AUTOMATED MEDICINE BILLING WITH IMAGE RECOGNITION

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "AUTOMATED MEDICINE BILLING WITH IMAGE RECOGNITION", submitted by Mohammad Ullah and Sayed Nahid to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 14th July 2024.

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We hereby declare that this project has been done by us under the supervision of **Mohammad Jahangir Alam, Lecturer (Senior Scale), Department of Computer Science and Engineering, Daffodil International University**. We also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

This research aims to revolutionize the manual billing processes in pharmacies through an innovative system leveraging image recognition technology. By using a strategically placed camera, the system captures images of prescribed medications and employs advanced Convolutional Neural Networks (CNNs) to accurately identify key details such as drug names, dosages, and quantities. This extracted information is seamlessly integrated into the pharmacy's existing billing software, thereby automating the billing process and calculating costs with precision. The automation eliminates the need for manual data entry, significantly reducing errors and enhancing operational efficiency. Moreover, the system securely stores both the medication images and the corresponding billing records in a database, ensuring data integrity and providing easy access for future reference. This approach not only speeds up the billing process but also ensures secure and accurate bill printing, contributing to a faster, more precise, and user-friendly pharmacy experience for patients and staff alike. The project ultimately aims to transform pharmacy operations, enabling staff to focus more on customer care rather than administrative tasks and enhancing the overall quality of healthcare delivery. By addressing the limitations of traditional manual billing methods, this system represents a significant step forward in creating a streamlined and efficient healthcare environment.

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LIST OF ACRONYMS

ML	Machine Learning
OCR	Optical Character Recognition
DL	Deep Learning
AI	Artificial Intelligence
DB	Database
UI	User Interface
UX	User Experience
GPU	Graphics Processing Unit
RNN	Recurrent Neural Network
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
REST	Representational State Transfer
SQL	Structured Query Language
MVT	Model-View-Template
HTTPS	HyperText Transfer Protocol Secure
URL	Uniform Resource Locator
DBMS	Database Management System
JS	JavaScript
CSS	Cascading Style Sheets
HTML	HyperText Markup Language
RAM	Random Access Memory
SSD	Solid State Drive
CLI	Command Line Interface
API	Application Programming Interface
SVM	Support Vector Machine
CNN	Convolutional Neural Network

CHAPTER 1

INTRODUCTION

1.1 Overview

This research addresses the inefficiencies of manual medication billing in pharmacies by introducing an innovative system that uses image recognition technology. Strategically placed cameras capture images of prescribed medications, which are then processed through advanced algorithms and Convolutional Neural Networks (CNNs) to extract crucial details such as drug names, dosages, and quantities. This extracted information is seamlessly integrated into the pharmacy's existing billing software, automating the billing process and significantly reducing the need for manual data entry. By streamlining the billing workflow, the system not only enhances efficiency but also minimizes errors, improving accuracy and reliability. Furthermore, the system ensures data integrity by securely storing medication images and billing records in a centralized database, allowing for easy access and future reference. This approach transforms the pharmacy experience by providing quicker, more accurate service and reducing the administrative burden on staff, allowing them to focus more on patient care. Overall, this project aims to revolutionize pharmacy operations, contributing to a more efficient and user-friendly healthcare environment.

1.2 Background and Present State

The traditional process of medication billing in pharmacies often relies on manual entry methods, which are prone to errors and inefficiencies. This manual approach can lead to inaccuracies in drug identification, dosage, and quantity, impacting patient safety and operational efficiency. As pharmacies strive for more precise and streamlined operations, the integration of advanced technologies such as image recognition has emerged as a promising solution. Image recognition technology utilizes sophisticated algorithms and Convolutional Neural Networks (CNNs) to accurately identify and extract key details from images of prescribed medications. By automating the billing process through image recognition, pharmacies can reduce errors, enhance accuracy, and improve the overall speed of transactions. This approach not only supports regulatory compliance but also enhances patient satisfaction by ensuring timely and accurate medication dispensing. Moreover, the secure storage of medication images and billing records in centralized databases ensures data integrity and facilitates easy access for audits and compliance checks. The adoption of image recognition technology in pharmacy billing represents a significant advancement towards achieving operational excellence and delivering high-quality patient care in modern healthcare environments.

1.3 Problem Statement

Manual medication billing processes in pharmacies are plagued by inefficiencies and inaccuracies, stemming from the reliance on traditional methods of data entry. These manual processes often lead to errors in drug identification, dosage recording, and quantity management, posing significant risks to patient safety and operational efficiency. The need for a more streamlined and error-free billing system is critical to ensure timely and accurate medication dispensing while maintaining compliance with regulatory standards. To address these challenges, this project aims to implement an innovative solution using image recognition technology. By automating the medication billing process through advanced algorithms and Convolutional Neural Networks (CNNs), the project seeks to enhance the accuracy, efficiency, and reliability of pharmacy operations. The integration of image recognition technology is expected to minimize errors associated with manual data entry, improve billing accuracy, and optimize workflow efficiency, ultimately contributing to a safer and more efficient healthcare environment.

1.4 Objectives

There are various issues with the manual pharmaceutical invoicing procedure that pharmacies currently employ. Due to human data entry, the process is often slow and prone to errors, leading to extended patient wait times, inaccuracies in medication, and decreased staff productivity. Additionally, individuals with vision impairments or other disabilities face challenges in using traditional methods of reading pharmaceutical labels. The need for a pharmaceutical billing system that is more accessible, accurate, and efficient has spurred this initiative. We believe that picture recognition technology can potentially address these issues by:

- Automating Data Entry: Implementing an image recognition system to automate the entry of medication details into the billing system, thereby reducing processing time and minimizing errors associated with manual input.

- Enhancing Accuracy: Utilizing advanced image analysis to accurately identify pharmaceuticals based on captured images, ensuring precise billing information and reducing the risk of medication errors.

- Improving Accessibility: Introducing touchless interfaces and image recognition capabilities to cater to diverse user needs, including individuals with visual impairments or disabilities, thereby enhancing accessibility and usability of the billing system.

- Increasing Efficiency: Streamlining pharmacy operations by speeding up the billing process, allowing pharmacists to allocate more time to patient care and enhancing overall staff productivity.

- Ensuring Data Security: Implementing secure storage protocols for medication images and billing records to maintain data integrity and facilitate easy access for audits and compliance checks.

- Advancing Technological Integration: Integrating the image recognition system seamlessly into existing pharmacy software to enhance overall system functionality and compatibility with current healthcare technology standards.

1.5 Scope and Limitations

1.5.1 Scope

There are several challenges associated with the manual pharmaceutical invoicing process currently used in pharmacies. Human data entry often results in delays, errors, and reduced staff productivity, impacting patient wait times and medication accuracy. Moreover, individuals with vision impairments or disabilities encounter difficulties with traditional methods of reading pharmaceutical labels. The need for a more accessible, accurate, and efficient pharmaceutical billing system has driven this initiative. Leveraging picture recognition technology, the project aims to address these issues by:

- Automating Data Entry: Implementing an image recognition system to automate medication details entry into the billing system, reducing processing time and minimizing manual input errors.

- Enhancing Accuracy: Utilizing advanced image analysis to precisely identify pharmaceuticals from captured images, ensuring accurate billing information and reducing medication errors.

- Improving Accessibility: Introducing touchless interfaces and image recognition capabilities to meet diverse user needs, including those with visual impairments, thereby enhancing accessibility and usability of the billing system.

- Increasing Efficiency: Streamlining pharmacy operations by accelerating the billing process, enabling pharmacists to focus more on patient care and enhancing overall staff productivity.

- Ensuring Data Security: Implementing secure storage protocols for medication images and billing records to uphold data integrity and facilitate easy access for audits and compliance checks.

- Advancing Technological Integration: Seamlessly integrating the image recognition system into existing pharmacy software to improve overall system functionality and align with current healthcare technology standards.

1.5.2 Limitations

Despite its benefits, the project faces several limitations:

- Dependency on Image Quality: The effectiveness of the image recognition system may be influenced by factors such as image clarity, lighting conditions, and camera resolution.

- Integration Challenges: Integrating the system with current pharmacy software and infrastructure may pose technical challenges and require adjustments for seamless operation.

- Cost Considerations: Implementing advanced image recognition technology involves initial setup costs for hardware and software, as well as ongoing maintenance expenses.

- Regulatory Compliance: Ensuring compliance with healthcare regulations and data protection laws adds complexity to the development and deployment of the system.

- User Acceptance: Pharmacy staff may require training and adjustment periods to effectively utilize the new system, impacting its adoption and success.

1.6 Report Organization

This section outlines the structure of the report on the development of an automated medicine billing system using image recognition technology. The report is methodically organized into several key chapters, each focusing on distinct aspects of the project. This structure ensures a thorough understanding of the research, development, and implementation process, guiding readers from the conceptual framework to the practical implications and societal impact of the system.

Chapter 1: Introduction

The introductory chapter sets the stage for the project by presenting an overview of the challenges in the current manual medication billing process in pharmacies. It articulates the motivations behind developing an automated billing system, defines the problem statement, and clearly outlines the objectives of the research. This chapter aims to highlight the significance of adopting advanced technologies in improving pharmacy operations and patient care, thus framing the context for the subsequent sections of the report.

Chapter 2: Literature Review

This chapter provides a comprehensive examination of existing literature and previous studies pertinent to the project. It delves into the inefficiencies and limitations of traditional pharmaceutical billing systems and explores recent advancements in image recognition technology. By synthesizing these findings, the review establishes a theoretical foundation for the project and identifies specific gaps in current solutions that the proposed system aims to address. This chapter not only justifies the necessity of the research but also aligns it with broader technological trends and innovations in the field of healthcare.

Chapter 3: Methodology

The methodology chapter outlines the systematic approach adopted to develop and evaluate the automated billing system. It describes the overall system architecture, the image recognition algorithms employed, and the process of integrating these technologies into existing pharmacy workflows. Detailed descriptions of the data collection methods, system design, and the experimental setup are provided, ensuring transparency and reproducibility of the research. This chapter serves as a blueprint for understanding how the theoretical concepts are practically applied to create a functional system.

Chapter 4: Implementation

This section delves into the technical aspects of the project, offering a detailed account of the system's implementation. It discusses the setup of hardware components such as cameras and servers, the development of software for image processing and data extraction, and the integration with pharmacy billing software. Each step of the implementation process is elaborated upon, including challenges encountered and solutions devised. This chapter aims to provide a clear and comprehensive understanding of how the system was brought to life from concept to reality.

Chapter 5: Result and Analysis

The results and analysis chapter presents the outcomes of implementing and testing the automated billing system. It includes quantitative performance metrics, accuracy rates, and comparative analyses with traditional billing methods. Visual representations such as graphs and tables are used to illustrate the system's effectiveness and reliability. This section critically evaluates whether the system meets its defined objectives and examines the impact of image recognition technology on enhancing the efficiency and accuracy of pharmaceutical billing.

Chapter 6: Impact on Society, Environment, and Sustainability

This section explores the broader societal, environmental, and sustainability impacts of the automated billing system. It discusses how the system can improve healthcare accessibility and efficiency, potentially reducing waiting times and enhancing patient experiences. The environmental impact is considered in terms of reducing paper usage and streamlining resource allocation. The sustainability aspect focuses on the system's long-term viability and its alignment with sustainable development goals, particularly in the context of evolving healthcare needs and technological advancements.

Chapter 7: Conclusion and Future Work

The concluding chapter synthesizes the key findings and contributions of the project. It summarizes the system's benefits in automating pharmacy billing processes and its potential to enhance patient care and operational efficiency. The chapter discusses the broader implications of the research and offers practical recommendations for implementing the system in real-world pharmacy settings. Additionally, it outlines areas for future research, suggesting directions for further exploration and development to build upon the current study's findings and address any unresolved challenges.

