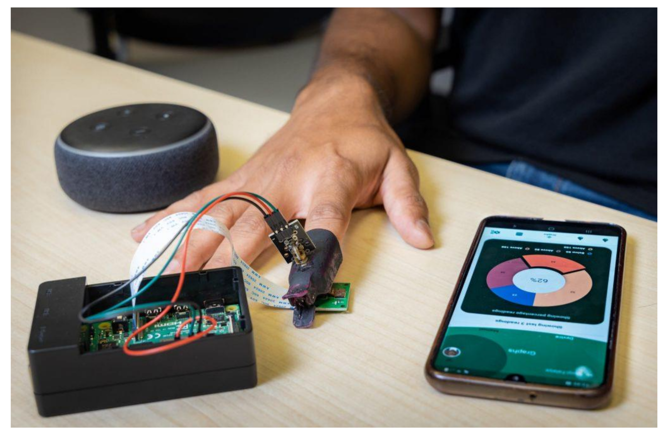
Introduction

Maintaining blood sugar under control requires eating a healthy and balanced diet, exercising, and adhering to medications. Traditional techniques for monitoring dietary consumption include recollection and manual record-keeping, but they can be tedious and prone to mistakes when used repeatedly. However, technologies for maintaining records that make use of computer vision and mobile cameras, such as food image recognition systems, can streamline the process and help diabetes patients better manage their chronic health condition by automating diet tracking. The goal is to efficiently track users' daily food intake and then offer nutritional suggestions to facilitate and encourage lifestyle improvements. Thus, in this work, we are designing a glucose monitoring mobile app; parallel to which which we implement a Machine Learning model that can recognize/classify food categories and estimate the corresponding volume and calorific content from picture(s) of an upcoming meal, which would help users assess the effect of the intake on their blood sugar levels. This is part of a larger project that involves an application to help GlucoCheck [1]— a non-invasive blood glucose monitoring device — users keep track of their blood glucose levels and possible spikes.

GlucoCheck

• Hardware consists of a compact camera and NIR laser affixed to bottom and top of a finger clip respectively that are connected to a Raspberry Pi
• Non-invasive glucose monitor, skips the finger prick
• Estimates blood sugar without needles by analyzing light through skin
•Budget-friendly materials used for hardware
•Generates and extracts data from images to assess blood glucose levels
•AI predicted blood glucose level is stored and retrieved from InfluxDB database



