Dissertation on

"Pill Detection and Medical Chatbot for Disease Prediction"

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UE20CS390B – Capstone Project Phase - 2

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CERTIFICATE

This is to certify that the dissertation entitled

'Pill Detection and Medical Chatbot for Disease Prediction'

is a bonafide work carried out by

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in partial fulfilment for the completion of seventh semester Capstone Project Phase - 2 (UE20CS390B) in the Program of Study - Bachelor of Technology in Computer Science and Engineering under rules and regulations of PES University, Bengaluru during the period August- December 2023. It is certified that all corrections / suggestions indicated for internal assessment have been incorporated in the report. The dissertation has been approved as it satisfies the 7th semester academic requirements in respect of project work.

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DECLARATION

We hereby declare that the Capstone Project Phase - 2 entitled **“Pill Detection and Medical Chatbot for Disease Prediction”** has been carried out by us under the guidance of Dr. Priyanka H, Associate Professor and submitted in partial fulfillment of the course requirements for the award of degree of **Bachelor of Technology** in **Computer Science and Engineering** of **PES University, Bengaluru** during the academic semester August - December 2023. The matter embodied in this report has not been submitted to any other university or institution for the award of any degree.

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ABSTRACT

This research introduces an innovative framework that combines image processing techniques for pill detection and machine learning algorithms for disease prediction. The primary objective is to develop a comprehensive system that can analyze images of medication, identify pills accurately. The pill detection component employs advanced computer vision algorithms to recognize and classify pills from images, ensuring a reliable and efficient identification process. By seamlessly integrating this pill detection module with disease prediction models, the proposed framework aims to enhance medication adherence monitoring and provide early insights into potential health risks associated with specific medications.

The pill detection system utilizes convolutional neural networks (CNNs) to extract meaningful features from pill images, enabling robust classification of various shapes, colors, and imprints. This approach ensures the system's adaptability to a wide range of medications commonly prescribed for different diseases. Moreover, the integration of disease prediction models, trained on comprehensive healthcare datasets, enables the framework to establish correlations between prescribed medications and potential health outcomes. By leveraging machine learning techniques, the system can identify patterns and associations that may not be apparent through traditional medical assessments, thereby contributing to more personalized and proactive healthcare.

The proposed framework holds significant promise for healthcare professionals, enabling them to make informed decisions regarding medication management and patient care. The seamless integration of pill detection and disease prediction not only facilitates medication adherence monitoring but also assists in identifying potential adverse reactions or contraindications. This research contributes to the ongoing efforts to enhance the synergy between computer vision and healthcare analytics, fostering a more data-driven and patient-centric approach to medical practice. The proposed system has the potential to revolutionize medication management, providing a valuable tool for both healthcare providers and patients in optimizing treatment plans and improving overall health outcomes.

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Chapter – 1

Introduction

Pill detection using images is a rapidly developing area of research that has significant potential to revolutionize healthcare. The process of identifying pills based on their visual features is crucial for ensuring that patients receive the correct medications, avoiding potential harm from incorrect medication, and identifying medications in a timely manner for emergency situations. Traditional methods of pill identification rely on manual inspection, which can be time-consuming and prone to error, particularly when identifying medications with similar physical characteristics.

Recent advances in computer vision and machine learning techniques have led to the development of more accurate and efficient methods of pill detection using images. These methods are capable of identifying pills based on their unique visual features such as shape, colour, and markings. This has the potential to significantly improve patient care by automating the process of pill identification, reducing errors, and improving the speed and accuracy of diagnosis and treatment.

As the demand for improved patient care and safety increases, there is a growing need for accurate and reliable methods of pill detection using images. With the help of machine learning and computer vision algorithms, we can expect to see further advancements in this area that can have a positive impact on patient outcomes and the healthcare industry.

Disease prediction using chatbot technology is a promising area of research that has the potential to improve the quality of healthcare delivery. Chatbots are computer programs that use natural language processing to interact with users through text or voice-based conversations. They can be used to provide a wide range of services, including customer support, information retrieval, and personalized recommendations. In the healthcare industry, chatbots are being used to provide personalized disease prediction and prevention services to patients.

The process of disease prediction using chatbot technology involves analyzing patient data and providing predictions about the likelihood of developing specific diseases. Chatbots can use the symptoms of patients to provide personalized recommendations for disease prevention and management.

Chapter – 2

Problem Statement

1. Detection of pills using the image of a pill.

2. Using a chatbot we take symptoms of the patient, predict his/her disease and we do provide precautions.

Chapter – 3

Literature Survey

A literature review is an overview of the previously published works on a topic. The term can refer to a full scholarly paper or a section of a scholarly work such as a book, or an article. Either way, a literature review is supposed to provide the researcher/author and the audiences with a general image of the existing knowledge on the topic under question. A good literature review can ensure that a proper research question has been asked and a proper theoretical framework and/or research methodology have been chosen. To be precise, a literature review serves to situate the current study within the body of the relevant literature and to provide context for the reader. In such case, the review usually precedes the methodology and results sections of the work.

Producing a literature review is often a part of graduate and post-graduate student work, including in the preparation of a thesis, dissertation, or a journal article. Literature reviews are also common in a research proposal or prospectus.

