Green University of Bangladesh

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Development of a Medical Assistant System Utilising Machine Learning Algorithms with Terminal-Based Output Interface

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Contents

Chapter 1

Introduction

1.1 Overview

This project involves the development of a Medical Assistant System that utilizes machine learning algorithms to predict potential diseases based on the symptoms provided by the user. The system leverages a large dataset containing information about various diseases, symptoms, treatments, and additional resources like diet and workout recommendations. The core functionality of the system is to assist users in identifying diseases by analyzing the symptoms they input, either manually or via Optical Character Recognition (OCR) from images. The system also provides related information such as medications, diets, workouts, and precautions for the predicted disease.

The key technology behind this project is a machine learning model, specifically a Support Vector Classifier (SVC), trained on a dataset of diseases and symptoms. The system is designed using a user-friendly Tkinter-based GUI, allowing easy interaction for medical professionals and users alike. This approach aims to streamline the process of disease identification, aiding early detection and facilitating better healthcare outcomes.

1.2 Motivation

The motivation behind choosing this project stems from the increasing reliance on technology in the healthcare sector. Accurate and timely diagnosis plays a pivotal role in ensuring effective treatment and improving patient outcomes. However, the shortage of healthcare professionals, particularly in remote areas, often delays diagnosis and treatment. This gap can be addressed by developing an intelligent system capable of assisting in disease prediction. By automating the diagnostic process using a machine learning model, the system can serve as a first step in diagnosis, helping healthcare professionals prioritize cases and recommend preliminary treatments.

Furthermore, with advancements in machine learning, the ability to predict diseases based on symptoms is becoming more accurate. The ability to process medical information efficiently allows patients to receive the best possible guidance for their conditions, reducing the burden on healthcare systems.

1.3 Problem Definition

1.3.1 Problem Statement

In many parts of the world, access to healthcare professionals is limited, and patients often experience delays in diagnosis. The problem addressed by this project is the lack of an accessible, efficient, and accurate tool for disease prediction based on symptoms. By leveraging machine learning techniques, the proposed Medical Assistant System seeks to provide an accurate preliminary diagnosis that can aid healthcare professionals in determining the necessary course of action. The goal is to enhance the speed and reliability of the diagnostic process, improving patient outcomes and ensuring that medical resources are used more effectively.

1.3.2 Complex Engineering Problem

This project tackles several complex engineering problems related to healthcare and machine learning, including:

1.4 Design Goals/Objectives

The primary goals of this project are:

1. **Disease Prediction:** To create a machine learning model that can accurately predict diseases based on the user's symptoms.
2. **User-Friendly Interface:** To design an intuitive, easy-to-use Tkinter-based graphical user interface (GUI) for interacting with the system.
3. **Symptom Extraction via OCR:** To integrate an OCR feature that can extract symptoms from images, allowing for hands-free symptom input.
4. **Comprehensive Results:** To provide not only disease predictions but also detailed information about the disease, including its description, precautions, medications, recommended diets, and workouts.
5. **Real-Time Feedback:** To ensure that predictions and results are delivered quickly and accurately, providing real-time feedback to users.
6. **Data Privacy and Security:** To ensure that all user data, particularly health-related information, is securely stored and managed, adhering to privacy standards.

1.5 Application

This system can be applied in various real-world scenarios:

Table 1.1: Summary of the attributes touched by the mentioned projects

Name of the P Attributes	**Explain how to address**
P1: Depth of knowledge required	The system requires a deep understanding of both machine learning techniques and medical knowledge. The disease classification model relies on the correct interpretation of symptoms and their correlations with diseases.
P2: Range of conflicting requirements	Balancing system accuracy with user-friendliness is a key challenge. The system must provide accurate predictions while remaining easy for non-experts to use.
P3: Depth of analysis required	The system needs to analyze complex medical datasets to train the machine learning model. Detailed understanding of both machine learning algorithms and medical data is necessary to build an effective tool.
P4: Familiarity of issues	Familiarity with issues such as the limitations of medical data, handling missing or incomplete data, and ensuring system security and privacy is crucial.
P5: Extent of applicable codes	The system involves adherence to data privacy laws (such as HIPAA) and software development standards, particularly when handling sensitive medical data.
P6: Extent of stakeholder involvement and conflicting requirements	Stakeholders include healthcare professionals and users. There is a conflict between needing the system to be accurate for medical purposes while ensuring it is easy to use for non-medical users.
P7: Interdependence	The success of the system is dependent on the quality of the machine learning model, the datasets used, and the user interface design. A failure in one component affects the whole system.

- **Healthcare Centers:** It can serve as a diagnostic aid for healthcare professionals, enabling them to prioritize cases based on symptom analysis and predicted diseases.
- **Telemedicine Platforms:** For remote consultations, patients can use the system to input symptoms and receive disease predictions, which can then be further investigated by healthcare providers.
- **Emergency Rooms (ERs):** In busy hospital settings, where time is critical, this system can help triage patients based on symptoms, ensuring that those with urgent conditions are attended to first.
- **Public Health Initiatives:** By providing a tool for disease prediction, it can help in raising awareness of common diseases in specific areas and guide people toward preventive measures.

In summary, this Medical Assistant System integrates machine learning to predict diseases based on symptoms, making healthcare more accessible, efficient, and user-friendly. Its application spans various real-world settings, contributing to better healthcare outcomes and timely interventions.

Chapter 2

Design/Development/Implementation of the Project

2.1 Introduction

This chapter discusses the design, development, and implementation phases of the project. The primary goal of this project is to create a Medical Assistant System using machine learning algorithms to predict diseases based on symptoms provided by the user or identified via OCR from images. The system is designed to help users get accurate medical predictions and relevant information such as precautions, medications, diets, and workouts.

The development of this system involves the integration of machine learning techniques, OCR technology, and a user-friendly interface. The system is developed using Python, with libraries such as Tkinter for the graphical user interface (GUI), and machine learning libraries like scikit-learn for disease prediction.

