UNCONVENTIONAL INDICATORS FOR DIABETIC DIAGNOSIS

Project ID : R24-120

Project Proposal Report

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BSc (Hons) in Information Technology Specialization in IT

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

February 2024

Detect signs of diabetes by using nail images and image analysis techniques

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Declaration

"I declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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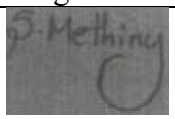
Methiny S	IT21083228	

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

29/02/2024

Signature of the supervisor Date

(Ms. Wishalya Tissera)

29/02/2024

Signature of co-supervisor Date

(Ms. Karthiga Rajendran)

Abstract

This research outlines a novel approach for diabetes prediction through nail analysis. Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood sugar levels. It is a major public health concern, affecting millions of people worldwide. Early detection and intervention are crucial for managing diabetes and preventing complications. Traditional diagnostic methods involve blood tests, which can be invasive, costly, and inconvenient for patients. This proposal report presents a novel approach for diabetes prediction using nail analysis.

Nails, being an easily accessible biomaterial, have the potential to reflect systemic health conditions, including diabetes. The structure of nails can provide valuable insights into metabolic processes and biomarker concentrations indicative of diabetes risk. This research involves the development of a predictive model based on nail characteristics and biomarkers associated with diabetes. The methodology involves data collection, image preprocessing, using machine learning algorithms, and neural networks.

This research project will explore deep learning techniques for predicting diabetes. The outcome of this research could help diabetic patients take care of themselves.

Keywords: Nail analysis, Diabetes, Machine learning, Deep learning

Table of Contents

Contents

List of Figures

List of Tables

Introduction

Diabetes stands as a formidable global health challenge, necessitating effective early detection strategies. This proposal delves into the innovative realm of utilizing image processing techniques to scrutinize nail color and texture as a novel means of predicting diabetes. The human eye's constraints in accurately identifying colors are bypassed by computers, showcasing the ability to distinguish over 16 million hues. This divergence offers a promising pathway for more efficient and precise analysis in comparison to conventional diagnostic methods.[4]

Traditional pathological testing for diabetes often proves unpleasant and cumbersome, prompting the exploration of alternative, non-invasive approaches. Nail analysis emerges as a viable candidate, presenting a painless method for diabetes prediction. This avenue is especially appealing given the limitations associated with conventional testing methodologies, aligning with the global pursuit of patient-centric and minimally invasive healthcare solutions. Prior research highlights a pertinent need for enhancement in identifying diabetes mellitus through the analysis of RGB range values. This research gap underscores the significance of the proposed approach, positioning it as a pioneering endeavor to refine and elevate the diagnostic landscape for diabetes. By exploring the intricate nuances of nail color and texture, the proposal aims to contribute not only to early detection but also to the overall improvement of diabetes diagnosis methodologies.[5]

In conclusion, this proposal signifies a bold step towards revolutionizing diabetes prediction through the innovative utilization of image processing techniques in nail analysis. The unique advantages offered by computers in discerning colors, coupled with the non-invasiveness of nail analysis, promise a more patient-friendly and efficient approach to early diabetes detection. As the global healthcare community seeks advancements in diagnostic precision and patient comfort, this proposal holds significant promise for reshaping the trajectory of diabetes care.[1]