A literature review can be a type of review article. In this sense, a literature review is a scholarly paper that presents the current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources and do not report new or original experimental work. Most often associated with academic-oriented literature, such reviews are found in academic journals and are not to be confused with book reviews, which may also appear in the same publication. Literature reviews are a basis for research in nearly every academic field.

The proposed paper in [1] uses the following artificial intelligence concepts:

1. Natural Language Processing
2. Natural Language Understanding
3. Natural Language Generation
4. Automatic Speech Recognition

Any person who has an awareness of typing in their language on the desktop version and in the mobile application can use these chatbots very easily. This chatbot offers a personalized analysis based upon symptoms. Disadvantages include grammar mistakes cannot be recognized. This chatbot has less accuracy. This chatbot cannot identify the emotions of any subject about which human talks.

The author in paper [2] has adopted Google Net Inception Network as their primary classifier. Three Google Net models with different specialties on color, shape and feature are trained on the augmented dataset. Basically, every Google Net model output the class predictions and corresponding confidence scores. Confidence scores from all three models are normalized to the range of 0 to 1 by a customized SoftMax function added at the end of each network. The method can detect on a real dataset that contains pill images with noise, different backgrounds, poor lighting conditions, various resolutions, and points of view. The MAP (Mean average precision) score is very less in this paper.

The machine learning models used for classification in the research paper [3] are:

1) LSTM
2) Recurrent Neural Network
3) Decision Tree

TensorFlow is used to build NLP for the chatbot. NLP is used to understand the user query and convert it into well-defined input. The chat bot can be used 24/7 without any breaks. The chatbots are always useful in saving the time of operators as well as the users. The chatbot have the ability to respond to any query immediately. The accuracy of Decision tree model is very less. Time complexity is high.

In paper [4], model UNSW-NB15 has been generated in an synthetic environment .It is a modern dataset with a combination of modern attacks.Helped in training models to modern network traffic. The model has the potential to be used in the dynamic and rapidly changing clinical environments. The proposed identification technique assumes that the image contains a top view/birds-eye-view of the pill (if the sidewise image of pill is inserted then it is not possible to identify).It may fail if we put the image of distorted pill.

The system in paper [5] includes two stages, detection and classification. In the detection stage, pills location is provided by drug-pill localization. The feature extraction and feature pyramid construction are performed using a deep convolutional neural network with stronger semantics. The position of the pills is output by improving the regression and classification models. In the second stage, drug pills classification is performed using the drug pills position output by the pills localization stage, and the pill types are classified using a deep convolutional neural network R-CNN. The advantages are High accuracy, efficiency, scalability, versatility. The model fails to detect object suffered from motion blur at low resolution as hand.

The model in paper [6] uses NLP for text-based pattern recognition and LSTM for making deep learning model. This bot offers medical-related information like doctor's contact details, address of nearby hospitals, contact details for getting an oxygen cylinder, about the disease, its symptoms, its prevalence, diagnosis, and its treatment procedures.

The system in paper [7] inquires for relevant particulars, e.g., name, age, etc. and appeals for symptoms. The bot can withdraw patterns from messages using AIML (Artificial Intelligence Mark-up Language) based on XML (Extensible Mark-up Language) to strengthen AI (Artificial Intelligence) applications. The structure asks progressively more specific questions in order to obtain a good diagnosis. It Engages patients in the conversation for their medical query and problems to provides an individualized diagnosis based on their diagnosed manifestation and profile. Medical chatbot can provide a somewhat accurate diagnosis to patients with simple symptom analysis and a conversational approach, this suggests that an effective spoken language medical bot could be viable. Moreover, the relative effectiveness of this bot indicates that more proceeds automated medical products may flourish to serve a bigger role in healthcare. This chatbot only answers the questions from a closed domain, or answer those questions, which are defined in the database. The accuracy is not satisfactory.

In paper [8], The UI gets the user query and after that sends it to the chatbot application. In the chatbot application, the literary experiences preprocessing steps incorporate tokenization where the words are tokenized, at that point the stop words are removed and feature extraction depends on ngram, TF-IDF, and cosine likeness. The question answers are stored in the knowledge database to recover the retrieve the answer. This chatbot is not intelligent (uses predefined conversation).

The [9] paper focuses on extracting pill image features to classify different appearances of round pills. The experiment's results indicate an accuracy rate of 92.28%, making the round pill recognition system effective in assisting medical professionals to identify round pills and improve medical quality. The Model used is YOLO Deep learning model. The Advantages of this model are:

1. Effective recognition of pills with round shapes: The AY model is designed specifically to recognize pills with round shapes such as round-flat, round-convex, ellipsoid and sphere, which are difficult to recognize using traditional image recognition approaches.
2. Focus on feature extraction: The AY model is capable of mostly focusing on extracting the features of pill images to classify the appearance of different round pills.
3. High accuracy: The experiment results show that the accuracy rate of the AY model is 92.28%, indicating that the round pill recognition system can effectively assist medical professionals to identify round pills and improve medical quality.
4. Fast performance: The AY model is also reported to be fast in operation, although no specific speed was mentioned.

But it has lower accuracy for small pill images.