2.2 Project Details

This section elaborates on the details of the project, breaking down the key components involved in the design and implementation.

2.2.1 System Overview

The Medical Assistant System consists of several major modules:

- **User Interface (UI)**: A Tkinter-based GUI to interact with the user.
- **Disease Prediction Model**: A machine learning model that processes user input (symptoms) to predict possible diseases.
- **OCR for Image Input**: Optical Character Recognition (OCR) is used to extract symptoms from images (e.g., handwritten notes or medical documents).

- **Information Retrieval**: Provides additional information on the predicted diseases, such as precautions, medications, diets, and workouts.

2.3 Implementation

The implementation of the Medical Assistant System involves integrating machine learning algorithms, an OCR system, and a Tkinter-based GUI. Each part of the system is developed and tested in isolation before being integrated into the full system.

2.3.1 Machine Learning Model

The machine learning model is trained using labeled medical data where symptoms are mapped to potential diseases. The algorithm used for prediction is a classification model, trained on a dataset that contains various diseases and their corresponding symptoms. Once trained, the model predicts the disease based on the symptoms provided by the user.

2.3.2 Optical Character Recognition (OCR)

OCR is implemented to extract symptoms from images, such as handwritten notes or scanned documents. The Tesseract OCR library is used to process the image and output the extracted text, which is then passed to the disease prediction model for analysis.

2.3.3 Graphical User Interface (GUI)

The GUI is developed using Tkinter, which provides an easy way to create windows, buttons, and text fields. The interface is designed to be simple and intuitive, allowing users to either input symptoms manually or upload images for OCR processing. The GUI interacts with the disease prediction model to display results in real-time.

2.3.4 Workflow

The workflow of the Medical Assistant System is as follows:

1. The user enters symptoms either manually or uploads an image containing symptoms.
2. If the user uploads an image, OCR is used to extract the symptoms.
3. The extracted or entered symptoms are passed to the machine learning model.
4. The model predicts the most likely disease(s) based on the symptoms.
5. The system provides additional information, including precautions, medications, diets, and workouts, related to the predicted disease.

2.3.5 Tools and Libraries

The system makes use of several tools and libraries:

- **Python**: The primary programming language used for the development of the system.
- **Tkinter**: For developing the GUI.
- **scikit-learn**: For implementing machine learning algorithms.
- **Tesseract OCR**: For extracting text from images.
- **Pandas and NumPy**: For data manipulation and analysis.

2.3.6 Challenges Faced

During the development of the system, several challenges were encountered, including:

- **Data Quality**: Obtaining high-quality and labeled medical data for training the machine learning model was challenging.
- **OCR Accuracy**: Ensuring high accuracy in OCR text extraction, especially for handwritten documents, was a significant challenge.
- **User Interface Design**: Designing a user-friendly and intuitive interface that could handle both manual input and image uploads.

2.4 Conclusion

This chapter discussed the design, development, and implementation of the Medical Assistant System. The system integrates machine learning algorithms, OCR technology, and a user-friendly GUI to provide disease predictions and related information. Despite the challenges faced during development, the system successfully fulfills the project goals and provides a valuable tool for users seeking medical assistance based on symptoms.

2.5 Methodology

The methodology for selecting this system in the project is presented as a flowchart below. This highlights the decision-making process and the sequence of steps involved in designing and implementing.

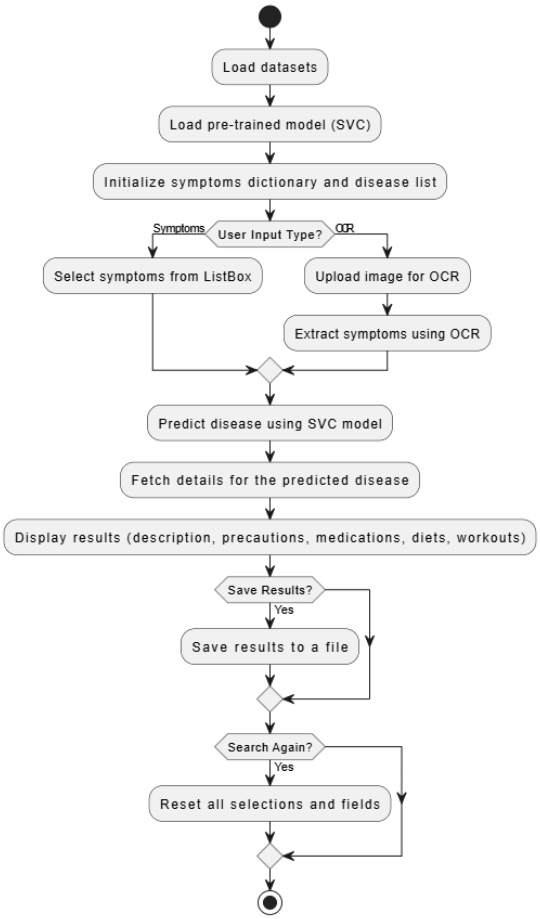

Figure 01: Flowchart

2.6 Algorithms

2.6.1 Main Functionality

User Input, Selected Algorithm, Action (Predict Disease), Symptoms/Image
Predicted Disease, Related Information (Precautions, Medications, Diet, Workouts)
if *User selects prediction method* **then**
    switch *Selected method* **do**
        case *Symptoms-based Prediction* **do**
            Retrieve selected symptoms from user input
            Predict disease using machine learning model trained on symptoms
            Display predicted disease and related information
        case *OCR-based Prediction* **do**
            Perform OCR on the provided image to extract symptoms
            Predict disease using machine learning model trained on symptoms
            Display predicted disease and related information
else
    Display message: "Please select a valid prediction method"