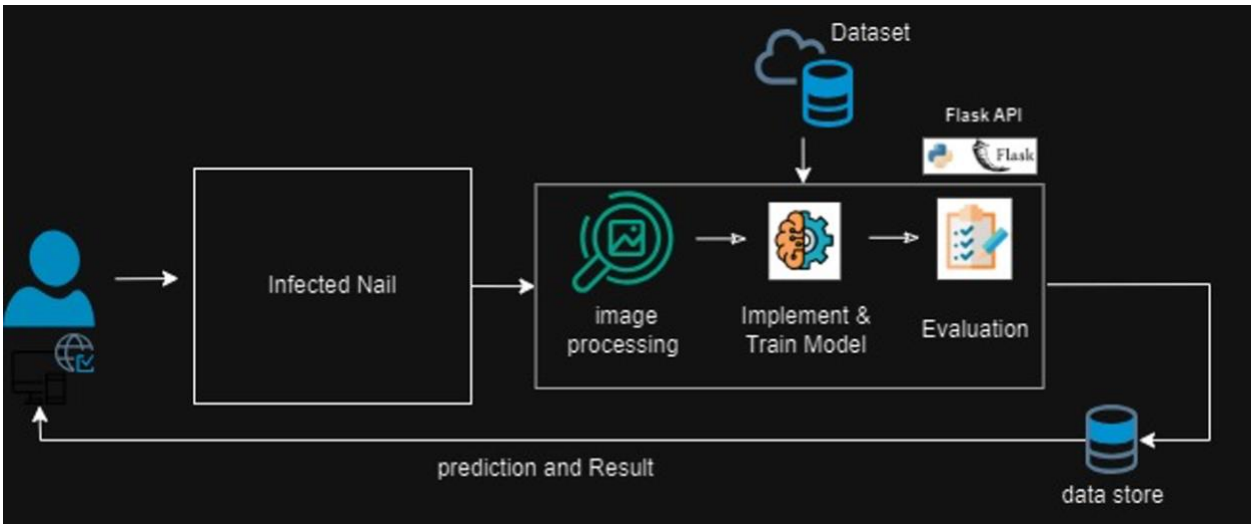


Figure 1 : Overall system diagram

Background & Literature Survey

Diabetes mellitus, a pervasive chronic metabolic disorder characterized by elevated blood glucose levels, imposes a substantial health burden on millions across the globe. The significance of early detection and management cannot be overstated, as it plays a pivotal role in averting severe complications associated with diabetes. While traditional diagnostic methods, such as blood glucose monitoring, have proven effective, they are often invasive and inconvenient. This has prompted the exploration of alternative screening methods, leading to the spotlight on nail analysis as a non-invasive and painless approach for diabetes screening[2].

The integration of image processing techniques into nail analysis represents a paradigm shift in diabetes screening methodologies. Computers, with their remarkable ability to distinguish a vast spectrum of colors, provide a unique advantage over the human eye's limitations in accurate color identification. This prompts the adoption of computer-aided nail analysis as an efficient and innovative approach, promising increased precision and reliability in diabetes detection.

Contrasting with conventional pathological testing, which can be time-consuming and invasive, nail analysis emerges as a rapid and convenient method for diabetes screening. The simplicity and non-invasiveness of this approach align with the growing emphasis on patient-centric healthcare solutions. By leveraging image processing technologies, nail analysis offers a streamlined and efficient screening process, potentially transforming the landscape of diabetes diagnosis.

Previous studies have already demonstrated the promising potential of nail analysis in diabetes detection. Notably, research has delved into the RGB range values of various nail categories, revealing an overlap that underscores the existing challenges in identification methods for diabetes mellitus. This revelation serves as a catalyst for further refinement and innovation in the field, emphasizing the imperative need for improved identification methods to enhance the accuracy and reliability of diabetes screening[3].

In conclusion, the exploration of nail analysis coupled with image processing techniques stands as a promising avenue in the quest for efficient and patient-friendly diabetes screening. The non-invasive nature of nail analysis, combined with the computational prowess of computers, positions this approach as a noteworthy contender in advancing early detection methods. As research endeavors continue to unfold, the potential for nail analysis to reshape diabetes screening methodologies and contribute to enhanced patient outcomes becomes increasingly evident.

Research gap

Despite advancements in nail analysis for predicting diabetes, notable gaps persist within the current body of research. A critical observation from Hillson et al.'s 2017 study indicates a predominant focus on color analysis, overlooking other potentially informative nail features like texture and shape[4][3]. This limitation underscores the need for a more comprehensive approach to nail analysis, considering a broader spectrum of features for a nuanced understanding of diabetes indicators.

Another prevalent shortcoming in existing methods lies in the reliance on basic feature extraction techniques, neglecting advanced feature selection algorithms that could significantly enhance identification accuracy. Incorporating more sophisticated algorithms in the feature extraction process becomes imperative for refining the precision and reliability of diabetes prediction through nail analysis.

