Dietary Recommendations Based on Medical Prescriptions

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Abstract

The intersection of healthcare and technology offers significant potential for enhancing patient outcomes through personalized dietary recommendations. This report presents the development of an automated system designed to read medical prescriptions, diagnose diseases, and provide tailored dietary advice. The system is divided into three main tasks: text extraction from medical prescriptions using Optical Character Recognition (OCR) technologies, disease diagnosis through from medicines prescribed, and dietary recommendations extracted on the basis of diagnosed diseases. Tesseract OCR and PyPdfium are employed to handle text extraction from images and PDFs, respectively. The idea behind this project is to utilize and see how different text generation LLMs would work in a medical environment and whether they can be fine-tuned to be utilized as medical assistants. We have used Gemini, Llama and GPT as our primary LLMs. The system's effectiveness is demonstrated through its ability to accurately read prescriptions, diagnose diseases, and provide relevant dietary advice, thereby promoting healthier lifestyles and improving disease management. This project underscores the feasibility and benefits of integrating advanced technologies in healthcare, paving the way for further enhancements and wider applications in personalized medicine.

1 Introduction

The integration of healthcare and technology has significantly enhanced the ability to improve patient outcomes through innovative solutions. A key area of interest is the development of dietary recommendation systems that are tailored to individual medical needs. Research has shown that diet and lifestyle play crucial roles in preventing, managing, and reversing many diseases. By leveraging advanced technologies such as Optical Character Recognition (OCR) and machine learning algorithms, it is possible to automate and enhance the process of providing personalized dietary advice based on medical prescriptions or diagnostic reports.

This report outlines the development of a system designed to recommend alternative diets or suggest modifications to existing diets based on a patient's medical prescription or diagnostic report. The system's development is broken down into three primary tasks: reading the medical prescription using OCR, diagnosing the disease from the prescription, and providing dietary recommendations based on the diagnosis.

2 Task Description

The primary objective of this project is to build a system capable of reading medical prescriptions in various formats, diagnosing diseases based on the content of these prescriptions, and providing tailored dietary recommendations. The project can be divided into three main tasks

1. Reading Medical Prescriptions: This involves extracting text from medical prescriptions that may be in image or PDF format using OCR technologies.

2. Disease Diagnosis: Once the text is extracted, the next step is to diagnose the disease by analyzing the prescription content.

3. Dietary Recommendations: Based on the diagnosed disease, the system will suggest dietary modifications or alternatives to aid in the patient's recovery and management of their condition.

3 Related Work

There are multiple papers that discuss the capabilities of OCR, diagnosing diseases, utilizing the diagnosis for dietary recommendation individually. Some of them are

- **Patients Medical Report analysis using OCR and Deep Learning (P et al., 2022)**: The paper mainly focuses on explaining all the different terms in the patient's medical report. It utilizes OCR to read text from the medical report then utilizes a Decision Tree Algorithm to identify similar texts from their database, and show these texts to the patient in AR. The idea is to make the patients familiar with what they are facing and make them feel at ease.

- **Extracting Medication Information from Typewritten Philippine Medical Prescriptions Using Optical Character Recognition (OCR) and Named Entity Recognition (NER) (Ang et al., 2022)** : This study explores the application of Tesseract OCR technology in extracting medication information from typewritten medical prescriptions. By utilizing Named Entity Recognition (NER), key details like dosage, drug name, and duration are annotated and extracted from prescription images. The developed web application demonstrates promising results with low error rates, paving the way for automated medication data entry and management in healthcare systems. Recommendations for future improvements include font diversity testing for the OCR tool, enhanced training for the NER model, and optimization of system speed and accuracy.