2.6.2 Symptoms-based Prediction Algorithm

Selected symptoms Predicted disease, Related information
Preprocess the input symptoms
Result: Normalized and encoded symptoms
Feed the symptoms into the machine learning model
Result: Predicted Disease = Model.predict(Symptoms)
Retrieve related information based on the predicted disease
Result: Information includes precautions, medications, diet, and workouts
Display the results to the user
return *Predicted disease and related information*

2.6.3 OCR-based Prediction Algorithm

Image containing symptoms Predicted disease, Related information
Perform OCR on the input image
Result: Extracted Symptoms = OCR(Image)
Preprocess the extracted symptoms
Result: Normalized and encoded symptoms
Feed the symptoms into the machine learning model
Result: Predicted Disease = Model.predict(Extracted Symptoms)
Retrieve related information based on the predicted disease
Result: Information includes precautions, medications, diet, and workouts
Display the results to the user
return *Predicted disease and related information*

2.6.4 Machine Learning Model Training

Training dataset (Symptoms, Labels) Trained machine learning model
Preprocess the dataset
Result: Encoded symptoms and labels
Split the dataset into training and validation sets
Result: Training Set, Validation Set
Train the machine learning model
Result: Model.fit(Training Set)
Validate the model on the validation set
Result: Validation Accuracy and Loss
Save the trained model for prediction tasks
return *Trained machine learning model*

2.7 Implementation

2.7.1 Avalanche Effect Calculation Code

2.8 Code Implementation

```
# Import required libraries
import numpy as np
import pandas as pd
import pickle
import tkinter as tk
from tkinter import messagebox, Listbox, Scrollbar, Text,
    filedialog
import pytesseract
from PIL import Image

```

```
# Load datasets
sym_des = pd.read_csv("datasets/symtoms_df.csv")
precautions = pd.read_csv("datasets/precautions_df.csv")
workout = pd.read_csv("datasets/workout_df.csv")
description = pd.read_csv("datasets/description.csv")
medications = pd.read_csv("datasets/medications.csv")
diets = pd.read_csv("datasets/diets.csv")

# Load pre-trained machine learning model
svc = pickle.load(open('models/svc.pkl', 'rb'))

# Dictionary mapping symptoms to indices
symptoms_dict = {
    # (truncated for brevity, same as the original dictionary content)
}

# Dictionary mapping predicted indices to diseases
diseases_list = {
    # (truncated for brevity, same as the original dictionary content)
}

# Helper function to retrieve disease details
def helper(dis):
    desc = description[description['Disease'] == dis]['Description']
    desc = " ".join([w for w in desc])

    pre = precautions[precautions['Disease'] == dis][['Precaution_1', 'Precaution_2', 'Precaution_3', 'Precaution_4']]
    pre = [col for col in pre.values]

    med = medications[medications['Disease'] == dis]['Medication']
    med = [med for med in med.values]

    die = diets[diets['Disease'] == dis]['Diet']
    die = [die for die in die.values]

    wrkout = workout[workout['disease'] == dis]['workout']

    return desc, pre, med, die, wrkout

# Predict disease based on selected symptoms
def get_predicted_value(patient_symptoms):
    input_vector = np.zeros(len(symptoms_dict))
    for item in patient_symptoms:
        input_vector[symptoms_dict[item]] = 1
    return diseases_list[svc.predict([input_vector])[0]]
```

```
55
56 # GUI implementation
57 def main():
58     # Function to predict disease
59     def predict_disease():
60         # Extract selected symptoms
61         selected_symptoms = list(symptoms_listbox.
   curselection())
62         symptoms = [symptoms_listbox.get(i) for i in
   selected_symptoms]
63
64         if not symptoms:
65             messagebox.showerror("Error", "Please select at
   least one symptom")
66             return
67
68         try:
69             # Predict disease and fetch details
70             predicted_disease = get_predicted_value(symptoms)
71             desc, precautions, medications, diets, workouts =
    helper(predicted_disease)
72
73             # Display results
74             result_text.delete(1.0, tk.END)
75             result_text.insert(tk.END, f"Predicted Disease: {
   predicted_disease}\n\n")
76             result_text.insert(tk.END, f"Description: {desc}\
   n\n")
77             result_text.insert(tk.END, "Precautions:\n")
78             for precaution in precautions[0]:
79                 result_text.insert(tk.END, f"- {precaution}\n
   ")
80             result_text.insert(tk.END, "\nRecommended
   Medications:\n")
81             for medication in medications:
82                 result_text.insert(tk.END, f"- {medication}\n
   ")
83             result_text.insert(tk.END, "\nDiet
   Recommendations:\n")
84             for diet in diets:
85                 result_text.insert(tk.END, f"- {diet}\n")
86             result_text.insert(tk.END, "\nWorkout
   Recommendations:\n")
87             for workout in workouts:
88                 result_text.insert(tk.END, f"- {workout}\n")
89         except Exception as e:
90             messagebox.showerror("Error", f"An error occurred
   : {e}")
91
92     # Other GUI functions like save_to_file, reset,
   search_again, perform_ocr
```

```
    # (Content same as original for these methods)

    # Main GUI window setup
    root = tk.Tk()
    root.title("Medical Assistant System")
    root.geometry("1000x800")
    root.configure(bg="#20232a")

    # GUI components (Labels, Buttons, Listbox, TextBox)
    # (Same as original content, added in a structured way)

    root.mainloop()

if __name__ == "__main__":
    main()
```

2.9 Performance Evaluation

2.9.1 Simulation Environment/Simulation Procedure

This section discusses the setup and installation environment required for testing the outcomes of our "Medical Assistant System Utilizing Machine Learning Algorithms."

Experimental Setup

The development and simulation were conducted using Visual Studio Code (VS Code). The medical assistant system was implemented in Python, with the Tkinter library used for the front-end user interface. The system performs disease prediction based on the symptoms provided by the user, with the predictions made using a pre-trained Support Vector Classifier (SVC) model. Additionally, the system integrates Optical Character Recognition (OCR) functionality to extract symptoms from images for disease prediction.