While some studies report promising outcomes, a critical gap exists in the absence of large-scale clinical trials encompassing diverse patient populations. Validating the effectiveness of nail analysis for diabetes prediction in real-world settings is crucial for establishing its practical utility and reliability. The transition from controlled studies to broader clinical trials becomes pivotal in assessing the robustness of this diagnostic approach across varied patient demographics and conditions[5].

In essence, addressing these identified gaps in research, encompassing a more comprehensive range of nail features and implementing advanced feature selection algorithms, while also conducting extensive real-world clinical trials, is essential for advancing the field of nail analysis for diabetes prediction. This approach ensures a more thorough and reliable application of nail analysis in practical healthcare settings.

	Research Paper A (https://doi.org/10.1002/pdi.2124)	Research Paper B (https://doi.org/10.1038%2Fs41598-019-39951-3)	Research Paper C (https://doi.org/10.1002/pdi.2124)	**Proposed System**
Global Prevalence of Diabetes	✓	✓	✓	✓
Historical Perspective	✓	✗	✓	✓
Infected nail images	✗	✓	✗	✓
Telemedicine Standards	✗	✗	✗	✓
Definition and Prevalence of Diabetic infected nail	✓	✓	✓	✓

Table 1 : Comparing with previous researches

Research problem

The research problem addressed in this proposal is to develop an improved system for diabetes prediction using nail analysis by addressing the gaps identified in the background literature. Many people are not familiar with the signs of diabetes, which can delay them from seeking help. Someone struggles to see a doctor because it's not easy to get to one or afford the costs. There is a lot of embarrassment and fear around talking about diabetes, so people might avoid it. Some communities don't have enough support to help prevent or manage diabetes effectively. The proposed system will explore a wider range of nail features, including color, texture, and wound. The system will employ state-of-art feature extraction and selection algorithms to identify the most discriminative features for diabetes prediction and improve the overall accuracy of the system[6].

Research Objectives

Main objective

The central aim of this research is to pioneer advanced feature extraction and selection algorithms. These innovations seek to pinpoint the most discriminative features crucial for diabetes prediction, ultimately elevating the system's accuracy. By delving into the intricacies of feature extraction and selection, this research aspires to refine the diagnostic process, ensuring that only the most relevant and impactful features are considered. This pioneering effort not only aims to enhance the overall accuracy of diabetes prediction systems but also represents a significant stride towards optimizing the efficiency and reliability of healthcare diagnostics.

Specific objective

1. To develop an accurate dataset of nail features, including color, texture, shape, and other relevant characteristics, for improved diabetes prediction.
2. To explore effective techniques for selecting and extracting relevant features from nail color and texture data to enhance the accuracy of diabetes prediction.
3. To perform a cost-effectiveness analysis to assess the economic feasibility and potential healthcare benefits of implementing nail analysis as a routine screening tool for diabetes prediction compared to traditional diagnostic methods.
4. To design a simple app to make the program easy to use.

Methodology

The proposed methodology for detecting signs of diabetes through nail images and image analysis involves a comprehensive series of strategic steps. Initially, we will amass a diverse dataset comprising high-resolution nail images sourced ethically from individuals diagnosed with diabetes and healthy controls, adhering strictly to ethical standards and securing informed consent from both Kaggle and hospital databases. Following meticulous data collection, a stringent set of image pre-processing techniques will be applied. These include noise reduction, normalization, and enhancement procedures, ensuring standardization of image quality and format.

The subsequent phase will delve into feature extraction methods, exploring texture analysis, color analysis, and shape analysis to draw out discriminative features from the nail images. Leveraging machine learning algorithms, such as Support Vector Machines (SVM), Random Forests, and Convolutional Neural Networks (CNNs), we aim to predict diabetes based on the extracted features, integrating clinical data for a more holistic understanding. To gauge the reliability and generalization of our models, we will implement cross-validation techniques like k-fold cross-validation. This not only evaluates model performance but also safeguards against overfitting, ensuring the robustness of our diabetes prediction models.