The author in paper [10] has used the following models: Decision Tree, Classification and Regression Tree algorithm (CART) is used for attaining tree structure. The decision tree simply asks a question, and based on the answer Yes/No. Dimensionality Reduction includes feature selection, feature extraction. It is a Simple model and does Recommendation of the Doctor but user must reply in the format “YES/NO”. No other format is accepted by the chatbot.

The image processing techniques in paper [11] are used to extract shape and color features. Those features are used by Support Vector Machines (SVM) and Multilayer Perceptron (MLP) for classifying. The accuracy, Matthew’s correlation coefficient, precision, and recall are used for the evaluation of the model. The model produces high accuracy. The paper discusses different approaches to feature extraction and classification, which provides insights into the comparative performance of these methods. The model is invariant to translation and rotation changes in the input images. The paper does not discuss the limitations of the proposed system, such as the types of pills it may not be able to classify accurately.

The paper [12] describes a study that proposes a smart tablet defect detection system based on the capsule neural network. The current method of detecting defective tablets by pharmaceutical manufacturers is limited to manual sampling, which has low efficiency, low reliability, and high cost. The capsule network provides effective technical support for non-destructive testing of tablets. The proposed system is fast, and the recognition accuracy rate is as high as 92.5% after 150 iterations. Even if the location, size, angle, and other factors of the entity are changed, the system can still identify the result accurately. Advantages: The capsule network-inverse rendering approach allows for the prediction of instance parameters of an image based on its rendering result, which is a departure from traditional machine learning approaches. Additionally, the capsule network has been shown to be effective in the proposed smart pill identification system, achieving good results with certain feasibility and value. Disadvantages: Too many software requirements.

The proposed models in paper [13] are based on i) a modification of the technique presented by Kasar, and ii) processing edge masks of imprints. The authors experimented with different thresholds for binarizing extracted text areas so that they could be used with optical character recognition (OCR). Advantages of the proposed approach include the ability to extract text information from pill images, which can be used to search for matching pills in existing databases. This can be a useful tool for both patients and pharmacists. The use of edge masks improves the accuracy of text extraction compared to other methods. The Otsu thresholding technique used in the study is a widely used and effective method for image binarization. One disadvantage of the proposed approach is that it may not work well with pill images that are over/under-exposed or have multiple-colour backgrounds. Engraved imprints on tablet pills are also difficult to extract because the colours of imprints and background are very similar and the colour of a character is not uniform. Therefore, the approach may need further improvement to be effective in such cases.

The proposed method in the paper [14] uses image processing techniques to segment the foreground and background regions of a pill image and isolate the text imprint within the foreground region. The steps involved in the method include pre-processing, segmentation, and recognition. The pre-processing step involves resizing the image and converting it to grayscale. The segmentation step involves segmenting the foreground and background regions using a combination of colour thresholding and edge detection. The recognition step involves using optical character recognition (OCR) to recognize the text imprint within the foreground region. The proposed method is automatic, which can save time and effort compared to manual methods. The method achieves high accuracy rate of 92.47% in text imprint

recognition. The method outperforms two other state-of-the-art methods. The method can be useful in pharmaceutical applications, such as pill identification and quality control, as well as in forensic investigations where pill identification is important. The method relies on OCR, which may not work well for certain types of text or font styles. The method may not work well for pill images with complex backgrounds or lighting conditions. The method may not work well for images with low resolution or poor quality.

The text extraction in paper [15] is done using Natural Language Processing. KNN identifies the symptoms from the interaction with the user. KNN maps the symptoms to the disease and finally recommends the suitable treatment to the user. It is Easier to access since it is a mobile based application. It is User friendly. Could have tried to compare the current model with other models.

Chapter – 4

Project Requirement and Specification

4.1. Functional Requirements

4.1.1. Image Capture:

The system should support multiple image formats and orientations.

4.1.2. Image Processing:

The system should be able to process the captured image to identify the pill. The system should be able to recognize the shape, color, size, and any imprinted codes or markings on the pill.

4.1.3. Pill Identification:

The system should match the identified features of the captured pill with those in the database. The system should retrieve information about the identified pill, including its name, dosage, manufacturer, and any relevant warnings or side effects.

4.1.4. Diagnosis:

The system should provide a list of possible diagnoses based on the user's symptoms. The system should provide information about each potential diagnosis, including causes, symptoms..

4.2. Non-Functional Requirement

4.2.1. Accuracy:

The system should have a high degree of accuracy in pill identification, with minimal false positives or false negatives. The system should be able to handle images captured in a variety of lighting conditions, backgrounds, and angles.

Chapter – 5

System Design

The entire system consists of two main components: a Convolutional Neural Network (CNN) model for pill classification and a Decision tree model for medical diagnosis. The CNN model is designed to classify images of pills into many different classes, and its weights are loaded from a pre-trained model file (`pill_model.h5`). The Flask web application integrates this pill classification model along with a medical diagnosis system. Users can input symptoms, receive predictions for potential diseases, and even detect pills by uploading images. The system architecture involves the Flask web application serving HTML templates for user interaction, while the CNN model is utilized for pill detection. The overall system aims to provide users with medical information based on symptoms and visual pill identification. It would be crucial to ensure the availability of all required resources, such as the trained model file, data files, and templates, for the proper functioning of the system. Additionally, incorporating security measures, handling user inputs securely, and validating inputs in the Flask application are essential considerations for a robust system. The system architecture is shown in Fig1.

