International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Conference Proceedings: Volume: 05 ACME – 2026 DOI:10.55041/ISJEM.ACME106
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Smart Pill Identification System with Medication Advisor

Ms. B Rupa Devi
Associate Professor,
Dept of AIDS, Annamacharya Institute of Technology and Sciences, Tirupati-517501, India.
rupadevi.aitt@annamacharyagroup.org
ORCID: 0009-0005-1298-737X

S Aashifa
UG Student, Dept. Of Artificial Intelligence and Data science, Annamacharya Institute of Technology and Sciences, Tirupati, India.
aashifasyed05@gmail.com

R Ezhil
UG Student, Dept Of Artificial Intelligence and Data science, Annamacharya Institute of Technology and Sciences, Tirupati, India.
ezhilrajeshkanna41@gmail.com

K Divya Sree
UG Student, Dept. Of Artificial Intelligence and Data science, Annamacharya Institute of Technology and Sciences, Tirupati, India.
kuppamdivyasree@gmail.com

V Bala Adithya
UG Student, Dept Of Artificial Intelligence and Data science, Annamacharya Institute of Technology and Sciences, Tirupati, India.
vacchaadithya@gmail.com

Abstract— *In this paper, we outline a Smart Pill Identification System that is based on deep learning techniques, and attempts to improve medication safety by creating an image classification paradigm. The architecture that will be proposed uses a transfer learning Convolutional Neural Network (CNN) that utilises lightweight MobileNet to classify pharmaceutical pills with high precision taking advantage of visual discriminative, visual features, i.e., the colour, morphology, texture, and imprint pattern. In addition to identification, the system provides comprehensive pill-related data, which includes the pharmaceutical name, therapeutic indications, dosage rule, time of administration, potential adverse outcomes and contraindications. The system is created to help both the health professionals and the patients eliminate medication errors that come about due to visual homogeneity of the pills. The choice of MobileNet has been made due to its quality equilibrium between classification performance and balanced computing efficiency and allows application to portable and resource-constrained devices. Furthermore, an interactive medical consultative feature allows the users to ask overall medical questions that are related to medication with the responses being enhanced by relevant safety warnings.*

Keywords—Deep Learning, Pill Identification, MobileNet, CNN, Healthcare AI, Medication Safety, Image Classification

I.INTRODUCTION

Proper identification of pharmaceutical pills is critical to the safety of patients and effectiveness of therapeutic interventions. Medication errors, including mismatched drug or wrong pill identification, may initiate adverse reactions and reduce the therapeutic efficacies. The growing multiplicity of drugs, combined with visual similarities in shape, color, and punches, intensifies the need to identify drugs in a reliable manner especially in cases where they are removed out of their container. The traditional methods of identification are based on either manual examination or barcode-based methods but in case of no packaging, the traditional methods prove to be ineffective. Manual checking is a time consuming process and always subjected to human error hence the need to have an automated and reliable method. Recent advances in deep learning and computer vision have made extensive advancement in automated image classification possible. Convolutional Neural Networks (CNNs) are particularly skilled at visual representation learning, which avoids the use of extrinsic feature engineering. However, most high-performance CNN designs (e.g., VGGNet and ResNet) require a significant number of computations and memory, thus limiting their use in real-time on a mobile platform or other resource-constrained healthcare devices.

In order to overcome these challenges, the current study offers a Smart Pill Identification System that is based on a lightweight MobileNet system. MobileNet-based CNN can effectively extract visual information such as pill color, shape, surface texture and imprints features, and maintain a low level of computational complexity. Such balance of accuracy and efficiency allows using it across the web-based platforms and in the resource-limited environment without losing the performance. The proposed system provides all the clinical details that are relevant to the specified medication, including the recommended dose, the effects of the treatment, administration schedule, possible side effects, and precautions. In order to enhance reliability and patient safety, it is supplemented with a confidence-aware prediction mechanism, which labels low-certainty prediction as UNKNOWN to prevent unsafe misclassification. The system also has an interactive medical advisory system, where inquiries by users can be made concerning general medication queries. The interface clearly states that the information presented is nothing more than a source of reference and should not be used to replace professional medical care.

II. LITERATURE SURVEY

There has been a great academic research on automated pharmaceutical pill identification due to ability to allay medication-related errors and improve patient care. Various studies have been conducted on machine learning paradigms, and deep learning-based methods of pills detection and classification.

G. Rajeswarappa et al. [1] proposed a pill identification framework based on deep learning, which uses a MobileNet architecture to identify pills with multiple classes. It focuses on the visual feature extraction which includes such aspects as shape, colour, and imprint patterns but maintains the low level of computational complexity compatible with healthcare utilisation in real-time. The research presented high classification rates and defined the relevance of lightweight architectures to realistic implementation. Vishnukirthik et al. [2] introduced DeepPill an automatic pill recognition device that argues that unlabeled pills have to be identified relying on their physical features like shape, size, colour and imprint. Regulatory requirements of identifying the pills and monitoring advances in the field of both manual and automated recognition were placed in the limelight of the report.