- **HPDocPres: a method for classifying printed and handwritten texts in doctor's prescription (Dhar et al., 2020)** : This paper presents a method for distinguishing between printed and handwritten text in doctors' prescriptions. The various steps involved in classifying the texts as handwritten or printed are pre-processing, segmentation at character level, feature extraction from the characters and the classification of the same. The proposed method demonstrates successful classification with minimal complexity, making it easily integrable into recognition modules as an additional resource. However, certain challenges remain for future investigation. Complex fonts pose difficulties for accurate classification of printed text, while issues like touching text and the inclusion of illustrations on prescriptions warrant further attention.

- **Realizing an Efficient IoMT-Assisted Patient Diet Recommendation System Through Machine Learning Model (Iwendi et al., 2020)**: This paper utilizes a deep learning approach to recommend dietary changes to better improve a patient's lifestyle. The deep learning models take features such as age, gender, weight, calories, protein, fat, sodium, fiber, cholesterol. The models classify food items as "Allowed" and "Not Allowed".

- **Large language models in food science: Innovations, applications, and future (Ma et al., 2024)** : This paper explores the transformative role of Large Language Models (LLMs) in food science, particularly in areas such as recipe development, nutritional analysis, food safety, and supply chain management. It highlights the significance of LLMs in automating processes, improving accuracy, and enhancing efficiency within the global food system. Addressing challenges like data biases and ethical concerns, the paper emphasizes the need for interdisciplinary collaboration to fully leverage the potential of LLMs in revolutionizing food science.

- **PMC-Llama: Towards Building Open-source Language Models for Medicine (Wu et al., 2023)**: This paper presents the development of PMC-LLaMA, a specialized language model tailored for medical applications. By integrating vast biomedical literature and medical textbooks, and fine-tuning with a comprehensive dataset, PMC-LLaMA demonstrates superior performance in medical question-answering tasks. Through systematic investigations and thorough ablation studies, the paper highlights the effectiveness of each component, showcasing PMC-LLaMA's prowess even against larger models like ChatGPT.

4 Models Used

4.1 Tesseract

Tesseract is an open-source Optical Character Recognition (OCR) engine. It supports over 100 languages and various image formats, converting them into editable text with high accuracy. It is widely used for digitizing documents, automating data entry, and improving accessibility, Tesseract is a key player in OCR technology.

4.2 Gemini AI

Gemini is an AI project developed by Google DeepMind, designed to advance the capabilities of artificial intelligence. It combines techniques from large language models, like those used in GPT-3, with DeepMind's extensive research in reinforcement learning and other areas of AI. The goal of Gemini is to create more versatile and efficient AI systems that can understand and generate human-like text, solve complex problems, and learn from interactions. By integrating these advanced techniques, Gemini aims to push the boundaries of what AI can achieve in natural language processing and beyond, enhancing applications in areas such as automated reasoning, robotics, and personalized assistance.

4.3 Llama

LLaMA (Large Language Model Meta AI) is a language model developed by Meta. It excels in generating human-like text and performing various natural language processing tasks, such as translation, summarization, and question-answering. Trained on extensive and diverse datasets, LLaMA achieves high performance and scalability, making it suitable for a wide range of applications, from conversational agents to automated content creation.

4.4 GPT

GPT (Generative Pre-trained Transformer) is a language model developed by OpenAI. It generates human-like text by predicting the next word in a sequence, based on extensive training on diverse text data. GPT excels in various natural language processing tasks, including text generation, translation, summarization, and question-answering. It is known for its high performance and versatility, and can be applied in numerous areas, such as conversational agents, automated content creation, and advanced research in AI.

4.5 PMC-Llama

PMC-LLaMA is a specialized variant of Meta's Large Language Model Meta AI (LLaMA) tailored specifically for biomedical applications. It is trained on a vast collection of biomedical literature from the PubMed Central (PMC) database. This specialized training allows PMC-LLaMA to excel in understanding and generating text related to biomedical and clinical topics, making it highly useful for tasks such as literature summarization, question-answering, and knowledge extraction in the medical and scientific fields. By leveraging domain-specific data, PMC-LLaMA provides enhanced accuracy and relevance in biomedical natural language processing applications.