1.7 Summary

This project focuses on developing an automated medicine billing system using image recognition technology to improve the traditional manual invoicing process in pharmacies. Manual billing is often slow, error-prone, and can decrease staff productivity while posing challenges for visually impaired individuals who struggle to read pharmaceutical labels. The proposed system addresses these issues by utilizing cameras to capture images of prescribed medications. Advanced algorithms analyze these images to extract critical details such as drug names, dosages, and quantities. The system also ensures secure storage of medication images and billing records, aiding in audits and compliance checks. By streamlining the billing process, this system aims to alleviate the workload on pharmacy staff and improve the patient experience through shorter wait times and fewer medication errors. Despite challenges like dependency on image quality and initial setup costs, the project promises significant improvements in efficiency and accessibility in pharmacy operations, aligning with modern healthcare technology standards.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

A comprehensive literature review had to be conducted for the dual objective of understanding the existing landscape of our current goal and grasping the various approaches that can provide valuable insight towards establishing our final objective. The literature review was methodical while employing standards that suit the purpose of identification of related works and their analysis. The literature review provided the solid foundation to develop the final project.

Our main purpose for the literature review was to gather the existing knowledge on the subject matter by analyzing the methodologies alongside the strengths and weaknesses of previously done theoretical works. It also gave us the opportunity to collect new ideas and explore the gaps left behind. We have searched for recent works using our systematic search strategies which consisted of using various databases and search engines to gather studies that were related to our scope. We have utilized several keywords such as “automated billing”, “image recognition”, “object recognition” and “object identification” to identify if the study was constructive towards our purpose.

2.2 Related Works

We have found multiple studies that have previously worked with the concept of automatic billing incorporated by machine learning and artificial intelligence. Some of the studies have pitched the idea of an automated billing system that does not rely on the old method of using barcodes and OCR, instead they propose the idea of identifying items using object recognition algorithms of machine learning. These studies suggest using a type of Artificial Neural Network to detect and identify objects produce the best accurate results amongst other machine learning algorithms. Shakshi Neha, Saveta K. et al. [1] proposed "Image Processing Based Billing System with Edge Computing” in 2020. In this paper Image Detection based billing system offers a practical solution to the inefficiencies of manual billing in local C-shops. While advanced OCR-based systems exist, they are often costly and complex. Leveraging edge computing and computer vision, this system uses simple camera devices like mobile phones to accurately identify products and assign prices based on size, achieving 90% precision. Developed as a web application, it enhances accessibility and usability, addressing the specific needs of small-scale retailers and streamlining billing processes effectively.

A.Vennila, S.B. et al.[2] proposed "Image recognition based billing system for fruit shop using raspberry PI" in 2020. They introduce an automated fruit billing system for retail settings, utilizing a smart billing system to identify and categorize fruits for accurate bill calculation based on type and quantity. Employing image processing and a load cell for weight measurement, along with an SVM classifier, the system effectively analyzes and classifies fruits, ensuring accurate billing.

Dr. Murugan, Sindhu S. et al. [3] came up with a solution titled "IMAGE PROCESSING BASED BILLING STRUCTURE USING EDGE COMPUTING AND REACTJS" in 2022 where the idea is an image processing-based billing system leveraging edge computing to address manual billing challenges encountered in remote shops lacking advanced technology. The system utilizes simple camera devices, such as mobile phones, integrated with IBM cloud's visual recognition tool to swiftly and accurately identify products. A notable feature is its ability to differentiate between products based on size, ensuring accurate billing even with multiple product variations. Achieving a 90% precision in object detection, the system is developed as a web application, offering a comprehensive solution for billing in local C-shops.

S Nagaraj, Satendra Pratap S. et al. [4] Presentants a solution called "Automatic Billing System using Resnet and Image AI" in 2021 and they said in the age of automation Industries are embracing automation and robotics to modernize their operations, aiming to decrease manufacturing costs, expedite processes, and reduce reliance on manual labor. In retail environments, long queues at billing counters often result from inefficient manual entry of product details for generating receipts. To address this, we propose an automated billing system capable of calculating total amounts without relying on cloud servers or internet connectivity. Utilizing edge computing, our system emphasizes local processing over internet dependence. We implement image classification techniques, including residual networks and Image AI, to accurately identify products based on dimensions and color, enhancing efficiency in retail transactions.

"Computer vision based automated billing system for fruit stores" by M. Sugadev, K.S. et al. [5] published in ICSSIT 2020. The paper introduces an innovative billing system for fruit retail outlets, which surpasses traditional methods in terms of precision and speed. The proposed system utilizes deep learning neural networks to classify fruits and strain gauge load cells to gauge their weight accurately. By processing input images in clusters and utilizing a Raspberry Pi board with TensorFlow and OpenCV libraries, the system efficiently identifies fruits like Apples and Bananas, computes their weights in grams, determines total costs, and generates itemized bills.

2.3 Comparison between existing works

In examining existing research pertinent to our project on "Automated Medicine Billing with Image Recognition," a spectrum of methodologies has been employed, showcasing a blend of traditional and modern techniques. These include established methods like Scale-Invariant Feature Transform (SIFT), Local Binary Patterns (LBP), and Weber Local Descriptor (WLD), alongside state-of-the-art deep learning architectures such as Convolutional Neural Networks (CNN) and Deep Belief Networks (DBN). Moreover, machine learning algorithms like K-Nearest Neighbor (KNN) and Support Vector Machines (SVM) are also prevalent in the literature. A meticulous comparison among these approaches reveals nuanced disparities across key dimensions critical to our research objectives. Notably, variations in accuracy, robustness to image variations, computational efficiency, and scalability are apparent. These factors hold significant implications for the development of an optimal automated medicine billing system tailored to our project's aims and requirements. Through a comprehensive examination of existing methodologies, we aim to distill insights that will inform our approach and contribute to the advancement of automated billing solutions in pharmacy settings.

Table 2.3.1. Comparative analysis with previous work

SL No	Author Name	Used Algorithm	Best Accuracy with Algorithm
1.	Shakshi Neha, Saveta K. et al. [1]	CNN, SqueezeNet, ResNet	SqueezeNet=90 %
2.	A.Vennila, S.B. et al. [2]	SVM, K-Nearest Neighbour, Decision Trees, Artificial Neural Networks and Convolutional Neural Networks	SVM= 89%
3.	Dr. Murugan, S. et al. [3]	CNN, ANN, SVM	CNN=90%
4.	Nagaraj, S. et al. [4]	SVM, Random Forest, Logistic regression, Naïve Bayes	______
5.	M. Sugadev, K.S. et al. [5]	SVM, Local binary pattern, Histogram, SURF, ANN, PNN	PNN=84.4%
6.	R.Patil, Alim B. et al. [6]	YOLO, CNN, KNN	CNN=90%
7.	Lee, Chang et al. [7]	Neural Network	Neural Network = 84.66%
8.	Nitish L, Dr. P. Kumar et al. [8]	CNN, SVM	CNN=80.51%
9.	Suraj C, Prof. S. P. et al. [9]	CNN, KNN, SVM	CNN=74.2%

2.4 Open Issues

While significant strides have been made in automating medicine billing through image recognition, several critical gaps persist that require targeted attention. Notably, the current landscape lacks robust feature extraction techniques adept at accurately capturing and processing essential medication attributes from images. There is a pressing need for the development of more sophisticated algorithms capable of precisely identifying drug names, dosages, and quantities to enhance billing accuracy. Additionally, existing classification algorithms tailored for medication billing tasks are lacking, highlighting the necessity for optimized algorithms to improve system efficiency and effectiveness. Addressing scalability concerns is vital for seamless integration into pharmacy workflows and meeting increasing demands. Furthermore, enhancing robustness to environmental variations, such as lighting conditions and image distortions, remains a key priority. Rectifying these gaps is crucial for advancing automated medicine billing systems, fostering their accuracy, efficiency, and adaptability.

2.5 Summary

In summary, our investigation into automated medicine billing with image recognition has revealed a spectrum of methodologies utilized in existing research. From traditional techniques like Scale-Invariant Feature Transform (SIFT) and Local Binary Patterns (LBP) to advanced deep learning architectures such as Convolutional Neural Networks (CNN) and Deep Belief Networks (DBN), alongside machine learning algorithms like K-Nearest Neighbor (KNN) and Support Vector Machines (SVM), the literature demonstrates a rich landscape of approaches. Despite the progress showcased by these methodologies, critical disparities persist across dimensions crucial to our project's objectives, including accuracy, robustness to image variations, computational efficiency, and scalability. These insights underscore the necessity for further exploration and innovation to address these gaps and challenges, ultimately paving the way for the development of an optimal automated medicine billing system tailored to our research aims.

CHAPTER 3

METHODOLOGY

3.1 Overview

This project focuses on the development of a cutting-edge system designed to automate the billing process for medications in pharmacies using image recognition technology. The primary objective is to enhance the efficiency and accuracy of billing operations while maintaining cost-effectiveness, making it accessible even for smaller pharmacies. By leveraging advanced image processing techniques and deep learning models, the system aims to streamline the extraction of crucial medication details such as drug names, dosages, and quantities directly from captured images. These details are then integrated seamlessly into the pharmacy's billing software, eliminating manual data entry and significantly reducing the likelihood of errors. The project encompasses a comprehensive methodology, including data collection, model training, backend development, and frontend integration, ensuring a robust and user-friendly solution. Through this innovative approach, the project aspires to revolutionize pharmacy operations, providing a quicker, more precise, and more accessible billing process that ultimately contributes to a more efficient healthcare environment.

3.2 Proposed Methodology

Our proposed methodology and system design overview is shown in Figure 3.2.1: System Design Overview. Our proposed system methodology and design will consist of these parts

1. Data collection and Model training
2. Backend implementation with the trained model
3. Frontend implementation for the Backend

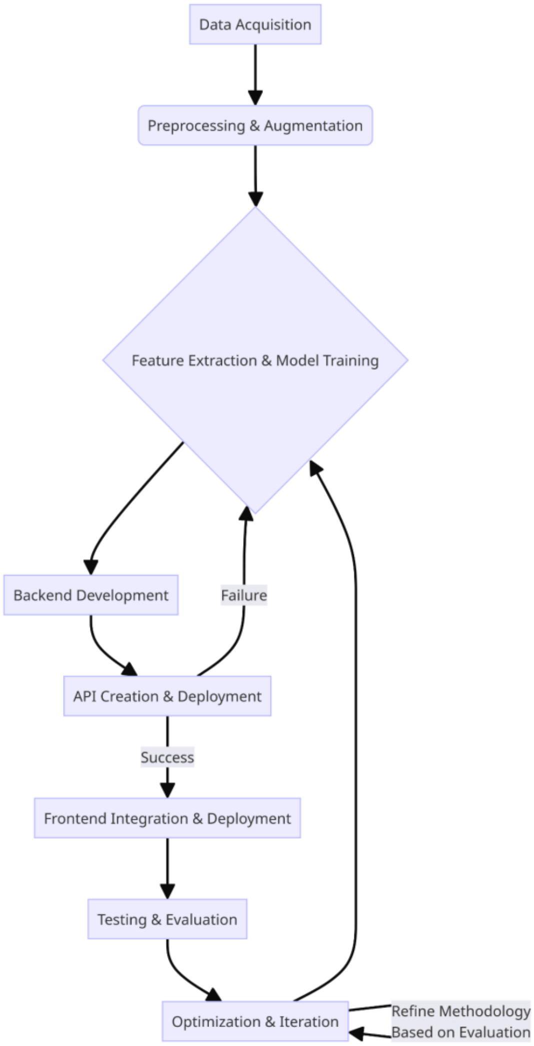

Figure 3.2.1: System Design Overview

3.2.1 Data Collection and Model Training

Data collection was done by our team selecting samples from the web and collecting high quality images for most purchased drugs and pharmaceutical items. The process of data collection is detailed in the next section. After collecting the data, we had to thoroughly preprocess them before applying the model for training. For training we have used different deep learning methods such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) alongside the traditional Optical Character Recognition and Rule based systems matching. In the training Deep Learning models provide a better result as traditional approaches many times fail to deliver proper outputs. We then also tried to optimize the models by changing hyperparameters such as network architecture and learning rate of the algorithms for best performance. We have also used transfer learning methods to train over a large pretrained model and then fine-tuning them to get better results.