Further insight into the intricacies of diabetes prediction will be gained through the interpretation of learned features and model decision boundaries. This analytical process is pivotal in unraveling the underlying patterns indicative of diabetes, contributing to our understanding of the disease.

Transparency and reproducibility are paramount, and thus, documentation of our methodology, experimental procedures, and findings will be meticulous. The dissemination of research outcomes through academic publications and conferences will contribute to the broader scientific communi

Individual system architecture

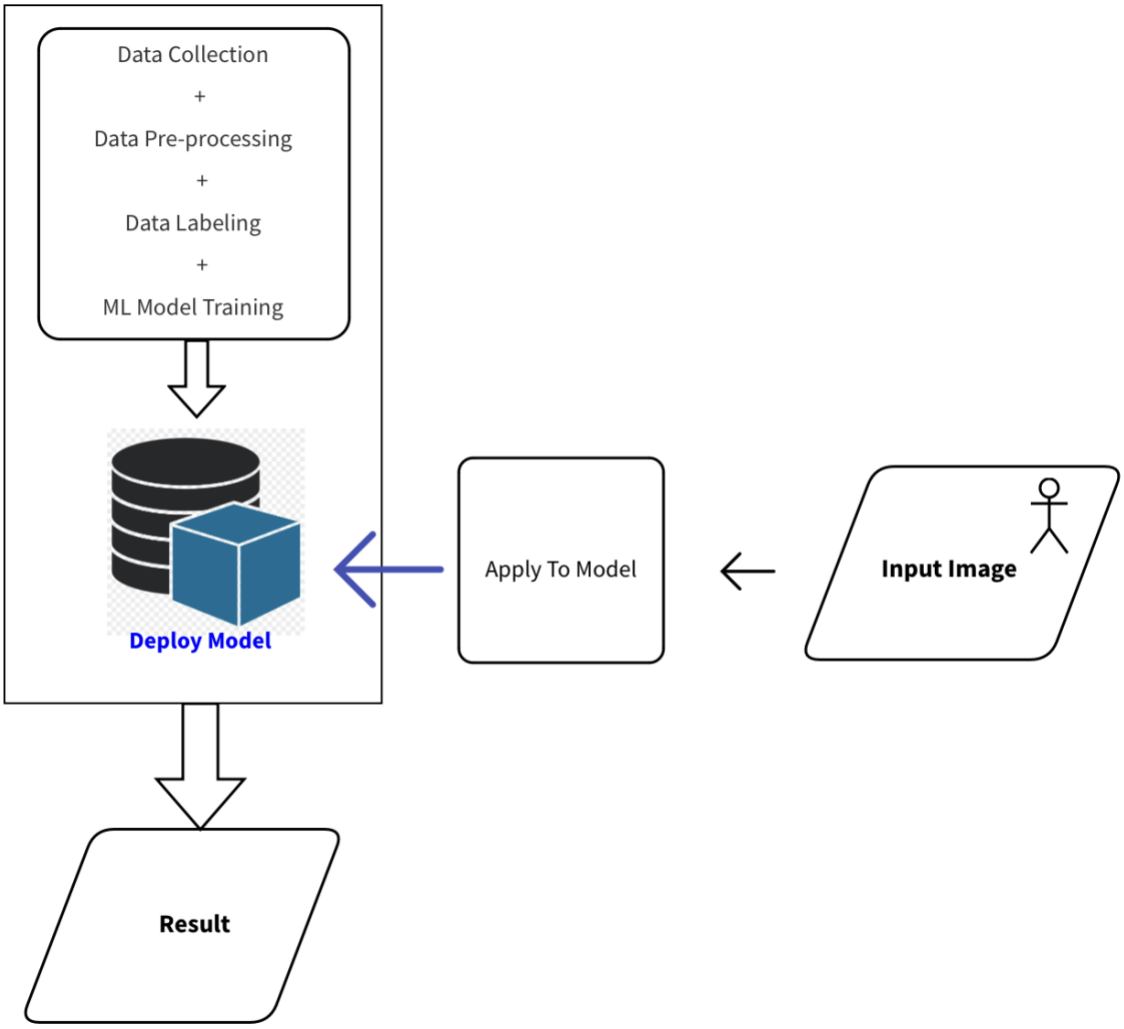


Figure 2: Individual system architecture

* A user app that allows users to take photos of their nails and upload them to the cloud.