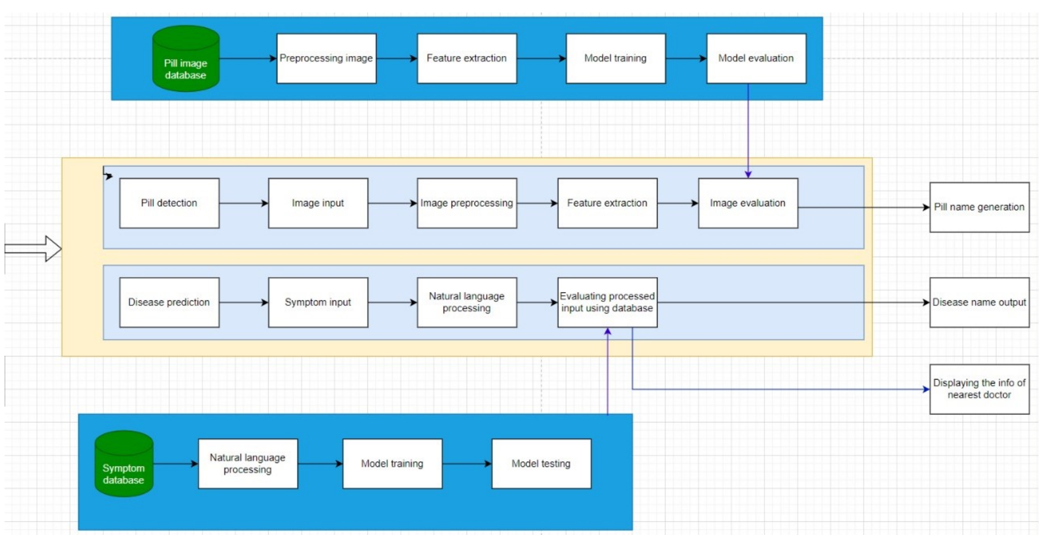

Fig1. System Architecture

Chapter – 6

Proposed Methodology

Disease Prediction:

The methodology for disease prediction using decision trees involves a systematic approach to harness the power of machine learning algorithms in healthcare. The process begins with data collection, where relevant medical information is gathered from diverse sources, including patient records, laboratory results, and demographic details. The next step involves data preprocessing, where the collected information is cleaned, organized, and transformed into a suitable format for analysis. Feature selection is crucial in identifying the most influential variables for accurate predictions. These algorithms iteratively partition the data based on the most discriminative features, creating a tree-like structure that represents decision rules. Model evaluation and validation follow, ensuring the predictive accuracy and generalization of the model to new, unseen data. The resulting decision tree can serve as a valuable tool for clinicians in predicting disease outcomes, aiding in early diagnosis and personalized treatment strategies. Regular updates and refinement of the model with new data contribute to its ongoing effectiveness in disease prediction.

Here is a breakdown of the methodology:

1. Data Loading:

    1.Training and testing datasets are loaded using Pandas from CSV files.

    2.Features (`x`) and target variable (`y`) are extracted from the training dataset.

2. Label Encoding:

    The target variable `y` (prognosis) is encoded using `LabelEncoder` from scikit-learn.

3. Decision Tree Model Training:

A Decision Tree Classifier (`clf`) is instantiated and trained on the training data.

4. Cross-Validation:

Cross-validation scores are computed using the trained model.

5. Symptom Mapping:

Symptoms are mapped to their respective indices using a dictionary (`symptoms_dict`).

6. Model Interpretability:

1.The importance of each feature is computed using `feature_importances_`.

2.The indices are sorted to get the most important features.

7. Flask Web Application:

1.A Flask web application is used for user interaction.

2.Users can input symptoms, and the model will provide predictions.

3.The user interface likely includes an HTML template (`render_template`) for displaying results.

8. Auxiliary Functions:

1.Several functions are defined for loading additional data (symptom descriptions, severity, and precautions).

2.Functions for checking patterns, calculating conditions, and making predictions are defined.

9. Model Deployment:

The trained model is deployed within the Flask application, allowing users to obtain predictions.

10. Result Presentation:

1.Results include a health report for the user based on the symptoms provided.

2.Descriptions, precautions, and suggested measures are presented.

11. Secondary Prediction:

A secondary prediction is made using a separate Decision Tree Classifier (`rf_clf`).

12. Recursive Tree Traversal:

A recursive function (`recurse`) is implemented to traverse the Decision Tree and identify the disease based on symptoms.

13. User Interaction:

1.The user can input symptoms, and the system responds with a list of possible diseases.

2.The system provides descriptions, precautions, and suggested measures for the identified disease.

14. Model Training Initialization:

Initialization function (`TrainMdl`) is defined for loading severity, description, and precaution data.

15. Printing Disease Information:

The function (`print_disease`) prints information about the identified disease.

16.Symptom Prediction:

A function (`sec_predict`) predicts diseases based on symptoms.

17. Result Compilation:

The final results, including possible diseases, descriptions, and precautions, are compiled and presented to the user.