3.2.2 Backend Implementation

Our backend has been implemented with the popular python Django web framework. Django provides a simple and easy to use framework to create a backend for our project. Our backend architecture overview is illustrated in Figure 3.3.2. We have created a Django server with database models and REST API endpoints to interact with our Machine Learning Model. The Django server will handle both the object detection using our machine learning model and handle bill calculation. For the bill calculation and inventory management we have used a separate MySQL database which will store the inventory, price and other data.

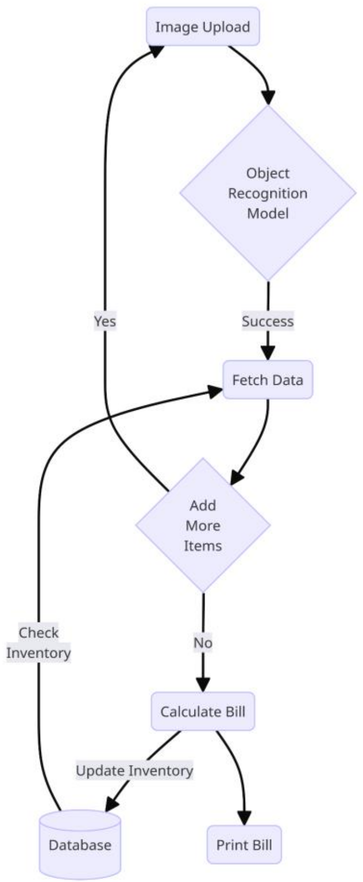

Figure 3.2.2: Backend Architecture with Database

3.2.3 Frontend Implementation

The frontend of the system was designed to provide an intuitive and user-friendly interface for pharmacy staff. It facilitates the easy capture and submission of medication images for processing. The frontend communicates with the backend through API calls, sending image data to the server and retrieving processed billing information. This interaction ensures that the entire billing process, from capturing medication images to generating accurate bills, is streamlined and efficient. The user interface was crafted to be accessible and straightforward, allowing pharmacy staff to focus on patient care while the system handles the intricacies of billing and data management.

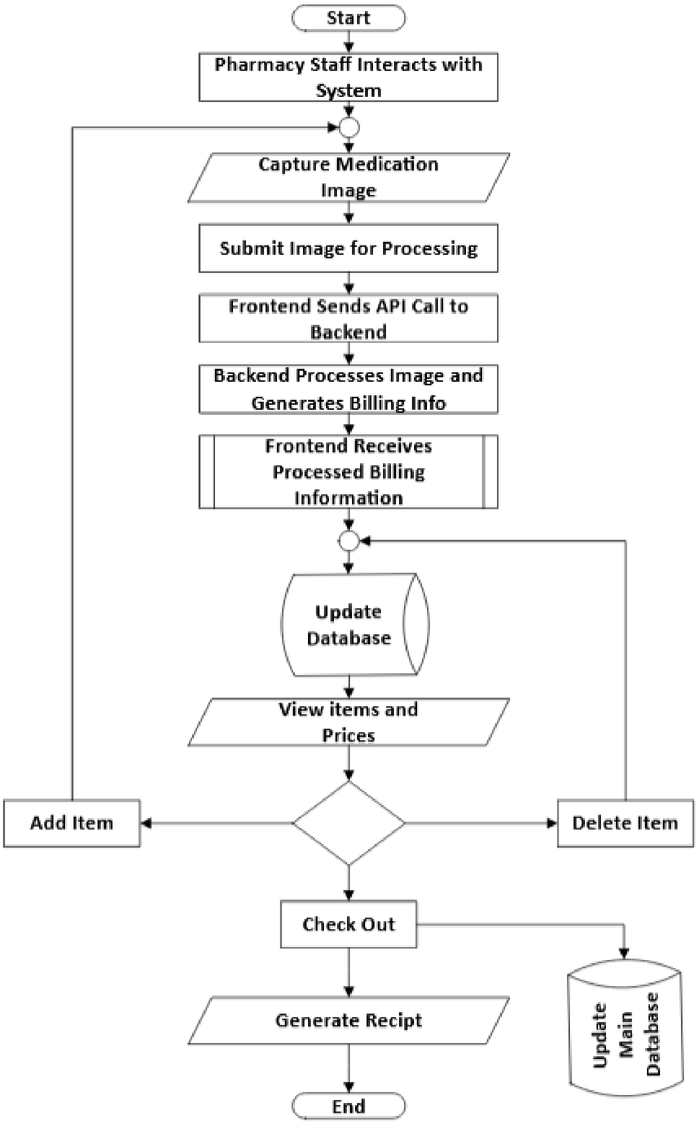

Figure 3.2.3: Frontend Architecture

3.3 Hardware/ Software Requirement

To implement the automated medication billing system using image recognition technology, the following hardware and software components are essential.

3.3.1 Hardware Requirements

1. High-Resolution Camera:
   - Details: Capable of capturing clear images of medication labels with a resolution of at least 1080p.
   - Purpose: To accurately capture medication details for processing.
2. Processing Unit:
   - Details: A powerful computer with a multi-core CPU, a high-performance GPU (e.g., NVIDIA RTX 2080), 16 GB RAM, and 500 GB SSD.
   - Purpose: To efficiently process and analyze images using deep learning algorithms.
3. Database Server:
   - Details: Server with a multi-core CPU, 32 GB RAM, and 1 TB storage.
   - Purpose: To store and manage medication images and billing records securely.
4. Networking Equipment:
   - Details: Reliable Gigabit Ethernet and secure Wi-Fi.
   - Purpose: To facilitate fast and secure data transfer within the system.

3.3.2 Software Requirements

1. Operating System:
   - Details: Windows 10/11 or Linux (Ubuntu 20.04 LTS or newer).
   - Purpose: To provide a stable environment for system operations.
2. Image Recognition Software:
   - Details: Tools like OpenCV for image processing and TensorFlow/Keras for deep learning.

- Purpose: To extract and analyze information from captured images.

3. Backend Framework:
   - Details: Django framework for server-side logic and RESTful API development.
   - Purpose: To manage data processing and integration with the frontend and database.
4. Database Management System:
   - Details: MySQL or PostgreSQL.
   - Purpose: To ensure secure and efficient data storage and retrieval.
5. Front End Development Tools:
   - Details: HTML, CSS, JavaScript, and React.js.
   - Purpose: To create a user-friendly interface for pharmacy staff.
6. Development Environment:
   - Details: IDEs like Visual Studio Code or PyCharm.
   - Purpose: To facilitate software development and debugging.
7. Security Software:
   - Details: Firewalls, antivirus, and SSL certificates.
   - Purpose: To protect the system from security threats.

3.4 Project Management and Financial Analysis

Effective project management and financial planning are crucial for the success of our automated medication billing system using image recognition technology. Here’s how we have managed the project and finance.

3.4.1 Project Management

1. Planning and Scheduling: We began by developing a comprehensive project plan that laid out clear milestones for each phase of the project, including hardware setup, software development, machine learning model training, and system integration. A Gantt chart was employed to visually map the timeline and track the progress of various tasks, ensuring that we met our deadlines and

maintained a steady workflow

2. Resource Allocation: To maximize efficiency, we strategically assigned our self with relevant expertise to specific tasks. This included specialists in web development for building the Django-based site, data scientists for training and optimizing machine learning models, and project managers for overseeing the overall process. Technical resources were allocated to support the backend infrastructure and to handle the computational demands of our machine learning models.
3. Risk Management: We proactively identified potential risks that could impact the project, such as data inconsistencies, integration challenges, or unexpected technical issues. For each risk, we crafted mitigation strategies to minimize their impact. Regular risk assessments and contingency planning ensured that we were prepared to address any issues that arose promptly.
4. Quality Assurance: Maintaining high-quality standards was a priority throughout the project. We conducted thorough testing at every stage, including unit tests for individual components, integration tests to ensure smooth operation between the web interface and machine learning models, and user acceptance tests to confirm the system met the users' needs. This multi-layered approach to quality assurance helped us identify and resolve issues early, ensuring a reliable final product.
5. Communication and Collaboration: Effective communication and collaboration were central to our project’s success. We held regular team meetings to review progress, address any challenges, and realign our strategies as needed. Project management tools like Trello and Slack were utilized to streamline communication, manage tasks, and facilitate teamwork, ensuring that everyone stayed informed and engaged.

3.4.2 Risk Analysis

We have assessed the Strengths, Weaknesses, Opportunities and Threats for this project. Here is a SWOT analysis for the Automated Medicine billing with Image Recognition.

Figure 3.3.1: SWOT Analysis

3.4.2 Financial Analysis

Financial management was crucial to keep the project within budget. We developed a detailed budget plan that accounted for all expenses, including hardware, software, and personnel costs. We continuously monitored expenditures to ensure that we stayed within our financial limits and explored various funding opportunities to support the project. Regular financial reports were prepared to track spending and provide insights into our financial status, ensuring transparency and accountability. The table below shows our cost analysis for this project.

Table 3.4.1. Financial Cost Analysis

SN	Components	Estimated Cost (BDT)
01.	Software Tools and Equipment	1500 - 2000
02.	Servers and Hardware	3000 - 4500
03.	Data Collection and Processing	2500 - 3500
04.	Documentation and Report Writing	500 - 1000
05.	Market Survey and Promotion	2000 - 3000
06.	Miscellaneous (e.g., licenses, domain, certificates)	500 - 1000

07.	Contingency (10% of total)	1000 – 1500
Total Estimated Cost		11,000 – 16,500

3.5 Summary

The methodology for this project outlines a comprehensive approach to creating an automated medication billing system that leverages image recognition technology. The initial phase involves gathering and preparing a diverse dataset of high-quality images of frequently used medications. These images undergo preprocessing to ensure clarity and consistency, forming the foundation for training a sophisticated Convolutional Neural Network (CNN) model. This model benefits from transfer learning techniques, allowing it to build on pre-existing knowledge to achieve higher accuracy in recognizing medication details.

For the backend implementation, we use the Django framework, which facilitates the seamless integration of our trained CNN model. This backend manages not only the image recognition process but also handles billing computations and inventory management. A MySQL database supports these functions by storing crucial data related to inventory, pricing, and billing records.

The frontend of the system is designed with a focus on user-friendliness and efficiency. It enables users to easily upload medication images, which are then processed by the backend to generate billing information instantly. This interface communicates with the backend through RESTful API endpoints, ensuring smooth and reliable operations.

Testing and validation play a critical role in our methodology, ensuring that the system performs accurately and reliably under various conditions. Security measures are implemented to protect data and maintain compliance with privacy standards. Overall, the methodology provides a clear and effective pathway to developing a system that significantly enhances the efficiency and accuracy of pharmacy operations through advanced image recognition technology.