* A web service that deploys the ML model and provides a REST API for the app to call.

* An Azure Storage account that stores the training data and the ML model.

* An Azure ML Studio instance that is used to train and deploy the ML model.

* An Azure ML Compute instance that is used to run the ML model.

1. The user takes a photo of their nail and uploads it to the app.
2. The app sends the photo to the web service.
3. The web service calls the ML model to predict the disease severity.
4. The ML model returns the prediction to the web service.
5. The web service sends the prediction back to the app.
6. The app displays the prediction to the user.

The ML model is trained using a dataset of nail images that have been labeled by a dermatologist. The model is trained to identify the four most common types of nail diseases: onychomycosis, psoriasis, lichen planus, and alopecia areata. The model is also trained to predict the severity of each disease.

The solution is deployed to Azure using Azure App Service, Azure Storage, Azure ML Studio, and Azure ML Compute. Azure App Service is used to host the web service. Azure Storage is used to store the training data and the ML model. Azure ML Studio is used to train and deploy the ML model. Azure ML Compute is used to run the ML model.

The solution is designed to be scalable and reliable. The web service is hosted in Azure App Service, which is a highly scalable and reliable platform. The training data and the ML model are stored in Azure Storage, which is a durable and reliable storage service. The ML model is trained using Azure ML Studio, which is a powerful and user-friendly tool for training ML models. The ML model is deployed to Azure ML Compute, which is a dedicated compute service for running ML models.

Description of personal and Facilities

The proposed study on detecting signs of diabetes using nail images and image analysis techniques, I will assume the role of Principal Investigator (PI) and lead all aspects of the research project. With a background in medical imaging, data analysis, and machine learning, I will oversee the entire research process from data collection to dissemination of results. Collaborating closely with my supervisor, who will provide guidance, mentorship, and oversight throughout the project, I will ensure that the research adheres to high scientific standards and ethical guidelines. The supervisor's expertise in the field of diabetes research and image analysis will complement my skills and enhance the rigor and validity of the study. Additionally, I will have access with necessary computational resources and software tools for image processing and machine learning tasks. Regular meetings with my supervisor will facilitate progress updates, feedback sessions, and troubleshooting of research challenges. Through continuous learning and professional development opportunities, I will further refine my skills and knowledge in medical imaging and diabetes research, ensuring the successful completion of the project. This collaborative effort between myself and my supervisor, coupled with access to appropriate facilities, will enable the effective execution of the research and contribute to advancements in early detection and management of diabetes through nail image analysis.

Requirements

Functional requirements

The system will be able to capture nail images in a standardized manner to ensure consistency and accuracy. It will employ robust feature extraction algorithms to effectively extract relevant information from the nail images. It will utilize advanced feature selection techniques to identify the most discriminative features for diabetes prediction. It will integrate machine learning algorithms to develop a predictive model for diabetes based on the extracted features. It will provide a user-friendly interface for healthcare professionals to facilitate nail image acquisition, feature extraction, and diabetes prediction.

Non-Functional requirements

The system should be efficient in terms of computational resources and time to ensure real-time prediction. It should be reliable and robust to handle variations in nail appearance due to factors such as lighting conditions and nail polish. It will be secure to protect patient information and maintain confidentiality. It will be scalable to handle a large volume of nail images.

System requirement

Hardware requirement

1. Minimum system requirements of user end device for the client app to work is as follows:
2. Operating system: IOS or Android
3. RAM: 1GB
4. Storage: 300 MB free space
5. Internet connectivity

The minimum system requirement for a back-end server is either Windows or Linux, 8GB of RAM and 30 GB of storage. 200 megabytes of database storage space is sufficient for the implementation phase. These system requirements may increase during use, and these resources should be scaled in that case.