Al-Hussaeni et al. [3] examined how to use the convolutional neural networks (CNNs) to recognize and retrieve pills. They evaluated various CNNs, such as ResNet50 and hybrid-based models, along with advanced preprocessing, together. Using a practical dataset provided in the National library of medicine, the suggested CNN+KNN method produced an accuracy of 90.8, thus, demonstrating the effectiveness of deep learning in pill recognition problems. Yang-Yen Ou et al. [4] suggested a two-phase detection and classification pill detection. It is divided into two stages, the first one is a localization of the pills with the help of a deep CNN, and the second step is to categorize the pill types by the detected positions. Using a massive dataset of 131 categories, their system achieved the best-1 accuracy of 79.4% and thus showed that the idea of a CNN-based pill detector and classifier are feasible.

Sakthimohan et al. [5] designed a system of automated pill detection based on the visual features which were colour, size, and shape. Keras and TensorFlow are utilized by the system to detect pills in the images and also match them to identify drugs contained in a database. The paper highlights the role of environmental difference and broken labels in medication errors and experiment findings have shown better results compared to manual identification. Bodakhe et al. [6] also focused on the effect of environmental manipulation on the appearance of pill and published a deep learning-based object detection system based on Keras and TensorFlow. The methodology they employ is based on the detection of pills in pictures and their matching to a full database. Other challenges that are discussed in the investigation include limited training data and multiple pills within one image and optimisation methods are suggested to improve the detection performance of the different challenges.

Borude et al. [7] narrowed down the research on issues that are present when managing medications among the elderly individuals especially those with impaired cognitive functioning. They produced a system that operates under image processing where pills are categorised based on size, shape and colour. Its two-stage process builds a local database in the process of training and supports the recognition of pills and statistical processing, thus, helping users to control medication better. The article by Kwon et al. [8] investigated pill identification using deep learning in the limitation of the dataset. The authors also single out the problem of growing combinations of classes as the quantity of types of pills grows exponentially. To reduce the effect of this they suggest a database enrichment strategy, which increases the diversity of training data and leads to improved performance through detection, and a decrease in the number of errors made through human inspection.

Zhang et al. [9] proposed a pill recognition system based on deep learning and suited to unconstrained users. The authors optimise CNN models to work correctly in the real-life setting and on low-resource gadgets like smartphones. They combine the use of different image representations such as colour, greyscale and gradual feature in their strategy in order to support the classification performance. Alahmadi et al. [10] introduced a mobile application, which combines the tools of artificial intelligence and computer vision to help the elderly identify medicines. It uses the GPT-4 to extract imprints and YOLOv8 to detect and achieves an accuracy of 90.89%. This article targets medication literacy issues in the vulnerable and visually impaired.

III. METHODOLOGY

A. Dataset Collection

The first step of the methodology involves a procedure of obtaining heterogeneous and textually annotated corpus of pharmaceutical pill images. The corpus is chosen to contain pill forms that have differences in colour, morphology, size, and surface impressions; all these features are considered important in solid identification. Every picture will have the necessary metadata along with it such as the name of the pill, its therapeutic purposes and dosage requirements, time of administration, precautions, and adverse effects. Images are bought in varying lighting conditions, camera angles as well as the background to guarantee solidity. This kind of heterogeneity allows this model to internalize real-world variations and not perform only well within controlled conditions. Verification of the corpus is done to maintain accuracy and relevance, thus making sure that the model learns clinically significant patterns.

B. Data Preprocessing

After obtaining the dataset, it is pre-processed to improve the quality of images and to convert the inputs into the standard requirements of the deep learning model. All the images were rescaled to an amount of fixed spatial dimension that aligns with the characteristics of MobileNetV3. This is followed by the normalization of pixel intensities to fall in [0,1] so as to enhance numerical stability and enhance the speed at which the training process would be completed. To improve the overall performance in generalization and reduce the effect of overfitting a set of data augmentation approaches are used which includes image rotation, horizontal and vertical flip, modulation of brightness, and modulation of contrast. The model is trained to identify pharmaceutical tablets across a wide range of real-world imaging conditions through the creation of many transformed copies of every image, thus becoming trained to identify pharmaceutical tablets in different imaging conditions of the real world.

C. Model Development

A proper choice of deep learning model is the key to high classification accuracy and low computational cost. In the Smart Pill Identification system, MobileNetV3Large was selected as the basic architecture in which a pill image should be classified because of its lightweight structure and capabilities of extracting features. MobileNetV3Large is computationally efficient and more efficient than a normal deep learning model, including VGG16 and ResNet50, which are known to have a huge computational cost and require more time to be inferred. MobileNetV3Large architecture has been designed so that it can provide high accuracy using fewer parameters and calculations, making it a very suitable architecture in real-time healthcare and web-based systems. The transfer-learning plan used was to initialize MobileNetV3Large using ImageNet weights. This method utilizes the existing knowledge of visual features that is present in the model thus making it possible to adapt to the classification of pill images of 20 classes. Therefore, the model generalizes and converges faster, and it has less training time. The Middle Ground MobileNetV3Large is a good middle-ground in rate, computation efficiency and deployability of Smart Pill Identification System.