CHAPTER 4

IMPLEMENTATION

4.1 Overview

The project implementation integrates Django web development with advanced machine learning models to streamline medication billing in pharmacies. We built a user-friendly web application using Django, facilitating secure inventory management, medication data entry, and bill generation. To automate data extraction, we trained Convolutional Neural Networks (CNNs) for medication identification and utilized an object detection model for segmenting and counting the number of pills. These models, optimized with hyperparameter tuning and transfer learning, are integrated into the Django framework via a RESTful API. They process uploaded images to extract and auto-fill details like drug names, dosages, and quantities. Extensive testing, including unit, integration, and user acceptance tests, ensured system accuracy and reliability. The final application, deployed on a cloud server, offers scalable and secure access, significantly enhancing pharmacy operations by reducing manual entry errors and increasing efficiency. Future improvements could include expanding the system's recognition capabilities and integrating it with electronic health records for a more comprehensive healthcare solution.

4.2 Train Model

The integration of machine learning into our Django application centers around using a Convolutional Neural Network (CNN) for medication identification and an object detection model for segmenting and counting pills. This section provides an in-depth explanation of the CNN architecture, data preprocessing and augmentation techniques, training process, hyperparameter tuning, and transfer learning implementation. Additionally, it details the object detection model's architecture and training, emphasizing how these models work together to automate the extraction of medication details from images.

4.2.1 CNN Architecture

The Convolutional Neural Network (CNN) utilized in our project is designed to effectively classify medication images by extracting and learning from visual features. Figure 4.2.1 provides a basic visualization or the CNN architecture which is sequential and includes the following layers:

- **Convolutional Layers**: Three convolutional layers with increasing filter sizes (32, 64, and 128 filters) and a kernel size of 3x3. These layers are responsible for detecting features such as edges, textures, and patterns within the images.
- **Pooling Layers**: Each convolutional layer is followed by a max pooling layer with a pool size of 2x2, which reduces the spatial dimensions of the feature maps, thereby retaining essential information while reducing computational complexity.
- **Flatten Layer**: This layer converts the 2D feature maps into a 1D feature vector, preparing the data for the fully connected layers.
- **Fully Connected Layers**: Includes a dense layer with 128 neurons and a dropout rate of 0.5 to prevent overfitting. The final dense layer uses a softmax activation function to output probabilities for each medication class.

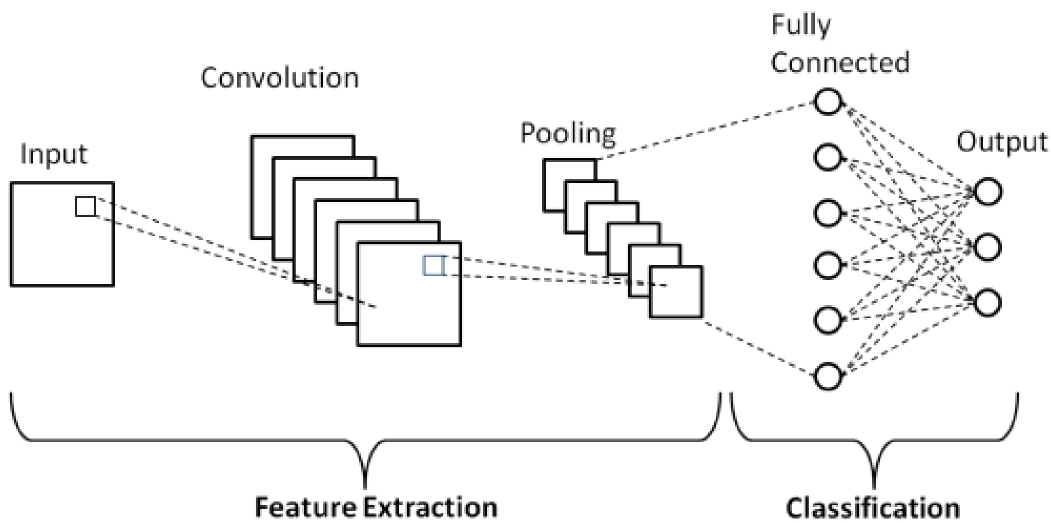

Figure 4.2.1: CNN Architecture

4.2.2 Object Detection Model

The object detection model used in our project is YOLOv8 (You Only Look Once version 8), which is designed to effectively segment and count the number of pills in medication images. YOLOv8 is known for its high accuracy and real-time processing capabilities. The architecture is streamlined for both precision and speed, making it suitable for applications requiring quick and reliable object detection.

4.2.3 YOLOv8 Architecture

- **Input Layer:** The model takes an input image, which is preprocessed to a fixed size suitable for the YOLOv8 network. The preprocessing includes normalization and resizing to ensure uniformity.
- **Backbone:** YOLOv8 uses a feature extraction backbone, which is a series of convolutional layers designed to capture and process low-level to high-level visual features from the input image. This backbone can be customized or use pre-trained networks for improved performance.
- **Neck:** The neck of the model includes several layers that enhance feature maps by combining different scales. This multi-scale feature extraction is crucial for detecting objects of varying sizes within the same image.
- **Head:** The head of the model is responsible for making final predictions. It outputs bounding boxes, object confidence scores, and class probabilities. In our case, the head is adapted to detect and segment individual pills, providing precise locations and counts.

Figure 4.2.2 provides a visualization of all these different sections of the YOLOv8 architecture.

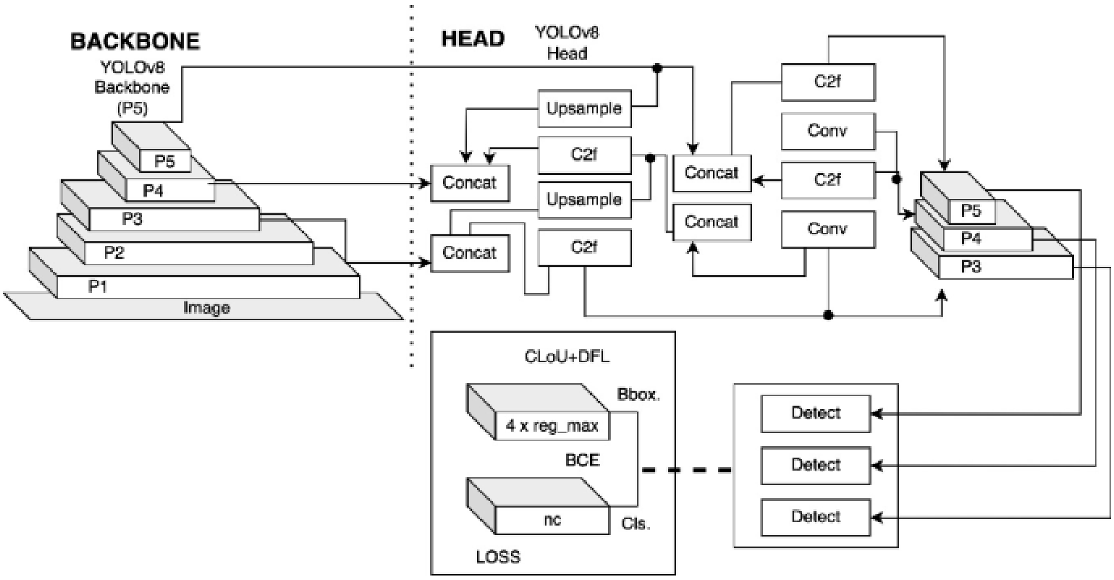

Figure 4.2.2: YOLOv8 Architecture

4.2.4 Data Preprocessing

Data preprocessing and augmentation are critical steps in preparing the dataset for training the CNN model. These techniques help enhance the model's performance and generalization capabilities. Data Preprocessing was done in our project by-

- **Resizing**: All input images are resized to a consistent shape (height and width) to match the input requirements of the CNN model. This ensures uniformity and facilitates efficient batch processing during training.
- **Normalization**: Pixel values of the images are normalized to a range of 0 to 1 by dividing by 255. This helps in speeding up the convergence of the training process.

4.2.5 Data Annotation

Accurate annotation is crucial for training the YOLOv8 object detection model for pill segmentation and counting. Using specialized annotation tools, each pill in the medication images was manually labeled with bounding boxes and corresponding class labels. Figure 4.2.3 provides some examples of the annotated data. Clear guidelines during the annotation process ensured consistency, and a quality control process involving multiple rounds of review was implemented to maintain accuracy. Handling occlusions and variations in pill sizes required meticulous attention, but these high-quality annotations were vital for the model's learning and generalization, ultimately leading to superior performance and reliability in real-world applications.

Figure 4.2.3: Image Annotation Example

4.2.6 Data Augmentation: To create a more robust model capable of generalizing to various scenarios, data augmentation techniques are applied to the training images. These techniques include:

- **Rotation**: Randomly rotating images within a specified range to simulate different orientations.
- **Shearing**: Applying random shear transformations to the images to imitate real-world distortions.
- **Flipping**: Horizontally flipping images to increase the diversity of the training data.

Figure 4.2.4 illustrates how an image can be augmented using the rotation and flipping. These augmentation techniques help in generating a more diverse training dataset, which reduces overfitting and improves the model's ability to handle variations in real-world images.

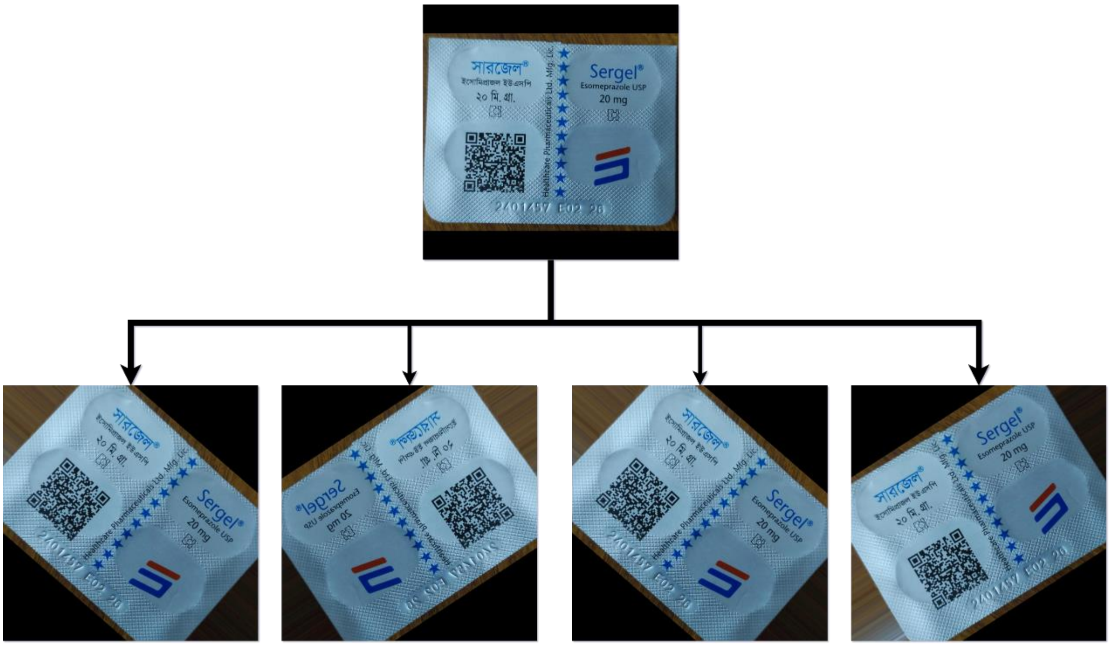

Figure 4.2.4: Image Augmentation Example

4.2.7 Training Process and Hyperparameter Tuning: Training the CNN model involves feeding the preprocessed and augmented data into the network and optimizing the model parameters to minimize the classification error.