Software Requirements

1. Visual Studio Code
2. PyCharm
3. Google Collab
4. Jupyter

Technological Requirement

1. Texture Analysis Models: Gray-Level Co-occurrence Matrix (GLCM), Local Binary Patterns (LBP)
2. Shape Analysis Model: Fourier descriptors
3. Color Analysis Models
4. Hybrid Feature Fusion Model
5. Transfer Learning Model (Pre-Trained model): VGG, ResNet
6. Generative Adversarial Networks (GANs)

Libraries

1. TensorFlow
2. KEras
3. Scikit-learn
4. PyTorch

Commercialization

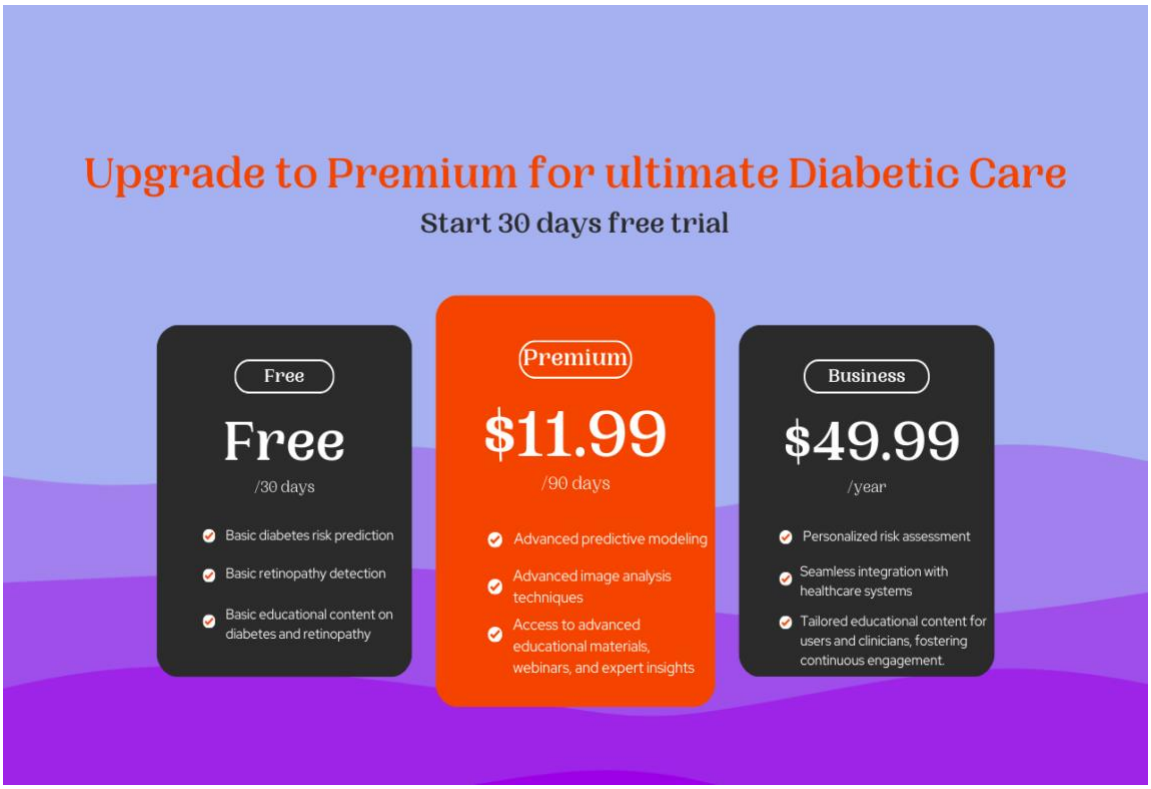


Figure 3 : Commercialization

This mobile application introduces a premium subscription service, offering users an elevated experience with exclusive features and content beyond the confines of the free version. Opting for the premium subscription, priced at $11.99 per month or $99.99 annually, grants users access to advanced functionalities. Notable among these are a more comprehensive risk assessment, advanced image analysis capabilities, and a wealth of educational resources, including webinars and expert insights.