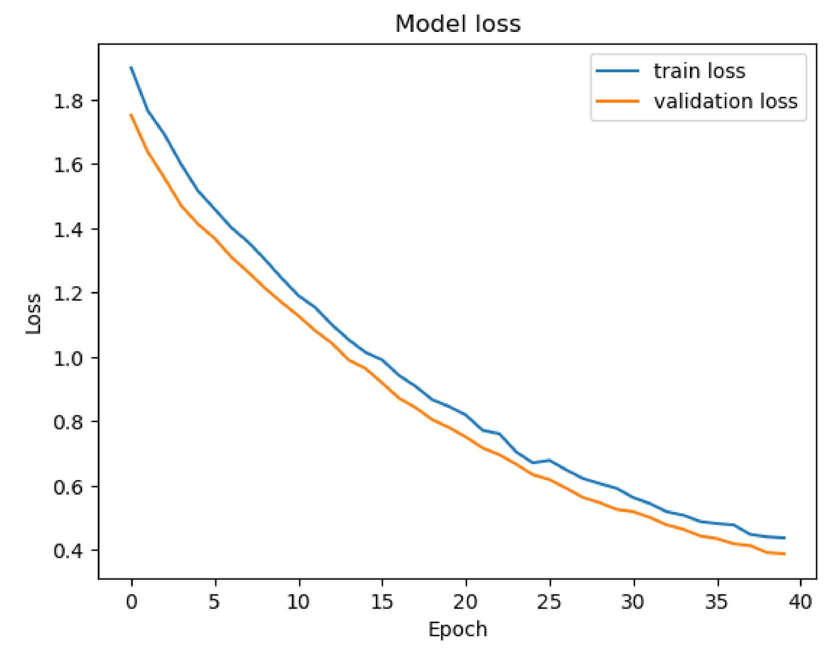


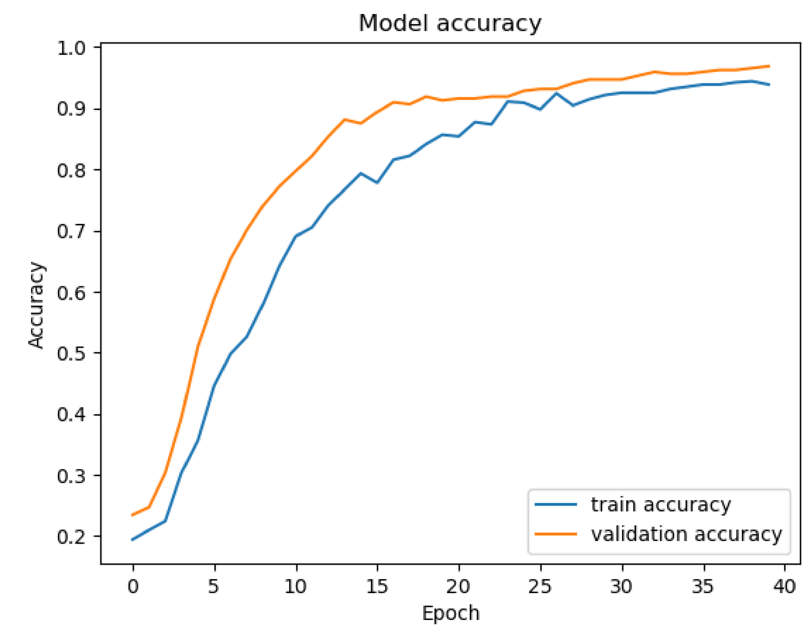
Method

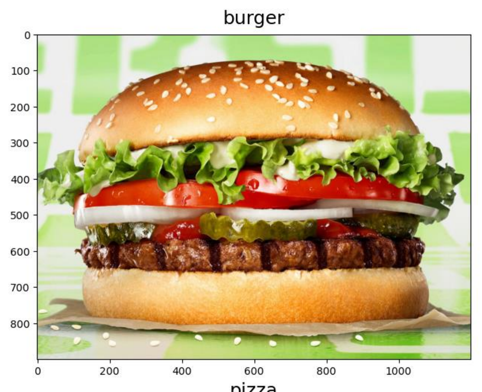
- Various image preprocessing techniques were applied. These include brightness normalization, sobel filter, principal component analysis
- For the model, we decided to use CNNs as they offer the best results in terms of image classification accuracy
- Transfer learning was applied via the pretrained Inception V3 model by Google
- Training dataset consisted of 1139 images and testing dataset consisted of 334 images, both belonging to 5 classes. For classes that lacked data compared to others, we performed offline data augmentation
- Model training parameters included a learning rate of 2e-5, batch size of 32, momentum of 0.9 and 40 epochs.

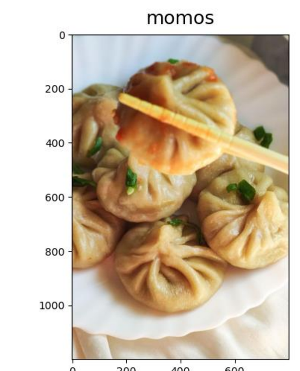
Results

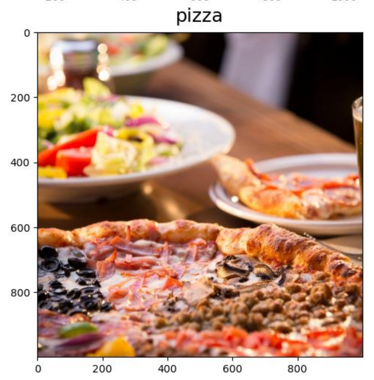
- Overall accuracy of 93% was achieved.
- Some challenges we faced included:
    - Unwanted feature selection for similar looking items with common attributes. E.g. Foods fried in batter tend to look similar no matter the content inside.
    - Multiple labels clashing together when different foods were on the same plate