Training Process

- **Dataset Splitting**: The dataset is split into training, validation, and test sets. The training set is used to train the model, the validation set to tune hyperparameters, and the test set to evaluate the model's performance.
- **Batch Training**: The model is trained using mini-batches, which helps in efficient utilization of computational resources and accelerates the training process.
- **Optimization**: An optimization algorithm, such as Adam, is used to update the model weights based on the gradients of the loss function.

Hyperparameter Tuning

Hyperparameters, such as the learning rate, batch size, and number of epochs, are tuned to optimize the model's performance. This process involves:

- **Grid Search**: Experimenting with different combinations of hyperparameters to find the optimal set.
- **Cross-Validation**: Using the validation set to assess the performance of each hyperparameter combination and selecting the one that yields the best results.

4.3 Model Evaluation

We assessed the performance of our trained models through various metrics. We analyzed the training loss and accuracy over epochs, represented graphically to visualize the model's learning progression. Additionally, we examined individual image class predictions by plotting a selection of images alongside their predicted and actual classes. This comprehensive evaluation provided insights into the model's accuracy and robustness, highlighting areas of strong performance as well as potential improvement.

4.3.1 Medicine Classification Model

Our medicine classification model, leveraging a Convolutional Neural Network (CNN), achieved an impressive accuracy of nearly 97%. To comprehensively assess its performance, we analyzed various metrics and visualized the model's learning progression. The evaluation involved examining Figure 4.3.1, which illustrates the training and validation accuracy over epochs, demonstrating the model's improvement and eventual stabilization. Additionally, Figure 4.3.2 depicts the training and validation loss, showing how well the model learned over time. Figure 4.3.3, the confusion matrix, provided a detailed view of the true and predicted classifications, offering insights into the model's precision for each class. Moreover, Figure 4.3.4 showcased example predictions, presenting a selection of test images alongside their predicted and actual classes, highlighting the model's prediction capabilities. These evaluations collectively demonstrated the model's high accuracy and robustness while also identifying areas where further improvements could be made.

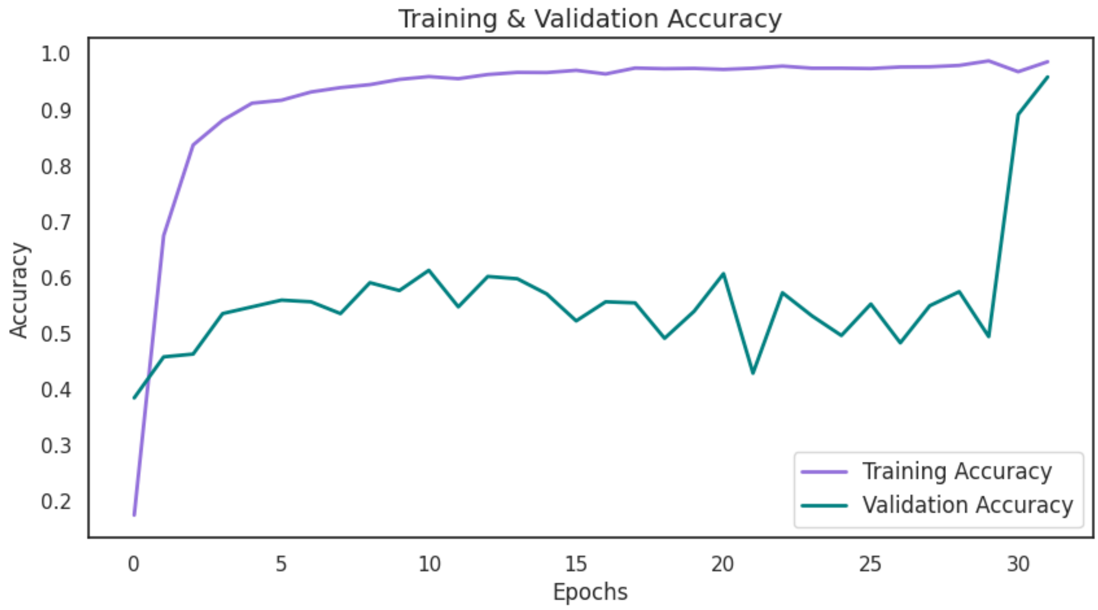

Figure 4.3.1: Training and Validation Accuracy for Medicine Classifier Model

Figure 4.3.2: Training and Validation Loss for Medicine Classifier Model

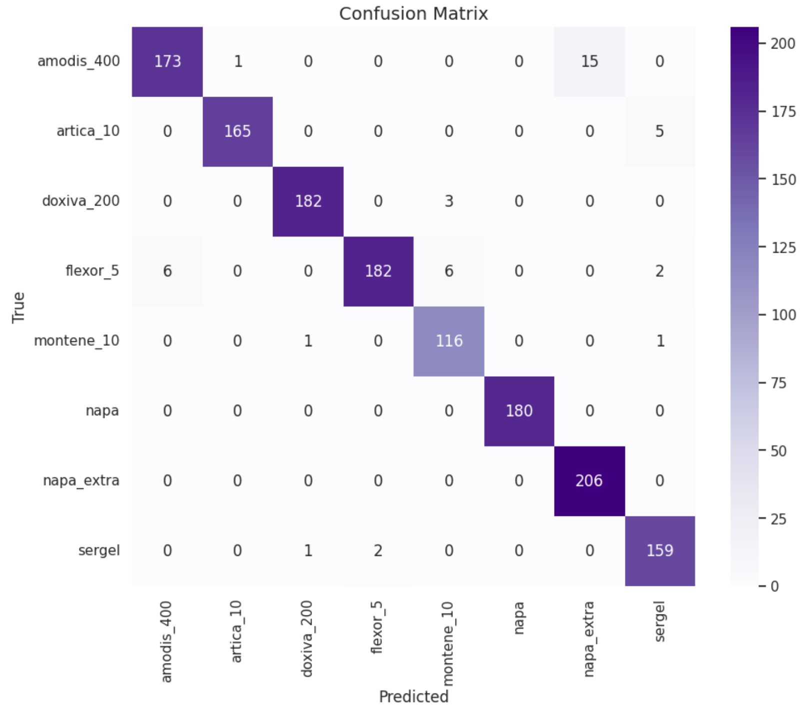

Figure 4.3.3: Confusion Matrix for Medicine Classifier Model

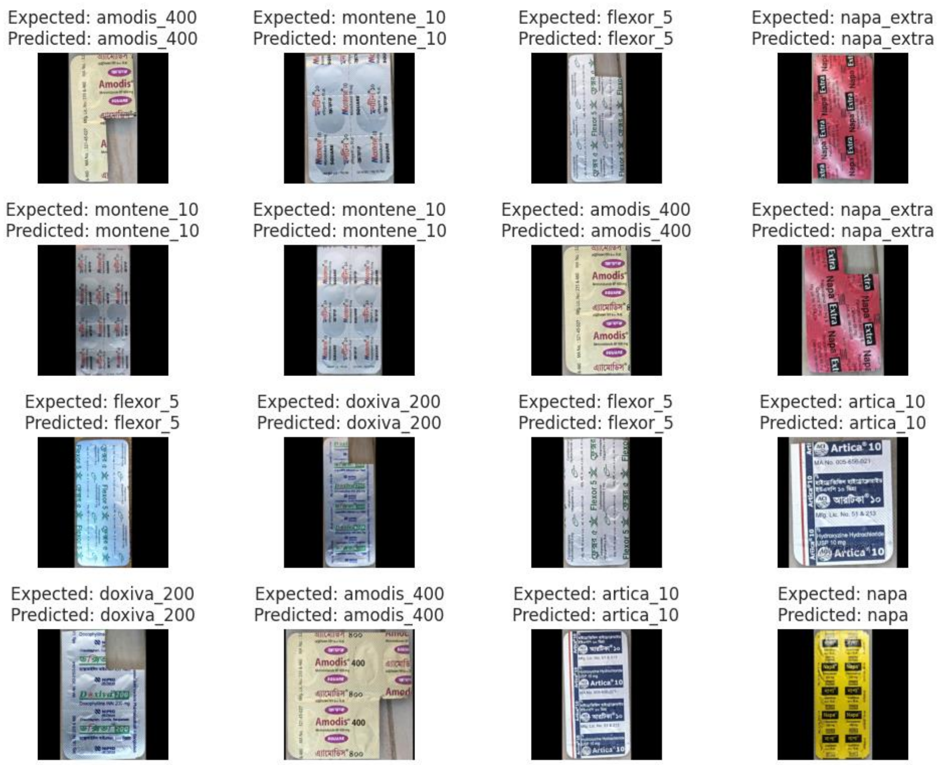

Figure 4.3.4: Example Prediction Testing

4.3.2 Pills Identification/Counting with Object Detection Model

Our object detection model, YOLOv8, trained with a custom annotated dataset, achieved an exceptional mean Average Precision (mAP) of 99%. To comprehensively assess the model's performance, we analyzed a range of metrics and visualizations. Figure 4.3.5 shows the training and validation loss over 100 epochs, alongside precision, recall and Mean Average Precision (mAP) indicating the effectiveness of the model's learning process.

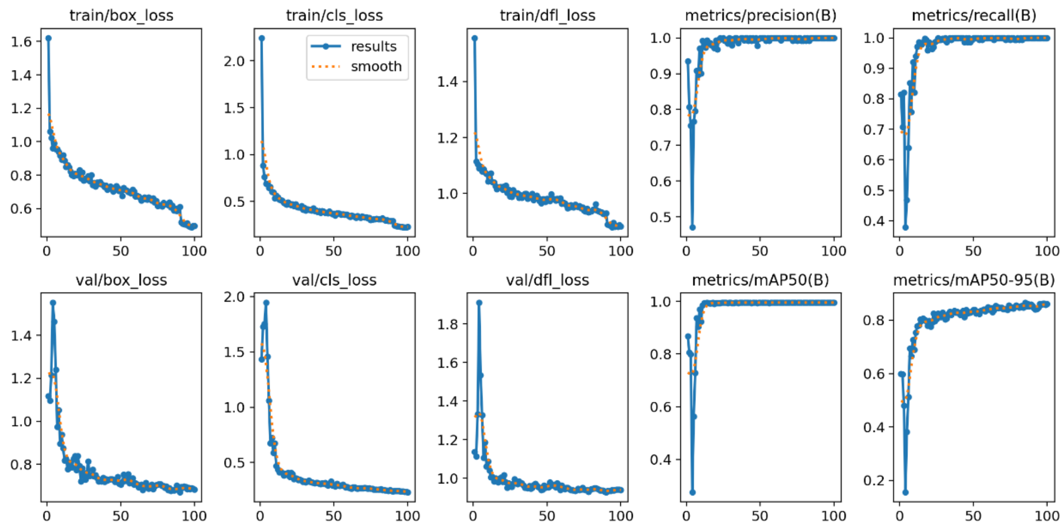

Figure 4.3.5: YOLOv8 Training Metrics

The confusion matrix in Figure 4.3.6 summarizes the true versus predicted classes, providing detailed accuracy analysis, where 140 pills from the test set were properly identified with a confidence level above 70%. Additionally, Figure 4.3.4 displays example predictions with bounding boxes and labels from both the validation and test sets, showcasing the model's detection capabilities. These evaluations provided a comprehensive understanding of the model's performance, emphasizing its strengths and identifying areas for potential enhancement.