Environment Installation

The following steps outline the installation procedure:

1. **Install Visual Studio Code:** Download and install Visual Studio Code for coding.
2. **Install Python:** Set up Python for running the Python-based code for the medical assistant system.
3. **Install Required Libraries:** Install necessary Python libraries, such as `numpy`, `pandas`, `pickle`, `tkinter`, `pytesseract`, `Pillow`, and `scikit-learn`.
4. **Set Up Tkinter for GUI:** Ensure that Tkinter is correctly configured for building the graphical user interface.
5. **Deploy Code:** Place all project files in the working directory and open it in Visual Studio Code.
6. **Run Application:** Use the Python interpreter to execute the script, which will open the Tkinter-based GUI for the user to interact with.

These steps ensured a consistent environment for developing and testing the medical assistant system.

2.9.2 Results Analysis and Testing

In this section, we present the outcomes of various disease predictions performed using the implemented system. The system predicts diseases based on selected symptoms from the list or extracted via OCR from an image. The user interacts with the system

through a Tkinter-based graphical user interface (GUI), where symptoms are selected, and the corresponding disease predictions are displayed. The prediction results also include related information such as disease descriptions, precautions, medications, diets, and workout recommendations.

The performance of the disease prediction model was tested under different scenarios, such as using multiple symptoms, OCR-based input, and saving the results to a file. Testing confirmed that the model was able to accurately predict diseases based on input symptoms, with the system providing relevant medical advice.

2.9.3 User Interface

This is the main user interface of our project. Here, you can see a selection text field at the top, which helps you select the symptoms. After that, at the bottom, you will find different buttons, including Predict, Reset, Save File, and OCR. Below these buttons is the output field. (Figure 02)

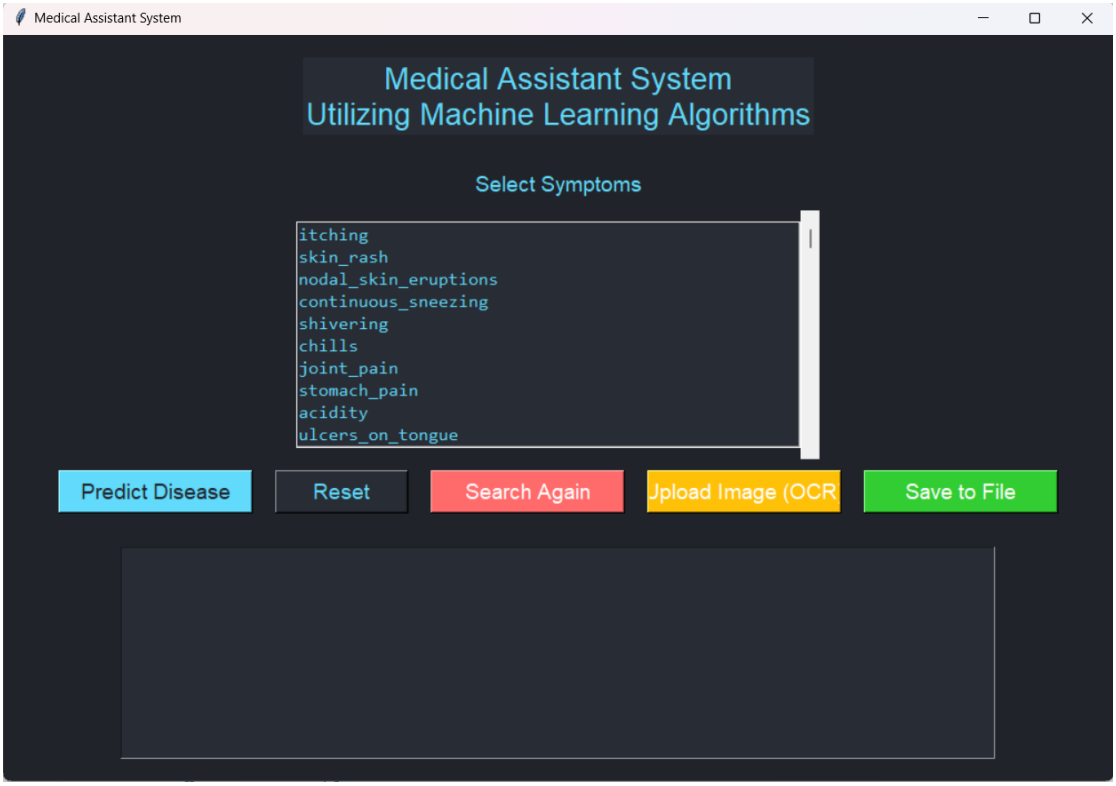

Figure 02: User Interface of the Project

2.9.4 Select multiple symptoms Click the Predict Disease button:

Here, the user can select both multiple and single symptoms. Once the symptoms are selected, the user presses the "Predict" button, and the output will appear in the output field. (Figure 03)