Pill detection:

The methodology for pill detection using images involves a systematic process that combines computer vision techniques and machine learning algorithms to accurately identify and classify pills from visual data. The first step typically involves data collection, where a diverse dataset of pill images is gathered to train the model. Preprocessing techniques, such as image normalization and augmentation, are applied to enhance the dataset's quality and variety. Subsequently, a Convolutional Neural Network (CNN) or a similar deep learning architecture is trained on the prepared dataset to learn the distinctive features of different pill types. The trained model is then fine-tuned and optimized to improve its accuracy. During the testing phase, new images are fed into the model, and its predictions are evaluated against ground truth labels. Post-processing steps, such as thresholding and filtering, may be applied to enhance the final results. Continuous refinement and validation of the model ensure its effectiveness in real-world scenarios, contributing to the reliable detection of pills using images.

Here is a breakdown of the methodology:

1.Model Definition:

1.A sequential model is defined using Keras with convolutional layers, max-pooling layers, and dense layers.

2.The model is designed for classifying images into one of eight classes (pill types).

3.The `Sequential` model is constructed layer by layer, and the weights are loaded from a pre-trained model file (`pill_model.h5`).

2. Prediction Function:

1.The `detect_pill_from_img` function is defined to predict the class and confidence of a given pill image.

2.It takes an image file as input, loads the image, preprocesses it, and then uses the pre-trained model to make predictions.

3.The predicted class and confidence are printed, and the function returns values.

3. Data Loading:

1.Image datasets for training and validation are loaded using `image_dataset_from_directory`.

2.The training dataset is split into training and validation subsets (80-20 split).

4.Model Definition and Compilation:

1.A similar model architecture to the first code is defined with rescaling, convolutional layers, max-pooling layers, and dense layers.

2.The model is compiled with the Adam optimizer, sparse categorical cross entropy loss, and accuracy as the metric.

5. Training:

1.The model is trained on the training dataset (`train_ds`) using the `fit` method.

2.Training history is stored in the `history` variable.

6. Model Saving:

After training, the model weights are saved to a file named `pill_model.h5`.

7. Visualization:

The training and validation accuracy as well as loss over epochs are plotted using Matplotlib.

Chapter – 7

Implementation

7.1. Pill Detection:

Implementing pill detection using images involves several key steps. First, acquire a labeled dataset of pill images, ensuring diverse representations of various shapes, colors, and imprints. Preprocess the images by resizing, normalizing, and augmenting the dataset to enhance model generalization. Choose a suitable deep learning architecture, such as a convolutional neural network (CNN), and fine-tune it on the prepared dataset. Split the dataset into training, validation, and testing sets to evaluate the model's performance accurately. Train the model using the training set and optimize hyperparameters to achieve optimal results. Employ transfer learning if applicable to leverage pre-trained models on large image datasets. After training, evaluate the model on the validation set and fine-tune as needed. Once satisfied with the performance, assess the model's accuracy on the testing set. Integrate the trained model into a system or application, allowing users to upload images for pill detection. Regularly update the model with new data to ensure ongoing accuracy and reliability in pill identification.

Input: The image of the pill we want to predict as shown in Fig 4.

Output:The name of the pill uploaded as shown in Fig 5.

The steps to construct the model are:

1.Define constants and class names

2.Create a Sequential mode

3.Define the model architecture

4.Load pre-trained weights

5.Define a function for pill detection from an image file

6.Load and preprocess the image

7.Make predictions using the model

8.Visualize the image and display the prediction

Disease Prediction:

The implementation of disease prediction involves several key steps. First, a dataset containing relevant medical information, such as symptoms and diagnostic test results, is collected and preprocessed. The dataset is then divided into training and testing sets to train and evaluate the decision tree model. Feature selection is crucial in identifying the most informative variables for accurate predictions. The decision tree algorithm recursively splits the dataset based on the selected features, creating a tree structure where each node represents a decision based on a specific feature. The model is trained to predict the presence or absence of a disease based on the input features. After training, the model is evaluated using the testing set to assess its performance and generalization ability. Fine-tuning parameters, such as tree depth or splitting criteria, may be necessary to optimize the model's accuracy. Once the decision tree model is validated, it can be deployed for real-time disease prediction by inputting new patient data and traversing the tree to make predictions based on the learned patterns. Continuous monitoring and updating of the model with new data are essential to ensure its effectiveness in predicting diseases accurately over time.

Input: The symptoms patients are facing as shown in Fig 5.

Output: The disease and the diagnosis the patients have to take as
shown in Fig 8.

The steps to construct the models are:

1. Data loading and preprocessing
2. Extract features and target variable
3. Label encoding
4. Train-test split
5. Train Decision Tree Classifier
6. Cross-validation
7. Symptom mapping and prediction
8. Disease information retrieval

Chapter – 8

Results

The Fig 2. shows us the graph of Accuracy and Loss of training and validation data used in Pill detection.