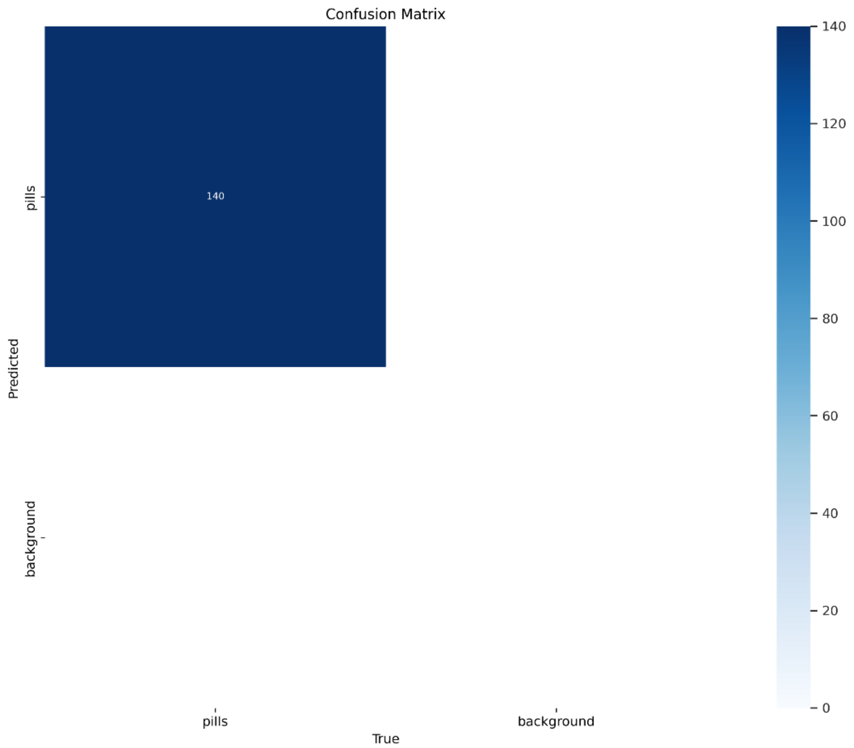

Figure 4.3.6: Pill Detection Confusion Matix

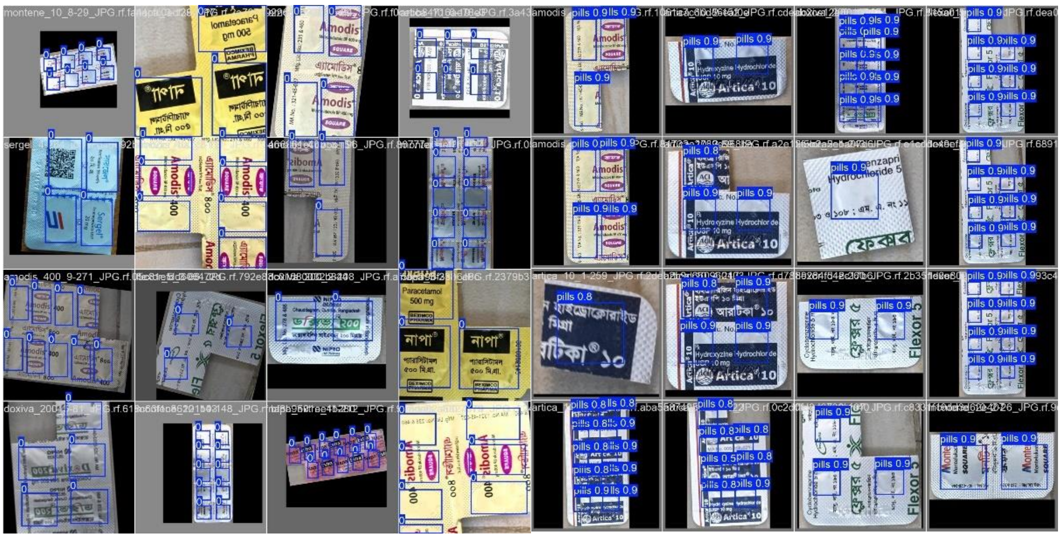

Figure 4.3.7: Pill Detection with Bounding Boxes

4.4 System Architecture

The system architecture of our application, combining Django web development with machine learning for medication billing in pharmacies, is designed to optimize efficiency and accuracy in pharmaceutical operations. Here's a concise overview of the system architecture.

4.4.1 Django Framework

Django is a high-level Python web framework that encourages rapid development and clean, pragmatic design. It follows the Model-View-Template (MVT) architectural pattern, which allows for the separation of concerns, making it easier to develop and maintain web applications. In our medication billing application, Django serves as the backbone, providing the following functionalities:

- **Routing**: Managing URL patterns and directing them to the appropriate views.
- **Data Management**: Using Django's ORM to interact with the database, ensuring secure and efficient data handling.
- **Template Rendering**: Rendering HTML pages using Django templates, enabling dynamic content display.
- **User Authentication**: Managing user authentication and authorization to secure the application.

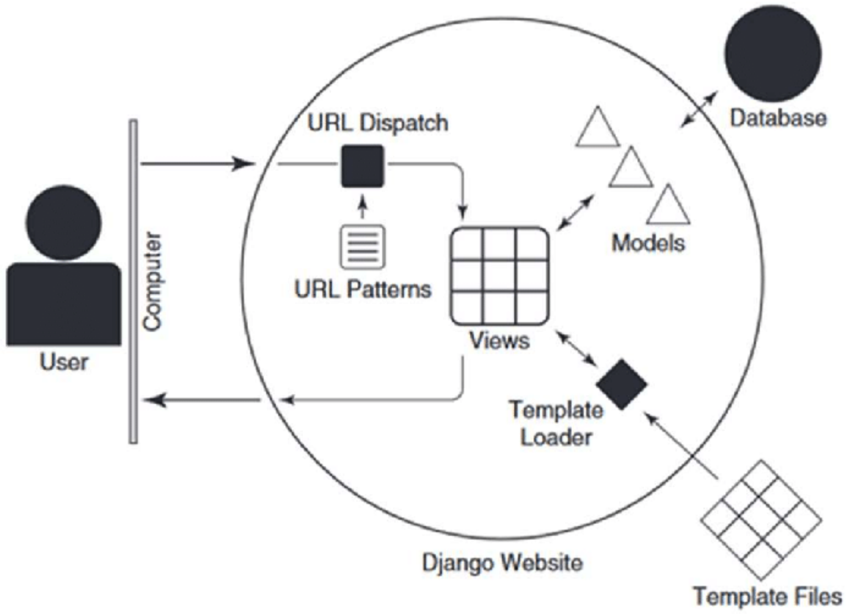

Figure 4.4.1: Django MVT Architecture

4.4.2 Components of Django Used

1. **Models:** Django models define the structure of the database. In our application, models represent various entities such as medications, users, and billing records.
2. **Views:** Views in Django handle the logic of the application. They process user requests, interact with the models, and pass the necessary data to the templates.
3. **Templates:** Django templates are used to generate dynamic HTML content. They allow embedding of Django template language (DTL) for rendering data passed from views.

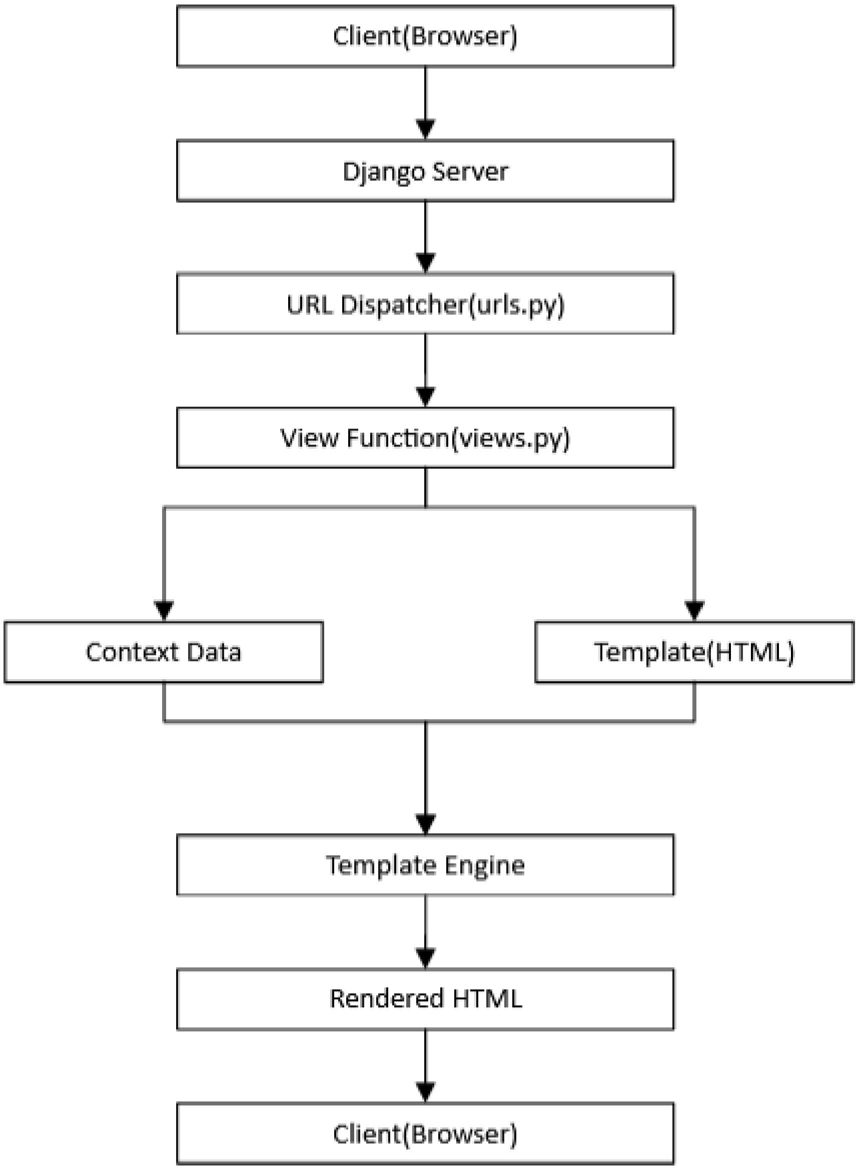

Figure 4.4.2: Django Template rendering process

4.4.3 Setting up the Django Project and App Structure

Setting up a Django project involves creating a project directory, setting up configurations, and creating individual apps for different functionalities.

Step 1: Create a Django Project

- Using the Django command-line interface, we initialize a new project.

Step 2: Configure the Project Settings

The settings.py file in the project directory is configured to include database settings, installed apps, middleware, and other configurations.

- **Key Configurations:** Configure security keys and environment variables
- **Database Setup**: Define the database connection details.
- **Installed Apps**: List of applications to be included in the project.
- **Middleware**: Middleware components for request and response processing.

Step 3: Create Django Apps

- Django apps are modular components that encapsulate related functionality. For our application, we create apps such as inventory, billing, and users.

Step 4: Define Models

- In each app, we define the models representing the database schema.

Step 5: Create Views and Templates

- Views are defined to handle the business logic and render templates with the necessary data.

Step 6: Configure URLs

- URL patterns are defined to route requests to the appropriate views.

Step 7: Migrate Database

- Finally, we run migrations to create the database schema based on the defined models.