5 Proposed approach

The solution that we brought to make advancement in the medical field in a way that helps people understand their own medical report and identify certain dietary changes they could make to help. The workflow of the application is given below,

Step 1: The user will be asked to upload their medical prescription in PDF format.

Step 2: Using either PDF text extraction or Optical Character Recognition(OCR) technique, the words are detected and converted to digital text.

Step 3: These texts are then trimmed and fed to an LLM for identification of medicines and their associated diseases.

Step 4: On identification of the diseases, we generate dietary recommendations which are shown to the user.

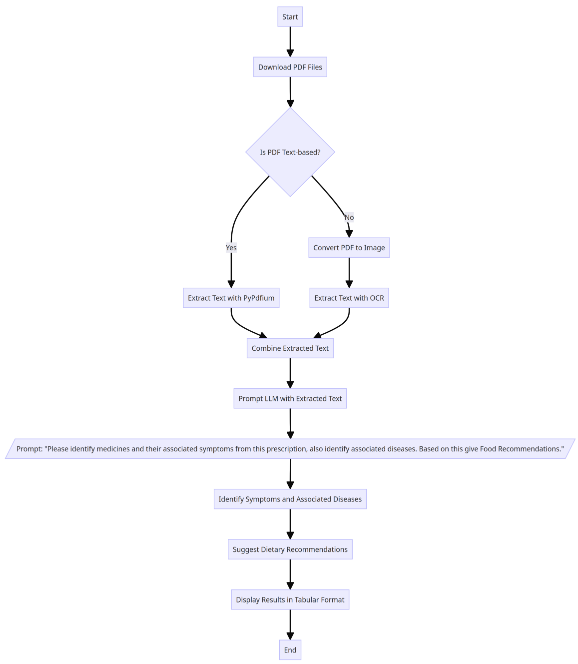

Figure 1: System Block Diagram

6 Methodology

6.1 Text Extraction

First, we use PyPdfium to see if text can be extracted from the PDF format. If text cannot be extracted, then we convert the PDF into an image format and utilize OCR to extract the text. We observed that non pre-processed text captured more medicines than pre-processed text. Extracted text is then concatenated into a String to be sent to the LLM.

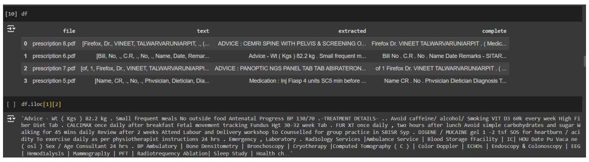

Figure 2: Sample of extracted text from multiple prescriptions(above) and data frame showing complete extracted text of one prescription(below)

6.2 Identifying Diseases

Next, we utilize the text alongside a LLM to identify the medicines prescribed in the text. We also identify what symptoms the medicines could be associated to and what disease the medicines could be associated to.

Medicine	Associated Symptoms
Abiraterone	Nausea, vomiting, diarrhea, fatigue, back pain
Wysolone	Weight gain, fluid retention, increased blood sugar
Zoledronic acid	Nausea, vomiting, diarrhea, bone pain
Calcitonin	Nausea, vomiting, diarrhea, constipation
Calcium	Constipation, gas, bloating, upset stomach
Ultracet	Nausea, vomiting, constipation, dizziness

Associated diseases:

- Prostatic Acinar Adenocarcinoma
- Bone metastases
- Urinary retention

Figure 3: Medicine Identification Example

6.3 Diet Recommendations

Finally, we use the diseases extracted to suggest dietary recommendations that a patient can use to better their lifestyle.