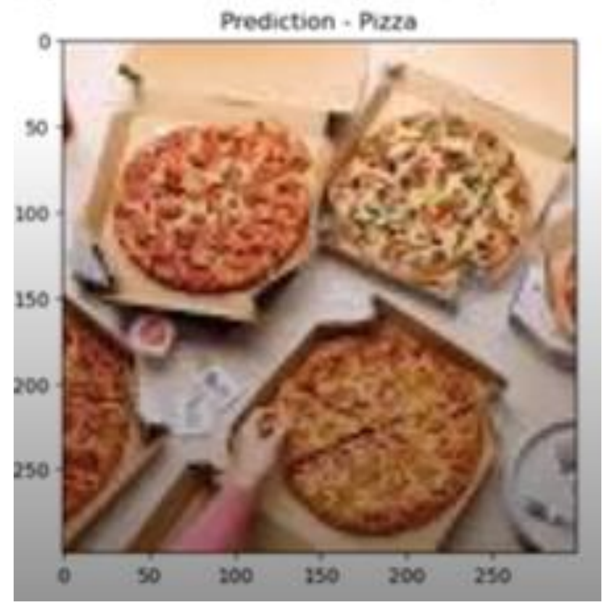






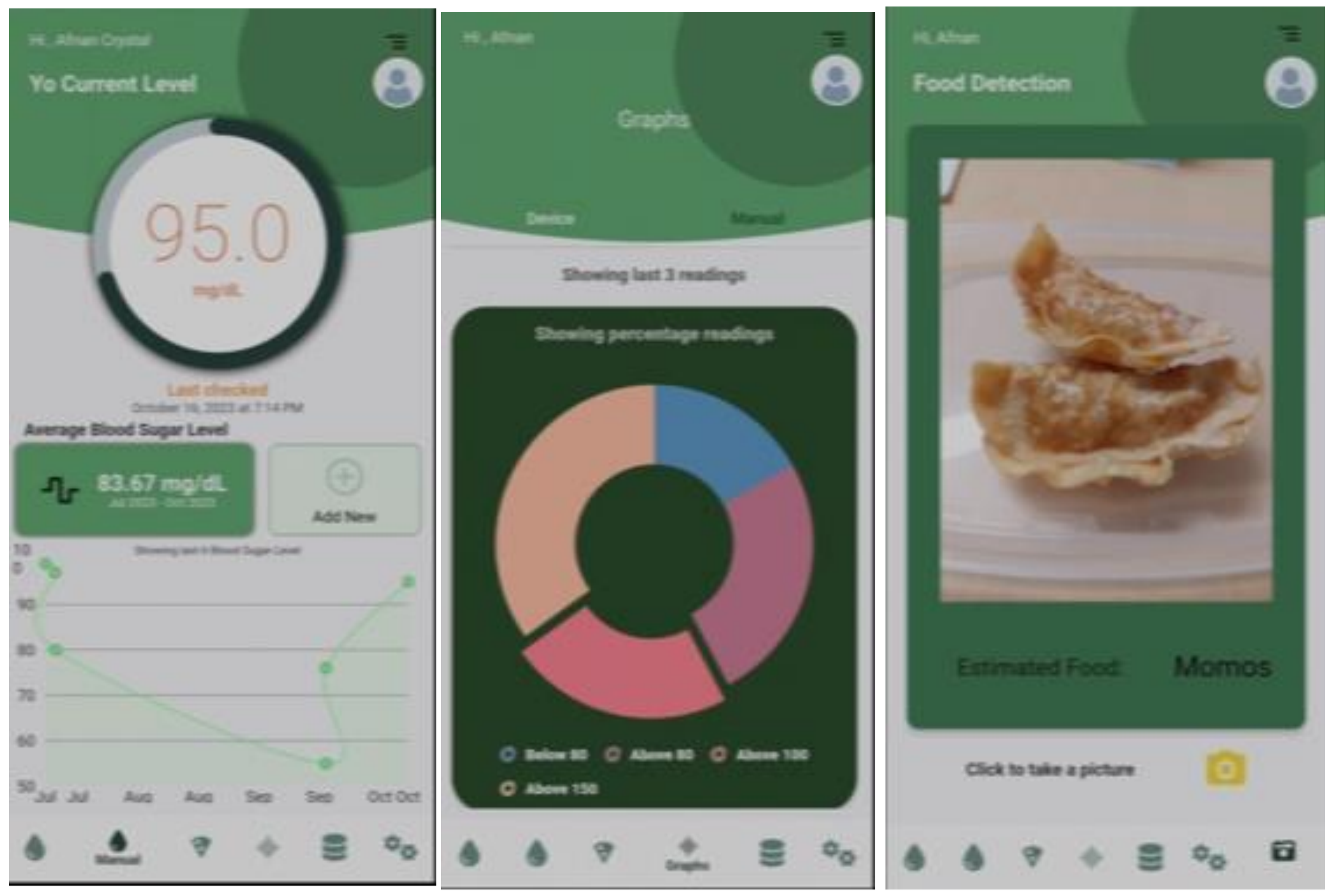






Mobile App

- Logs glucose values before and after meals to accurately store and view a customized, graphical representation of blood sugar levels
- Click a picture of meal(s) to log the type of food being consumed + caloric intake
- View blood glucose levels and trend over time via a graphical representation
- Current focus is on an American diet



Future Direction

We aim to increase the software's accuracy by model attuning alongside periodically retraining the model to ensure optimal accuracy at all times. Moreover, based on survey responses from current users, we'll try to enhance the user experience by bettering the UI according to feedback. Lastly, plans are in action to expand the cuisine range beyond an exclusive American diet.

Conclusion

Hassle free diet tracking coupled with an accurate non-invasive device for blood glucose monitoring could be a life-changing option for millions of elderly diabetics as it will be positively impactful in the diabetes and metabolic syndrome community. Moreover, it will provide access to a more affordable and less invasive self diabetes management tool at home.

Acknowledgments

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References

[1] Valero M, Pola P, Falaiye O, Ingram K, Zhao L, Shahriar H, Ahamed S Development of a Noninvasive Blood Glucose Monitoring System Prototype: Pilot Study JMIR Form Res 2022;6(8):e38664 URL: https://formative.jmir.org/2022/8/e38664 DOI: 10.2196/38664

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