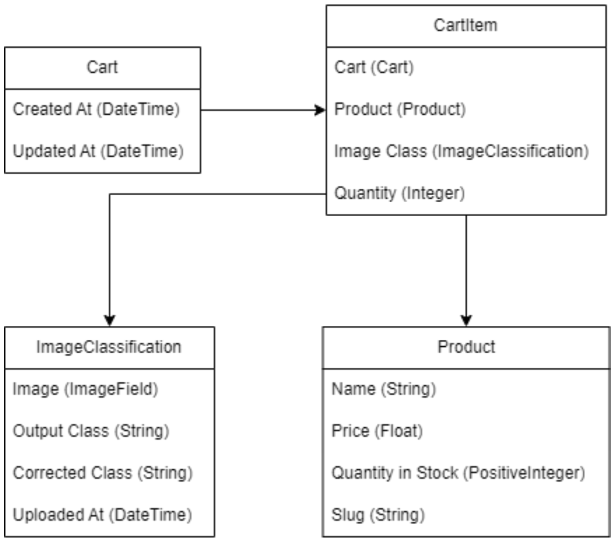

Figure 4.4.3: Model Architecture

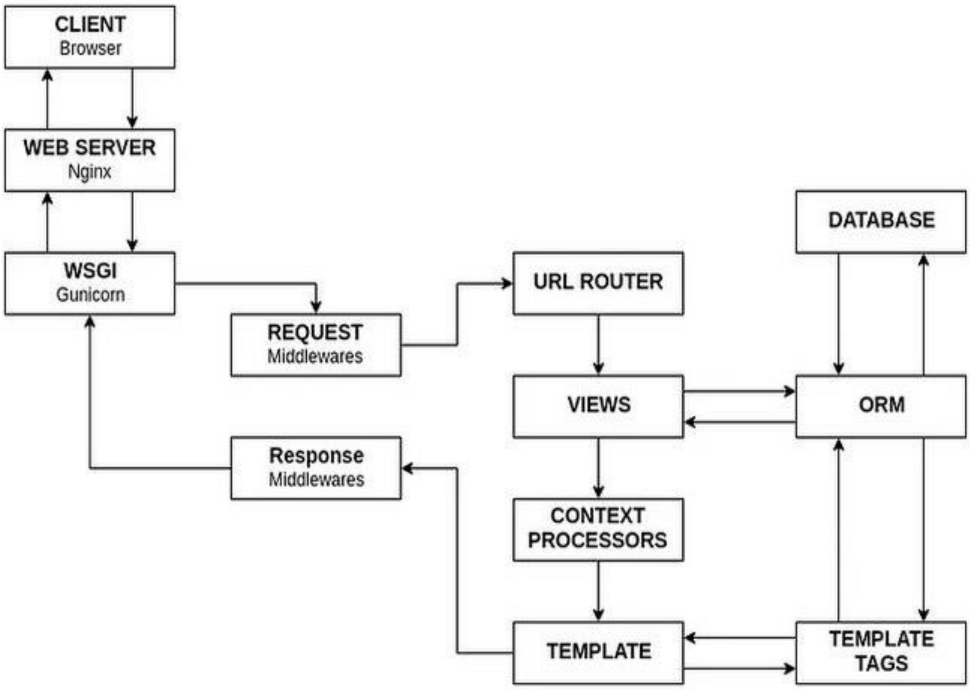

Figure 4.4.4: Request-Response Architecture of Django views

4.5 Image Classification Integration

The integration of image classification within our Django application is essential for automating the extraction of medication details from images. This section outlines the processes involved in developing and integrating a model for medication image classification and counting into the Django framework.

4.5.1 Designing the API Endpoints

We designed several API endpoints to handle different aspects of the image classification process. These endpoints include:

- **Upload Endpoint**: Allows users to upload medication images.
- **Process Endpoint**: Processes the uploaded images and returns extracted details.

These endpoints ensure that the system can efficiently handle image uploads, process images, and provide feedback to users.

4.5.2 Implementing the Image Upload Functionality

The image upload functionality is implemented using Django's built-in file handling capabilities. When an image is uploaded, it is temporarily stored on the server and then processed by the Dual Model. This involves creating a view that handles the file upload and saving it to a designated location for further processing.

4.5.3 Connecting the Django Backend with the CNN Model

Once the image is uploaded, it is passed to the model for processing. The model is pre-trained on a large dataset of medication images and fine-tuned for specific tasks such as identifying drug names, and quantities. The model processes the image and returns the relevant information, which is then used by the Django application.

4.6 Image Processing Pipeline

The image processing pipeline involves several steps to ensure accurate extraction of medication details from the uploaded images.

Steps Involved in Processing the Uploaded Image

1. **Image Preprocessing**: Resize and normalize the image to match the input requirements of the CNN model. This step ensures that the image is in the

correct format and size for the model to process.

2. **Feature Extraction**: Use the CNN to extract features from the image. The CNN analyzes the image and identifies key characteristics that are indicative of the medication details.
3. **Prediction**: Classify the image and extract relevant information such as drug names, and quantities. The model uses the extracted features to make predictions about the content of the image.

These steps are crucial for transforming raw image data into useful information that can be utilized by the application.

4.6.1 Extracting Relevant Features Using the Dual Model

The CNN model processes the preprocessed image and extracts features that are used to predict the medication details. The Object Detection Model processes the image to identify all the individual pills and their count. The output of the two models includes the drug name, and quantity. This information is then formatted and prepared for use within the Django application.

4.6.2 Auto-Filling Medication Details in the Django Application

The extracted details are sent back to the Django application, where they are used to auto-fill forms or directly update the inventory database. This reduces the need for manual data entry and minimizes errors. The integration ensures that the process of entering medication details is streamlined and efficient, improving overall workflow in the pharmacy.

4.7 User Interface Design

The user interface (UI) design of our Django application for medication billing in pharmacies focuses on intuitive navigation and responsive layout, ensuring seamless interaction for pharmacy staff. Utilizing Django templates and CSS frameworks like Bulma, the UI enhances user experience with visually appealing and functional design elements.

4.7.1 Frontend Development

- Using Bulma CSS for styling
- Creating user-friendly interface for medication entry
- Implementing AJAX for real-time data updates without page reloads

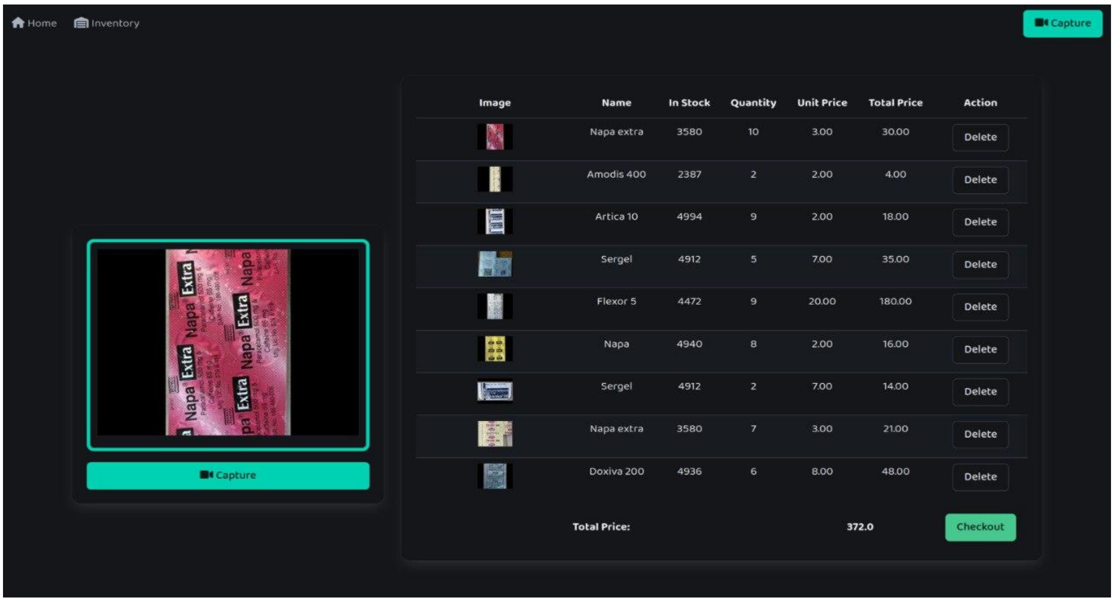

Figure 4.7.1: Image Capture and Cart

4.8 Testing and Validation

Testing and validation in our Django application for medication billing encompass unit testing, integration testing, and user acceptance testing. These ensure functionality, reliability, and user satisfaction across all components, from backend APIs to frontend user interfaces.

4.8.1 Unit Testing

- Writing and running unit tests for Django models, views, and templates
- Testing the API endpoints for correct responses

4.8.2 Integration Testing

- Ensuring seamless interaction between Django and the CNN model
- Validating the entire image processing pipeline

4.8.3 User Acceptance Testing

- Gathering feedback from pharmacy staff
- Making iterative improvements based on user feedback

4.9 Deployment

Deployment of our Django application for medication billing involves hosting on a scalable cloud server, ensuring reliable access, scalability, and security measures such as load balancing and continuous monitoring. This setup supports seamless operation and maintenance of the application to meet pharmacy operational needs efficiently.

4.9.1 Cloud Server Setup

- Choosing the appropriate cloud service provider
- Configuring the server for Django deployment

4.9.2 Continuous Integration and Deployment (CI/CD)

- Setting up CI/CD pipelines for automated testing and deployment
- Monitoring application performance and scalability

4.10 Future Improvements

- Enhancing the recognition capabilities of the CNN model
- Integrating the system with electronic health records (EHR)
- Expanding the application to support additional pharmacy operations

4.11 Summary

The implementation of our project focused on automating the medication billing process through advanced technologies. We developed a robust backend using Django, creating a secure and efficient platform for managing user data and handling system operations. To automate billing, we trained deep learning models, particularly Convolutional Neural Networks (CNNs), to recognize and extract crucial details from medication images, such as names, dosages, and quantities. This process involved collecting and preprocessing a diverse dataset of medication images and refining our models through extensive hyperparameter tuning and transfer learning techniques. Once optimized, these models were integrated into our Django-based system, enabling seamless image processing and data extraction. The extracted information was then synchronized with the existing pharmacy management software to automate the billing process. Our system underwent rigorous testing to ensure accuracy, efficiency, and security, with all data securely stored in a centralized database. The implementation significantly enhanced the billing workflow, reducing manual errors and improving overall operational efficiency.

CHAPTER 5

RESULT AND ANALYSIS

5.1 Overview

The culmination of integrating a Convolutional Neural Network (CNN) and a Object Detection model for counting with our Django web application has yielded significant advancements in automating medication detail extraction and enhancing user interaction. This section presents a comprehensive analysis of the results obtained from both the model and the web application.

5.2 Model Performance

The CNN model was trained on a diverse dataset of medication images, encompassing various drug types, dosages, and packaging variations commonly found in pharmacy settings. Here are the key aspects of the model's performance:

- **Accuracy**: The model achieved an accuracy of 97% on the test dataset for identifying the medicine and identified 100% of pills with over 70% confidence, demonstrating its capability to correctly classify medication images into their respective categories.
- **Precision and Recall**: Precision and recall scores were evaluated to measure the model's ability to minimize false positives and false negatives, respectively, ensuring robust classification performance.
- **Confusion Matrix**: Analysis of the confusion matrix provided insights into the model's strengths and weaknesses in classifying different medication types.

The trained CNN model successfully extracted medication details such as drug names and quantities from uploaded images with high accuracy, facilitating streamlined data entry and inventory management in the pharmacy application.

5.3 Web Application Integration

In tandem with the CNN model, the Django web application provided a user-friendly interface for seamless interaction and integration of automated medication detail extraction. Key highlights of the web application's functionality include:

- **Image Upload and Processing**: Users can upload medication images via a simple interface. The application processes these images using the integrated CNN model to extract and display medication details in real-time.
- **User Experience**: Designed with usability in mind, the application ensures smooth navigation and responsiveness, enhancing user satisfaction and efficiency in daily pharmacy operations.