Food Recommendations:

- **For nausea and vomiting:** Eat small, frequent meals. Avoid greasy, spicy, or acidic foods. Drink plenty of fluids to stay hydrated.
- **For diarrhea:** Eat bland foods such as rice, oatmeal, or bananas. Avoid dairy products, caffeine, and alcohol.
- **For constipation:** Eat foods high in fiber, such as fruits, vegetables, and whole grains. Drink plenty of fluids to stay hydrated.
- **For weight gain:** Eat a healthy diet that is low in calories and fat. Avoid sugary drinks and processed foods.
- **For fluid retention:** Limit your intake of sodium and fluids. Avoid salty foods and caffeinated beverages.
- **For increased blood sugar:** Eat a diet that is low in carbohydrates and sugar. Monitor your blood sugar levels regularly.
- **For bone pain:** Eat foods that are high in calcium and vitamin D, such as dairy products, leafy green vegetables, and fish.

Figure 4: Food Recommendation Example

7 Results and Discussion

The system successfully implemented the OCR functionality to read both text-based and image-based medical prescriptions. The text extracted from these prescriptions was then processed to identify keywords related to medications and advice. LLMs were used for diagnosing diseases from the prescriptions and recommend appropriate diets.

8 Challenges Encountered

- **Lack of API**: A lot of medical based LLMs lack any API to use them, as such we are required to load the models which in Colab with its limited RAM is not possible.
- **Digital Prescription**: For this project, we have only used digital prescriptions and no handwritten prescriptions.
- **OCR Accuracy**: Ensuring accurate text extraction from diverse formats and varying quality of medical prescriptions.
- **Supported Language** : Our model only supports prescriptions in English language.
- **Disease Classification**: Correctly identifying diseases based on prescription text.
- **Dietary Recommendations**: Tailoring dietary suggestions to individual patient needs based on their diagnosed conditions, lack of diet filters to select what type of food the user wants to avoid (i.e lactose-free, gluten-free, nut-free diets and so on).

9 Conclusion

This project demonstrates the potential of integrating OCR technology, and LLMs to develop a system that can read medical prescriptions, diagnose diseases, and recommend dietary changes. Future work includes improving the accuracy of each component and expanding the system to cover a broader range of diseases and dietary recommendations.

By leveraging the power of OCR and machine learning, this system can contribute significantly to personalized healthcare, helping individuals make informed decisions about their diet and lifestyle to promote better health and well-being

10 Personal Experience

- **@Rishabh**: "During emergencies or whenever the doctors are busy, when a patient asks to be treated they are sometimes given a prescription without any further instructions(Especially at over-worked, understaffed

Govt. Hospitals). This may benefit the patient in the short term but if they don't change their diet, their symptoms are likely to occur again. The idea behind this project is to build a model that can recommend changes in the diet based upon a prescription. This way the patient doesn't have to come again and again to the hospital for the same prescription."

- **@Suraj**: "Doctors play a critical role in shaping the mental well-being of the patient they are treating - from understanding their condition to evaluating possible treatment options. Inspite of their Hippocratic Oath, not all doctors are immune to temptations of personal gain and business driven goals to misrepresent the seriousness of a condition and fear-monger the patient into availing their prescribed treatment. Often this traumatizes the patient and leads to a condition called 'White-collar fear', leading to them avoiding doctors in general which could have severe repercussions. This project aims to provide an unbiased, incorruptible oracle of information which empowers patients by giving them the chance to get diet recommendations from the comfort and privacy of an application."

- **@Tanushi**:"I had suffered from dengue fever and as my platelet count dropped, I faced frequent changes in medication and dietary restrictions. I was so bored of eating the same kind of food daily and in such a scenario, having a system that provides varied dietary recommendations would have undoubtedly eased my situation. Such a system can also be helpful for patients with chronic diseases to minimize their visits to the dietician for constant monitoring of their diet. And, it is not just about helping patients. It would also significantly reduce the burden on healthcare professionals by automating mundane jobs like reading prescriptions and providing dietary guidance, freeing up their time to focus on more complex cases, thereby improving overall efficiency of the healthcare sector."

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