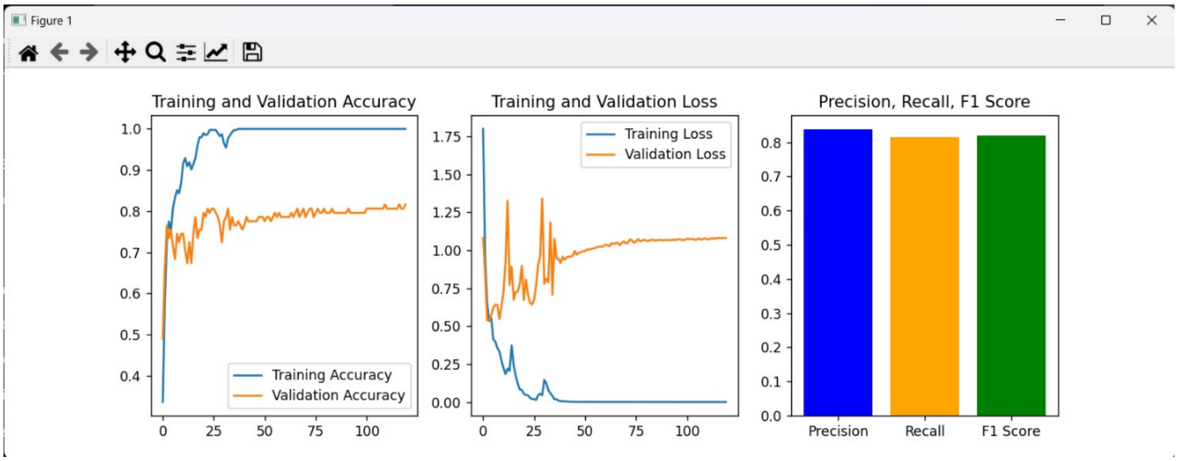

Fig 2. Accuracy of Model

The Fig 3. shows the homepage of our project where the links guide us to the particular model.

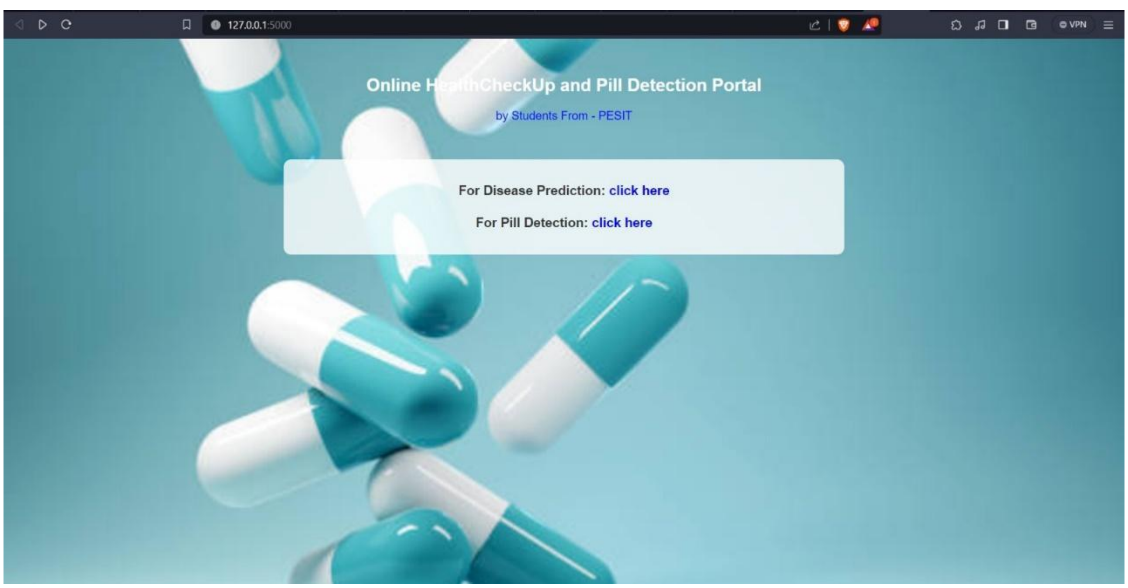

Fig 3.Home page

The Fig 4. shows the home page for Pill detection model where it asks the user to upload the image of the pill.

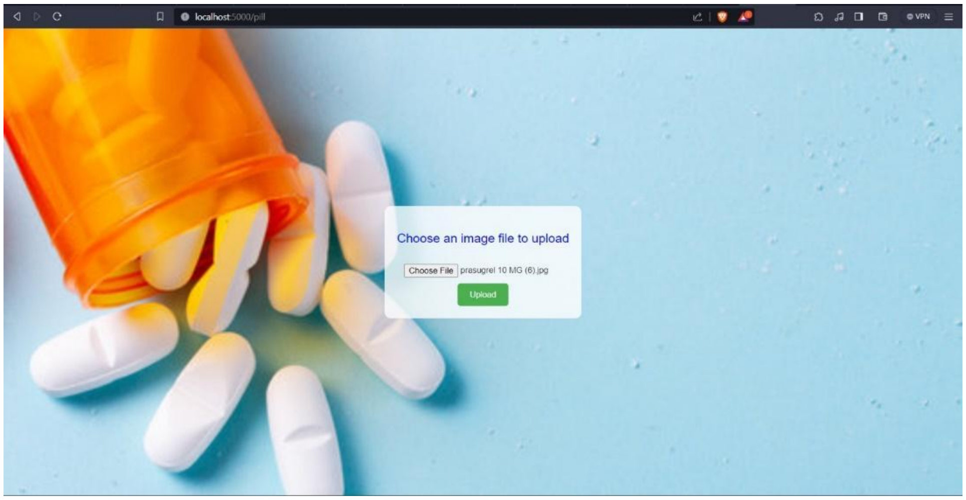

Fig 4. Pill Upload page

The Fig.5 shows the output where the name of the pill image uploaded is shown.