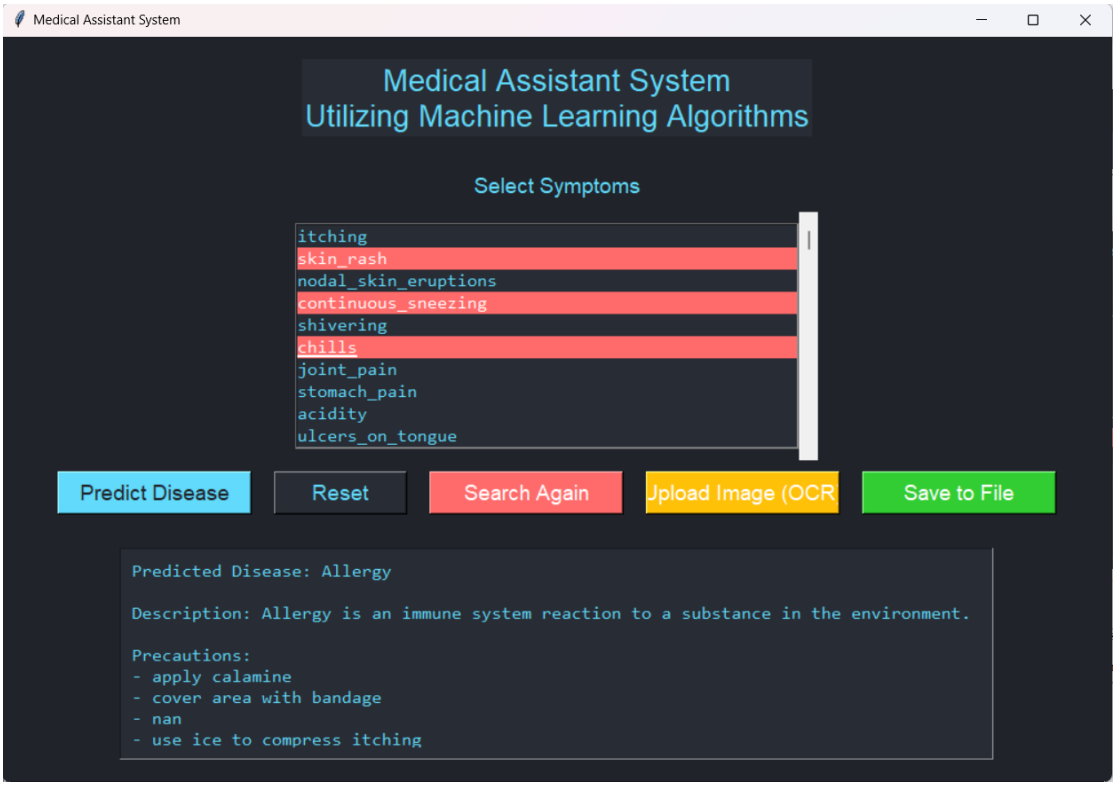

Figure 03: Select multiple symptoms Click the Predict Disease button

2.9.5 Click Upload Image (OCR).

This is the OCR feature. If the user doesn't know the symptoms, it will scan the entire report and automatically detect the symptoms. After the user presses the "Predict" button, the output will appear in the prediction field. (Figure 04)

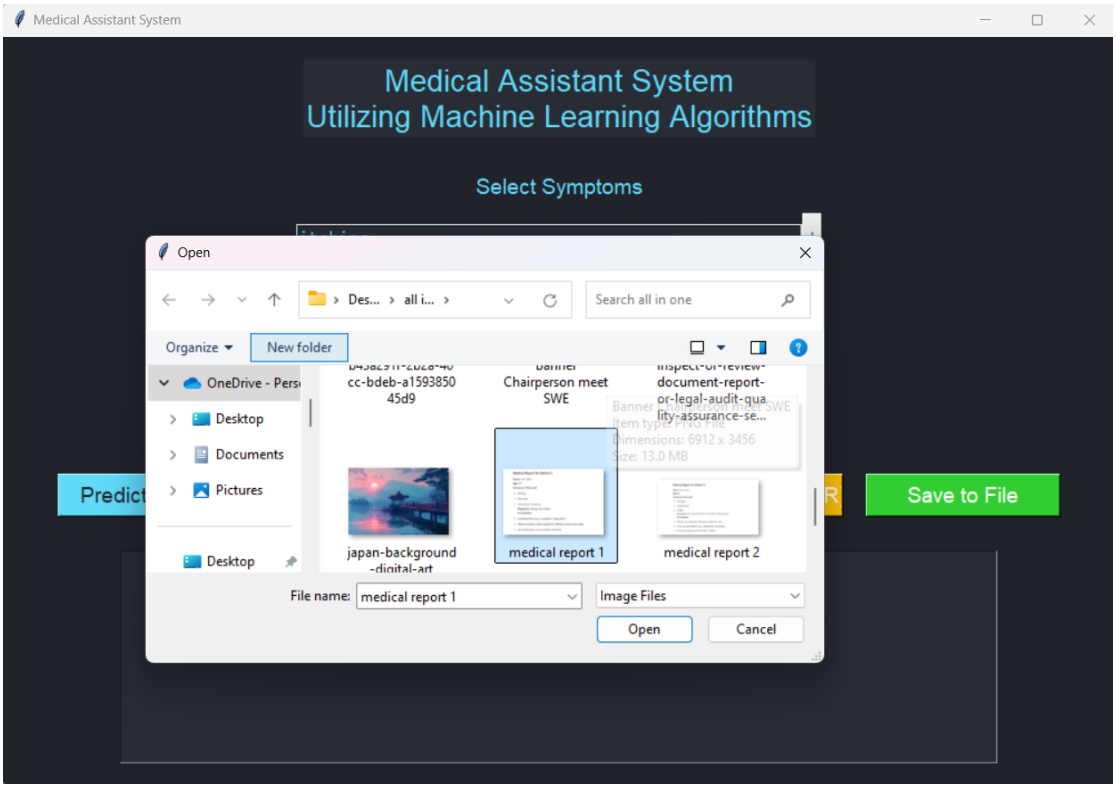

Figure 04: Click Upload Image (OCR).