5.4 Analysis and Impact

The combined integration of the CNN model and the Django web application has had a profound impact on pharmacy operations:

- **Efficiency Gains**: By automating medication detail extraction, the application significantly reduces manual data entry errors and accelerates the prescription fulfillment process.
- **Accuracy Improvement**: The CNN model's ability to accurately identify and classify medication details enhances inventory management and ensures the availability of precise drug information.
- **User Adoption**: Positive feedback from pharmacy staff indicates high user adoption rates due to the application's intuitive interface and effective automation capabilities.

5.5 Future Considerations

Looking forward, future enhancements to both the CNN model and the Django web application could include:

- **Enhanced Model Capabilities**: Further refinement of the CNN model to handle a wider range of medication types and packaging variations.
- **Integration with EHR Systems**: Expanding the application to seamlessly integrate with Electronic Health Records (EHR) systems for comprehensive patient and medication management.
- **Advanced Analytics**: Incorporating analytics and reporting features to provide insights into medication usage patterns and optimize inventory stocking levels.

CHAPTER 6

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

6.1 Impact on Life

The automated medicine billing system, leveraging advanced image recognition technology, revolutionizes pharmacy operations by delivering a multitude of advantages to patients, healthcare providers, and society at large. This innovative approach enhances various aspects of daily life and healthcare delivery.

1. **Enhanced Patient Convenience:** By speeding up the billing process, this system reduces waiting times for patients, making pharmacy visits quicker and more efficient.
2. **Accessibility for the Visually Impaired:** The system's ability to identify medications through image recognition assists those with visual impairments, enabling them to manage their prescriptions more independently.
3. **Reduction in Medication Errors:** Automated entry and verification of medication details greatly decrease the chances of errors, ensuring patients receive the correct dosages and prescriptions.
4. **Stress Reduction:** Automated billing and accurate processing provide peace of mind, reducing the stress associated with managing multiple prescriptions.
5. **Empowerment and Independence:** Patients gain more control over their healthcare with easy access to accurate medication and billing information.
6. **Improved Pharmacy Workflow:** By automating billing, pharmacy staff can focus more on patient care, enhancing operational efficiency and job satisfaction.
7. **Community Health Enhancement:** Efficient pharmacy operations support better public health outcomes by ensuring reliable access to medications.
8. **Technological Literacy:** Integrating advanced technology fosters greater acceptance and use of innovative tools in healthcare.
9. **Economic and Social Benefits:** Efficiency gains can lead to cost savings and improved healthcare services, benefiting both pharmacies and patients.

10. **Sustainability:** Digital storage of medication images and billing records reduces paper use and aligns with eco-friendly practices.

6.2 Impact on Society and Environment

6.2.1 Impact on Society

The automated medicine billing system employing image recognition technology represents a significant advancement in healthcare service delivery, benefiting society in various ways. By streamlining the medication billing process, the system reduces patient wait times in pharmacies, enhancing overall healthcare access and efficiency. This improvement supports better healthcare outcomes and patient satisfaction, contributing to a more effective healthcare infrastructure. Moreover, the system's accessibility features, such as image recognition for medication identification, empower individuals with visual impairments or disabilities, promoting inclusivity and equitable access to healthcare services. These enhancements underscore the system's role in fostering societal fairness, improving patient safety, and advancing healthcare accessibility.

6.2.2 Impact on Environment

The automated medicine billing system not only revolutionizes healthcare operations but also promotes environmental sustainability through its paperless approach and efficient resource utilization. By digitizing medication images and billing records, the system reduces reliance on paper, minimizing environmental impact and aligning with eco-friendly practices. This shift towards digital storage not only conserves natural resources but also reduces waste generation associated with traditional paper-based processes. Additionally, the system's implementation of advanced technology supports a broader healthcare sector transition towards sustainable practices, emphasizing the importance of environmental stewardship in healthcare operations.

6.3 Ethical Aspects

The implementation of an automated medicine billing system leveraging image recognition technology raises important ethical considerations that must be addressed to ensure responsible and equitable healthcare practices.

- **Patient Privacy and Data Security:** Safeguarding sensitive patient information, such as medication details and billing records, is essential. Ethical guidelines and robust data protection measures must prevent unauthorized access and breaches to maintain patient confidentiality.
- **Equitable Access and Inclusivity:** While improving accessibility for individuals with disabilities, the system must ensure equitable access for all demographics. Addressing potential biases and ensuring inclusive design are crucial ethical considerations.
- **Transparency and Informed Consent:** Patients should be informed about how their data is collected, processed, and used. Obtaining informed consent ensures patients understand and agree to the use of their health information for billing purposes.
- **Accuracy and Accountability:** The system's accuracy in medication identification and billing is paramount. Healthcare providers must uphold accountability for errors and discrepancies, ensuring patient safety and ethical healthcare delivery.
- **Professional Integrity:** Healthcare professionals must maintain ethical standards in using technology, ensuring patient confidentiality and advocating for patient welfare throughout healthcare operations.

6.4 Sustainability Plan

A robust sustainability plan for the automated medicine billing system leveraging image recognition technology encompasses several key elements to ensure long-term viability and environmental responsibility.

- **Paperless Operations:** Implementing a paperless approach for storing medication images and billing records reduces reliance on paper, minimizing environmental impact and promoting sustainable practices within healthcare operations.
- **Energy Efficiency:** Emphasizing energy-efficient practices in system operations, including optimized use of computational resources and hardware, reduces overall energy consumption and supports

environmental sustainability goals.

- **Resource Optimization:** Maximizing the efficiency of resource utilization, such as server capacities and data storage, minimizes waste and promotes sustainable resource management practices throughout the system's lifecycle.
- **Lifecycle Management:** Implementing sustainable lifecycle management practices ensures responsible disposal of electronic components and adherence to environmental regulations governing electronic waste (e-waste).
- **Continuous Improvement:** Regular monitoring and evaluation of environmental performance metrics enable ongoing improvements in sustainability practices. This includes assessing energy usage, waste reduction strategies, and implementing technological advancements that support environmental conservation.
- **Stakeholder Engagement:** Engaging stakeholders, including healthcare providers, patients, and technology partners, in sustainability initiatives fosters collective responsibility and promotes awareness of environmental impacts associated with healthcare technologies.

6.5 Summary

The impact of the automated medicine billing system leveraging image recognition technology extends significantly to society, environment, and sustainability. Societally, it enhances healthcare accessibility and efficiency by reducing patient wait times and ensuring accurate medication billing, thereby improving overall patient satisfaction and healthcare outcomes. Environmentally, the system promotes sustainability through its paperless operations, minimizing resource consumption and waste generation associated with traditional paper-based billing processes. It supports energy efficiency and responsible resource management practices, aligning with environmental conservation goals. Overall, by integrating technological advancements with sustainable practices, the system not only enhances healthcare service delivery but also contributes positively to environmental stewardship and sustainable healthcare operations.

CHAPTER 7

CONCLUSION AND FUTURE WORK

7.1 Conclusions

The automated medicine billing system leveraging image recognition technology marks a pivotal advancement in healthcare operations, fundamentally transforming the efficiency and accuracy of medication billing processes. By automating the traditionally labor-intensive data entry tasks, the system has demonstrated its ability to significantly reduce errors and streamline workflow efficiency within pharmacies. This innovation not only enhances the speed and precision of medication billing but also optimizes resource allocation, allowing healthcare professionals to devote more time to direct patient care. The successful integration of image recognition algorithms underscores its potential to revolutionize pharmacy operations, setting a new standard for accuracy and efficiency in medication management.

7.2 Further Suggested Work

Future developments in the automated medicine billing system should focus on advancing image recognition capabilities to achieve even greater accuracy and speed in medication identification. Exploring the integration of artificial intelligence for predictive analytics could further optimize inventory management and anticipate medication needs based on usage patterns and patient demand forecasts. Enhancements in user interface design, particularly with a focus on accessibility features for individuals with disabilities, will broaden system usability and ensure inclusivity. Moreover, expanding interoperability with diverse pharmacy management systems and scalability across different healthcare settings will facilitate broader adoption and integration of the technology.

7.3 Limitations/Conflict of Interests

While the automated medicine billing system offers substantial benefits, several considerations and challenges must be addressed. High initial implementation costs and ongoing maintenance expenses may present financial barriers for healthcare organizations, necessitating careful budget planning and resource allocation strategies. Ensuring robust cybersecurity measures to protect sensitive patient information from data breaches and unauthorized access is paramount. Compliance with healthcare regulations and ethical standards, including addressing potential conflicts of interest in vendor relationships and data privacy concerns, is crucial for maintaining trust and transparency. Proactively managing these limitations will be essential to sustain the system's effectiveness and ethical integrity in healthcare delivery.

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Appendix A

Complex Engineering Problems (EP) and Complex Engineering Activities (EA) Analysis

Title: AUTOMATED MEDICINE BILLING WITH IMAGE RECOGNITION

Students ID: 202-15-3833, 202-15-3849

CO Description for FYDP

CO	CO Descriptions	PO
CO1	Integrate recently gained and previously acquired knowledge to identify a real-life complex engineering problem for the Final Year Design Project	**PO1**
CO2	Analyze different aspects of the goals in designing a solution for the Final Year Design Project	**PO2**
CO3	Explore diverse problem domains through a literature review, delineate the issues, and establish the goals for the Final Year Design Project	**PO4**
CO4	Perform economic evaluation and cost estimation and employ suitable project management procedures throughout the development life cycle of the Final Year Design Project	**PO11**

Addressing of COs, Knowledge Profile (K), and Attainment of Complex Engineering Problems (EP):

SN	EP Definition	Attainment	CO	Justification (with Knowledge Profile)	References
1.	**EP1: Depth of Knowledge required**	Yes	CO1, CO2, and CO3	This project requires data collection from various sources and also collecting new data through ourselves which requires knowledge of the workings of machine learning models and quality of data required. Knowledge to choose a	**Page no: 15-16, 23-29**

				suitable model is also required which covers **K1, K2, K3 and K4.**	
				This project requires integrating different components such as machine learning models with an interface which covers **K5 and K6.**	**Page no: 29-40**
				For this project we have studied existing works which included various scientific literature and projects similar to ours which covers **K8.**	**Page no: 9-13**
2.	**EP2: Range of Conflicting Requirements**	Yes	CO2	Our project required us to analyze different findings and then implement based on the best outcome. Collection of data from various sources required the understanding of different regulations of collecting data. Also, different libraries are required to implement the whole project such as training the model and creating an interface.	**Page no: 14-17, 23-27**

3.	**EP3: Depth of analysis required**	Yes	CO2	There was no linear solution to achieve our objective in this project as the project has different phases for training operation. We had to extensively analyze different previous solutions and come up with one that suits our goal the best.	**Page no: 23-29**
4.	**EP4: Familiarity of Issues**	Yes	CO3	We had to first understand the existing technology that is already in place of billing systems to extract the flaws and improve upon them.	**Page no: 9-13, 34-41**
5.	**EP7: Interdependence**	Yes	CO3	This project incorporates different submodules for different purposes such as Training a model then implementing the model with a database and web backend finally connecting the backend with a frontend user interface.	**Page no: 28-35**
6.	**-**	Yes	CO4	We have prepared a budget to evaluate and estimate the cost required for our FYDP.	**Page no: 21-22**

AUTOMATED_MEDICINE_BILLING_WITH_IMAGE_RECOGNITI...

ORIGINALITY REPORT

19%	16%	8%	13%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	4%
2	Submitted to Daffodil International University Student Paper	3%
3	Submitted to University of East London Student Paper	1%
4	www.ijraset.com Internet Source	1%
5	Submitted to Higher Education Commission Pakistan Student Paper	1%
6	sites.google.com Internet Source	<1%
7	www.mdpi.com Internet Source	<1%
8	ebin.pub Internet Source	<1%
9	Submitted to Student Paper	<1%