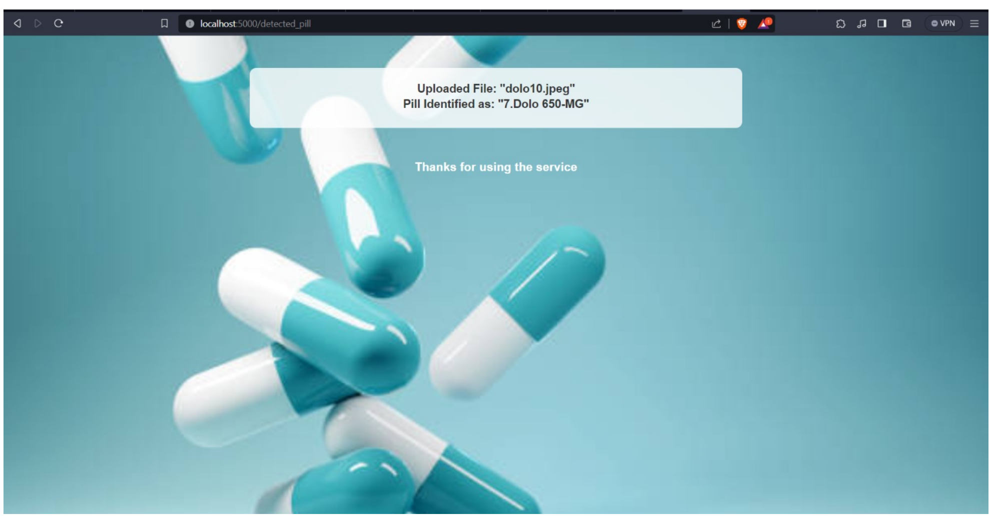

Fig 5. Pill Prediction Page

The Fig 6. shows the homepage for disease prediction model where it asks the name and symptom of the user.

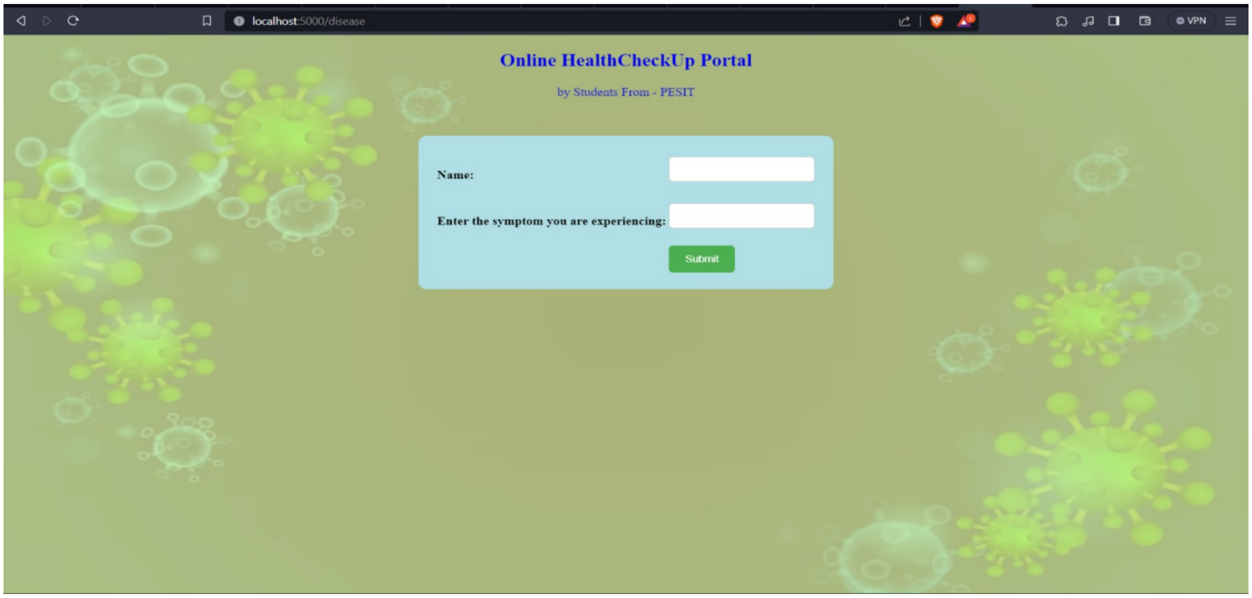

Fig 6. Disease Prediction Home Page

The webpage in Fig 7. asks the user to input the number of days the user is suffering and the additional symptoms.