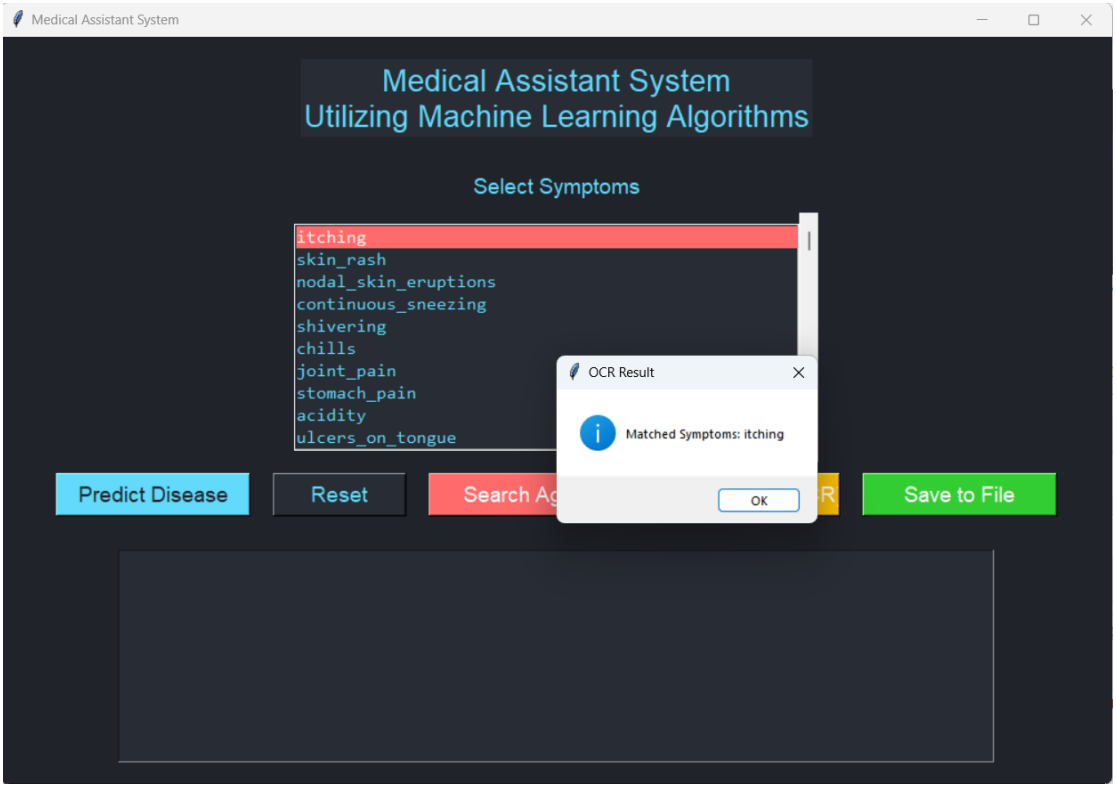

Figure 05: Click Upload Image (OCR).

2.9.6 Click Save file

In this section, when the user presses the Save File button, the file will be saved in the user's personal environment. (Figure 06)