The allure of the premium subscription lies not only in its enhanced features but also in the flexibility it affords users. With a 30-day free trial, individuals can explore the premium offerings risk-free before committing to a subscription. This trial period aims to showcase the value and efficacy of the premium features, allowing users to make an informed decision about the long-term benefits of the subscription.

In essence, this premium subscription service is designed to cater to users seeking a more sophisticated and in-depth experience. By combining advanced risk assessment, image analysis, and educational resources, the premium tier strives to provide value and empower users with a holistic approach to their needs. The pricing structure and trial period are carefully crafted to make this premium offering accessible, enticing users to unlock the full potential of the mobile app.

Project Timeline (Gannt chart)

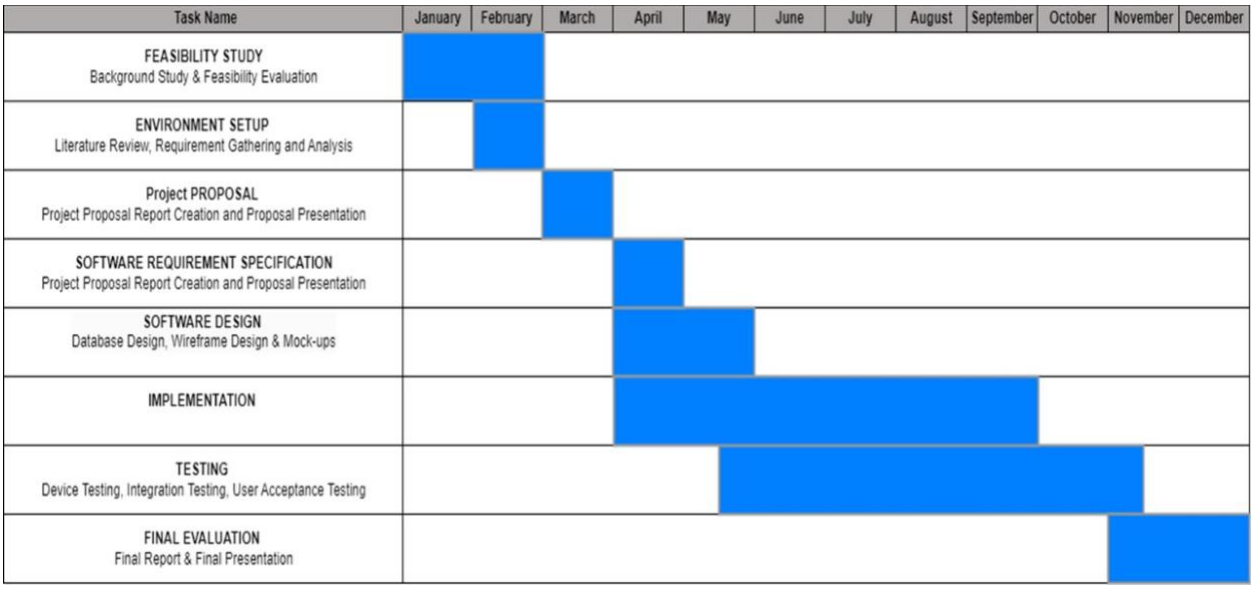


Figure 4 : Gantt Chart

Conclusions

The exploration of diabetes prediction through nail analysis holds immense potential to revolutionize early detection and management of this chronic disease. This research proposal charts a course to address gaps in existing studies, aiming to forge an enhanced system for diabetes prediction. The envisioned system will leverage a comprehensive array of nail features, integrating advanced feature extraction and selection algorithms, alongside machine learning models, to achieve precise and dependable diabetes prediction. The fruition of this project stands to contribute significantly to the creation of a non-invasive and user-friendly tool for early diabetes detection. The potential impact extends to improving patient outcomes and alleviating the strain on healthcare systems burdened by diabetes. By advancing the field of diabetes prediction through innovative methodologies, this research aligns with the broader objective of enhancing healthcare practices and fostering a proactive approach to chronic disease management.

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