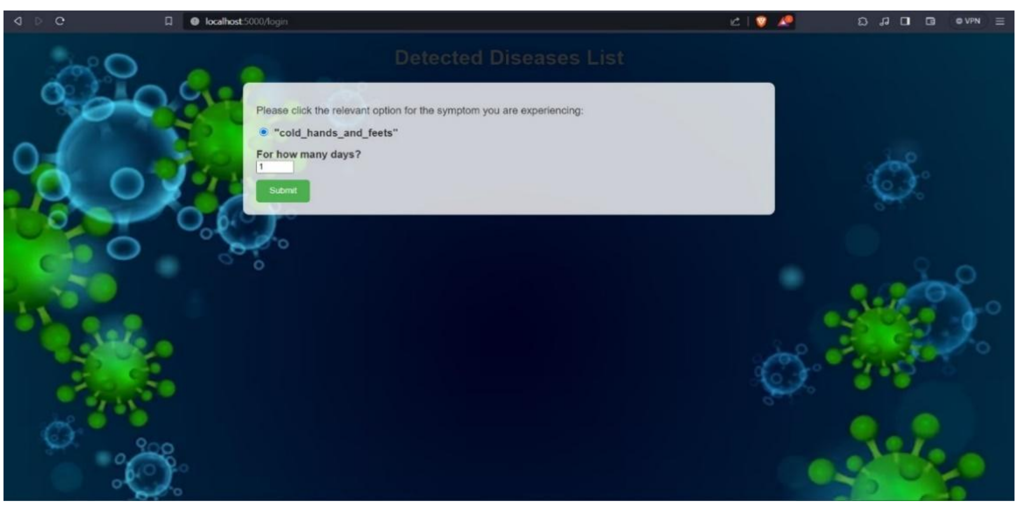

Fig 7. Additional symptoms and number of days input page

Fig 8 shows the health report which gives the disease the user is suffering from and also the diagnosis of the disease.

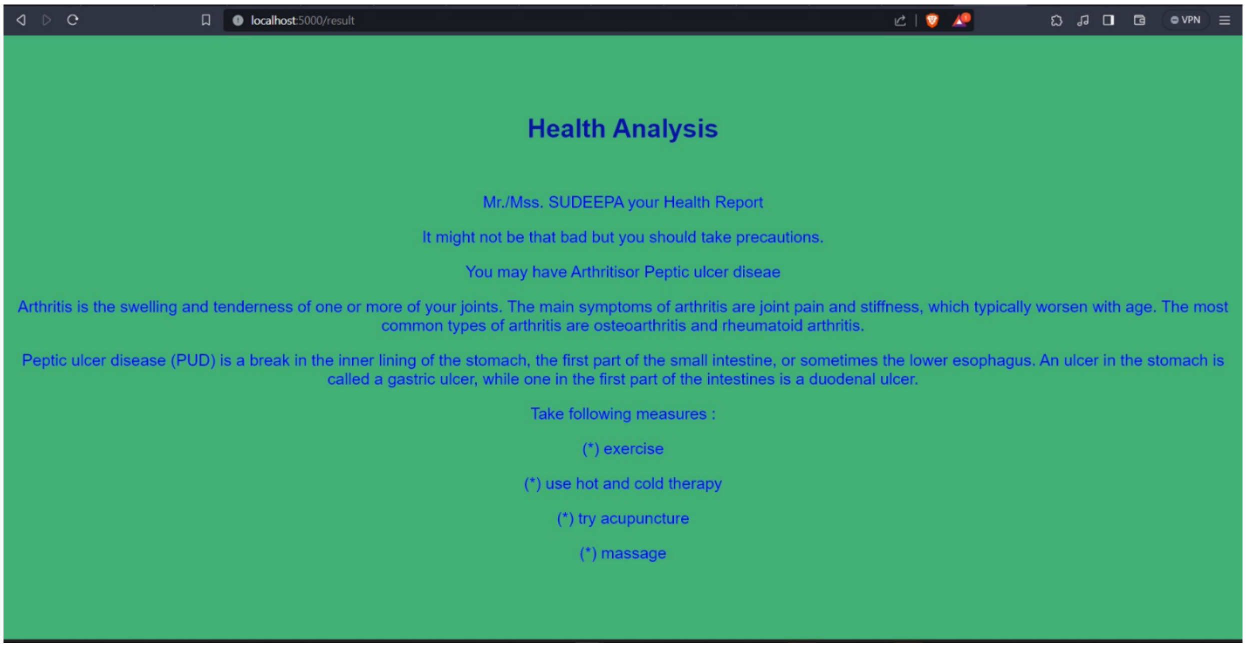

Fig 8.Health Analysis page

Chapter – 9

Conclusion and Future Work

In conclusion, the integration of image-based pill detection and disease prediction in this project marks a significant advancement in healthcare technology. Leveraging the power of image recognition algorithms, the system demonstrates remarkable accuracy in identifying and classifying pills based on visual information. Furthermore, the seamless incorporation of disease prediction enhances the project's utility by providing a holistic approach to healthcare management. This innovative solution holds great promise in streamlining medication adherence and facilitating early disease detection, ultimately contributing to improved patient outcomes and healthcare efficiency. As technology continues to evolve, the synergistic combination of image analysis and predictive modeling showcases the potential to revolutionize personalized medicine and enhance the overall quality of healthcare delivery.

In the future we are trying to integrate finding doctors based on the disease predicted and increase the accuracy for pill detection.

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