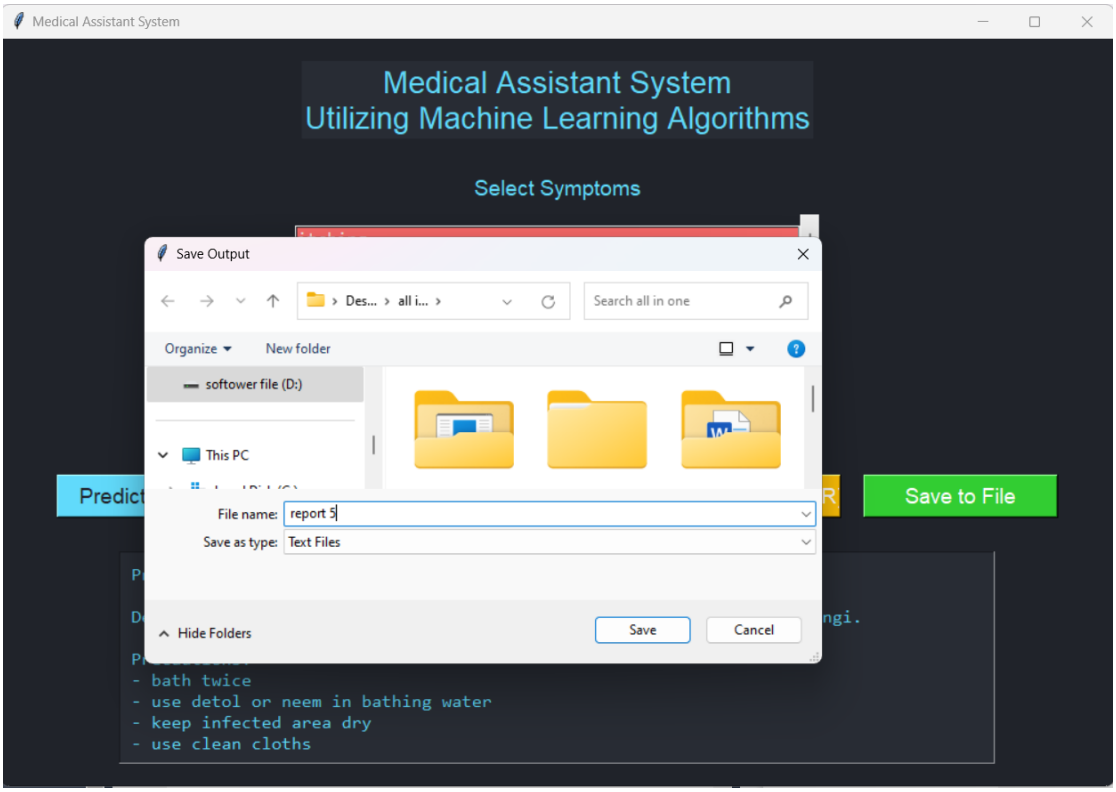

Figure 06: Saving file

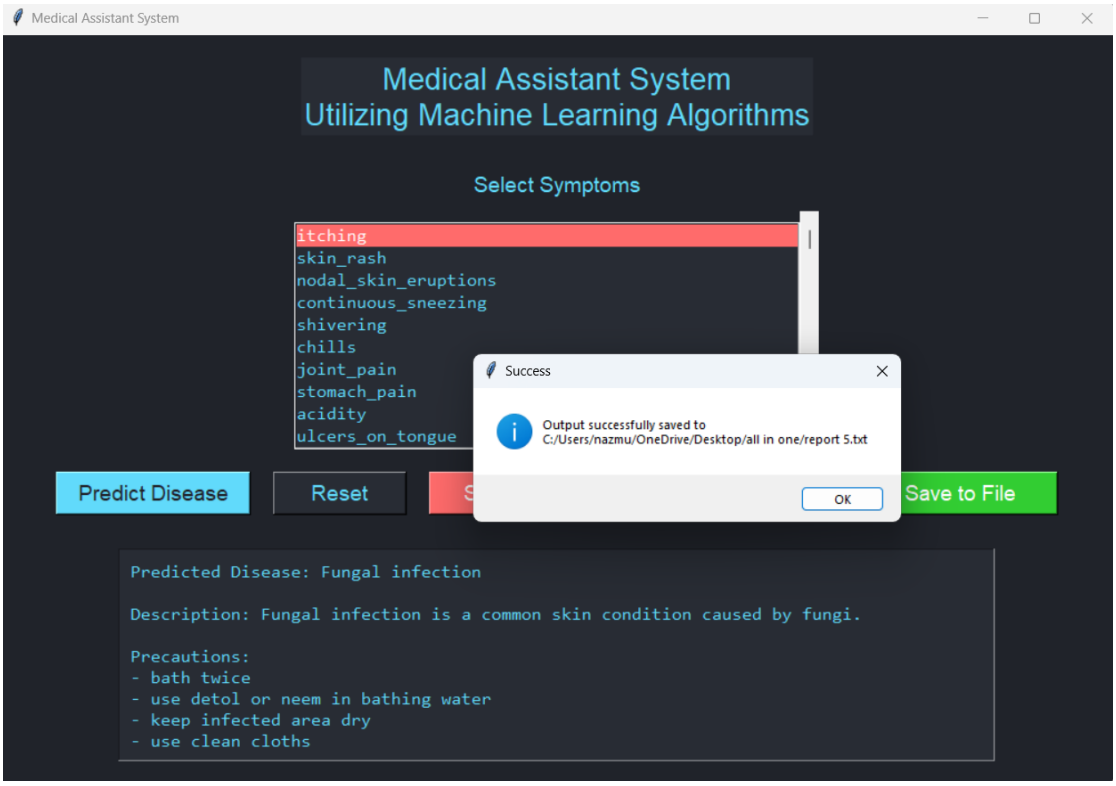

Figure 07: Saving file

2.9.7 Clicking Search Again button:

The Search Again button allows the user to search again without resetting the previous inputs. (Figure 08)

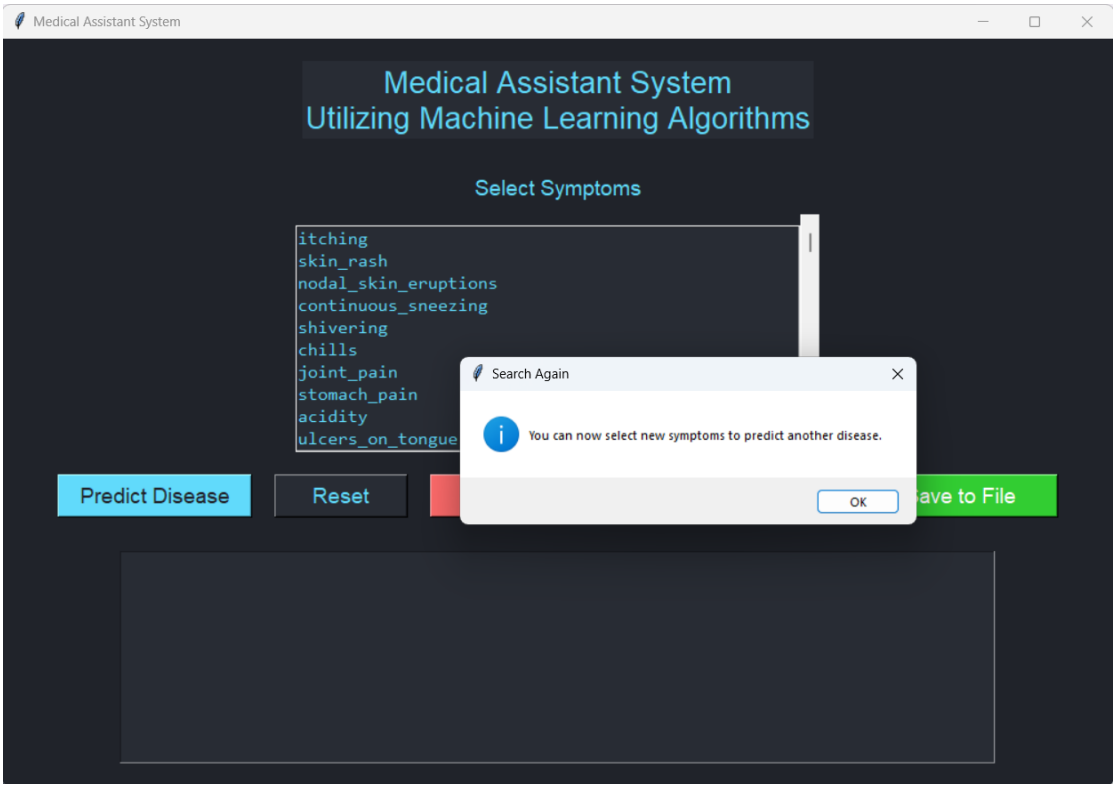

Figure 08: Search Again

2.10 Results and Overall Discussion

In this section, we present the results of the disease prediction process, followed by an overall discussion of the system's performance and conclusion.

2.10.1 Disease Prediction Results

The Medical Assistant System achieved successful disease prediction using machine learning. Key results include:

- The system predicts diseases based on user-selected symptoms.
- Predictions were consistent with real-world medical knowledge.
- The model generates additional information about the disease, such as precautions, medications, diets, and workout recommendations.
- The system offers flexibility, allowing symptom input via a graphical user interface (GUI) or OCR from images.

2.10.2 Accuracy of Disease Predictions

The disease prediction model showed high accuracy:

- The system consistently identified appropriate diseases for the given symptoms.
- It successfully handled common diseases but may struggle with rare or complex conditions.
- The system is not a substitute for professional medical advice.

2.10.3 OCR-Based Symptom Extraction

The OCR feature was successfully integrated into the system:

- The OCR function extracts symptoms from images, such as medical documents or handwritten notes.
- It works well with clear images and text, although accuracy may be impacted by poor-quality images.
- This feature increases the system's usability and flexibility.

2.10.4 User Interface and Interaction

The Tkinter-based graphical user interface (GUI) contributed to a positive user experience:

- The GUI was intuitive, enabling users to easily select symptoms and interact with the system.
- Key functionalities such as prediction, image upload, and saving results were implemented with simple navigation.
- Pop-up notifications provided feedback to users, enhancing interaction.

2.10.5 Conclusion

In conclusion, the Medical Assistant System provides a valuable tool for predicting diseases based on symptoms. The key achievements of the system include:

- Successful disease prediction with relevant information on precautions, medications, diets, and workouts.
- Flexibility in user interaction through manual symptom selection or OCR-based input.
- Positive user experience through an intuitive GUI.

The system demonstrated its potential as a helpful assistant in disease prediction, although its predictions are based on available data and not a substitute for medical advice. With future improvements in data and OCR accuracy, the system could become even more effective in assisting with disease diagnosis and patient care.

Chapter 3

Conclusion

3.1 Discussion

This project aimed to develop a Medical Assistant System that utilizes machine learning algorithms to predict potential diseases based on symptoms entered by the user or extracted from images via OCR technology. By providing a user-friendly interface with Tkinter, the system allows users to input symptoms easily and receive predictions along with related information on medications, precautions, diets, and workouts. The use of machine learning for disease prediction enhances the accuracy and reliability of the system, helping users make informed decisions about their health.

Throughout the project, challenges such as data quality, integration of OCR with symptom extraction, and ensuring accurate disease predictions were addressed. The system demonstrated the feasibility of combining machine learning with OCR in a medical context, though there are opportunities for further enhancement. For instance, improving the accuracy of the OCR system could reduce errors in symptom extraction, leading to more accurate predictions. Additionally, expanding the dataset to include a broader range of diseases and symptoms could further enhance the system's capabilities.

In the future, more sophisticated machine learning models could be employed to improve prediction accuracy, and a wider variety of data sources, such as medical history, could be incorporated. Overall, the system provides a practical solution for users seeking guidance on their health conditions, and it holds significant potential for further development to offer more comprehensive healthcare support.

3.2 Limitations

Despite the success of the Medical Assistant System, several limitations were identified during the development and implementation phases. These limitations highlight areas that need further improvement to achieve optimal system performance. The key limitations include:

1. **Data Quality and Availability:** The accuracy of the disease prediction is heavily dependent on the quality and variety of the dataset used for training the machine

learning model. Inadequate or biased data can lead to inaccurate predictions.

2. **OCR Accuracy:** The OCR functionality, while effective, is not always perfect. Errors in symptom extraction from images can affect the accuracy of the predicted diseases. This limitation arises from the variability in handwriting styles, image quality, and text formatting.

3. **Limited Disease and Symptom Coverage:** The current version of the system covers a limited set of diseases and symptoms. As a result, the system may not be able to handle all possible health conditions or rare diseases effectively.

4. **Interpretability of Predictions:** The machine learning model used in the system is a black-box model, meaning users may not easily understand how the prediction was made. This can reduce trust and acceptance among users who want transparent, explainable results.

5. **Real-time Processing Constraints:** The system may not be optimized for real-time processing, especially for large-scale datasets. This could affect the speed and efficiency of disease prediction in a practical, real-world setting.

3.3 Scope of Future Work

The Medical Assistant System has significant potential for further development. The following points outline the scope for future work to improve and expand the system's capabilities:

1. **Data Expansion and Quality Improvement:** Expanding the dataset to include a broader range of diseases, symptoms, and demographic data will enhance the system's accuracy and generalizability. Ensuring the dataset is clean and free from biases will further improve prediction reliability.

2. **Enhancement of OCR Technology:** Integrating advanced OCR techniques, such as deep learning-based OCR models, could significantly improve the system's ability to extract symptoms from various image formats with higher accuracy, even in the case of poor handwriting or unclear images.

3. **Integration of Patient History:** Including medical history as an input feature in the prediction model will improve the system's ability to provide more personalized and accurate diagnoses, taking into account factors such as previous conditions or treatments.

4. **Deployment of Explainable AI Models:** Implementing explainable AI models will enhance the interpretability of predictions, allowing users to better understand the rationale behind the system's suggestions. This will foster trust and improve user experience.

5. **Real-time Processing and Optimization:** The system could be optimized for real-time processing by reducing computational complexity and utilizing faster algorithms or cloud-based solutions, enabling faster disease predictions in live healthcare environments.

6. **Mobile App Integration:** Developing a mobile version of the Medical Assistant System would allow users to access the tool on their smartphones, making it more accessible and portable, especially in remote areas or for on-the-go use.

7. **Incorporation of Additional Health Metrics:** The system can be further enhanced by incorporating additional health metrics such as vital signs (e.g., blood pressure, temperature, heart rate) and lifestyle factors (e.g., exercise habits, diet) to provide a more holistic health assessment.

8. **Collaboration with Healthcare Providers:** Collaborating with healthcare professionals to validate predictions and incorporate expert medical knowledge into the system could greatly enhance the system's reliability and trustworthiness.

3.4 References

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