D. Model Training and Evaluation

The dataset is divided into training, validation and testing subsets after model development. The training subset is used to optimize model parameters minimising the classification loss of the model output against the ground-truth labels. During the training, the network modifies its weights repeatedly to detect unique visual patterns that constitute each type of pill. It is done at frequent intervals, i.e., to keep track of performance and calibrate hyperparameters, such as learning rate, batch size, and the number of epochs. Early stopping is one of the methods that are carried out to reduce overfitting and enhance strong generalization on unobserved data. When the training is completed the model is evaluated on an independent testing subset. The measures or metric-based evaluation entails accuracy, precision, recall, and F1-score. Lastly a confusion matrix is reviewed to see common misclassifications and also to assess the strengths and weaknesses of the model before deployment.

E. Deployment and User Interface

The trained MobileNetV3 was deployed in a user-based application after evaluation was successful. The system has a simple and easy to use interface that allows the user to put the picture of a pill. When an image is submitted, the model carries out a real-time inference and provides the results in a number of seconds. These outputs include the name of the pill, the confidence level, medical usage, the dosage, the time to consume the pill, the side effects, and precautions.
There is also a medical advisory feature that allow users to generalize their queries with regard to the identified pill. There should be some clear disclaimers to show that the information is intended to guide only, and should not be taken to be a substitute of professional medical advice.

IV. RESULTS AND DISCUSSION

The working of the proposed pill identification system is measured by applying several measures that consist of training and validation accuracy curves, loss curves and a confusion matrix. These comparative devices enable a conclusion of the dynamics of the model of learning and the level of classification of pharmaceutical pills of various classes and generalization.

A. Accuracy and Loss Analysis

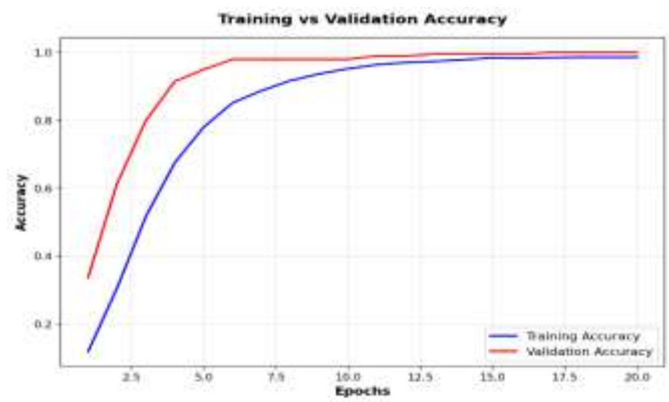

Fig1: Accuracy Curve

The accuracy of the training and validation after every 20 epochs was shown above. The plot of both stories show an even and progressive uphill movement, which is a sign that the model is learning very well. The percentage of accuracy is growing with each epoch and it reaches about 98 percent in last epochs. Besides, the narrow gap between the training and validation accuracy curves suggests that that model has a good generalization capacity and the overfitting is not significant.

Fig2: Loss Curve
The above graph represents the training and validation

loss curves for 20 epochs. Both training and validation loss curves are steadily decreasing, which indicates that the model is being optimized properly. The training loss is decreasing substantially from the early epochs and is stabilizing, whereas the validation loss is also steadily decreasing without any abrupt spikes.

B. Comparative Model Evaluation

To further evaluate the effectiveness of the proposed approach, the MobileNetV3-based model is compared against traditional machine learning algorithms, including SVM and KNN, as well as two widely adopted deep learning architectures for image classification, namely ResNet50 and VGG16.

Traditional machine learning models such as Support Vector Machines (SVM) and k-Nearest Neighbors (k-NN) rely on handcrafted features and are less effective in handling complex visual variations present in pharmaceutical pill images. As a result, their classification accuracy and scalability are limited.

Deep learning architectures such as VGGNet and ResNet achieve high accuracy on image classification tasks due to their deep and expressive architectures. However, these models require high computational resources, increased memory usage, and longer inference time, making them less suitable for real-time or resource-constrained deployment.

The proposed MobileNet-based CNN provides an optimal balance between accuracy and efficiency. Its lightweight architecture significantly reduces computational operations while maintaining strong predictive performance, making it well-suited for real-time healthcare applications and deployment in web or mobile environments.

Model	Accuracy (%)	Computational Cost	Parameters	Inference Time
SVM	68	Low	Dataset Dependent	Fast
k-NN	65	Low	No trainable parameters	Fast
VGG16	89	Very High	138M	Slow
ResNet50	92	High	25M	Moderate
MobileNetV3	98	Low	5.4M	Fast

Table 1: Model Performance Comparison

C. Confusion Matrix Analysis

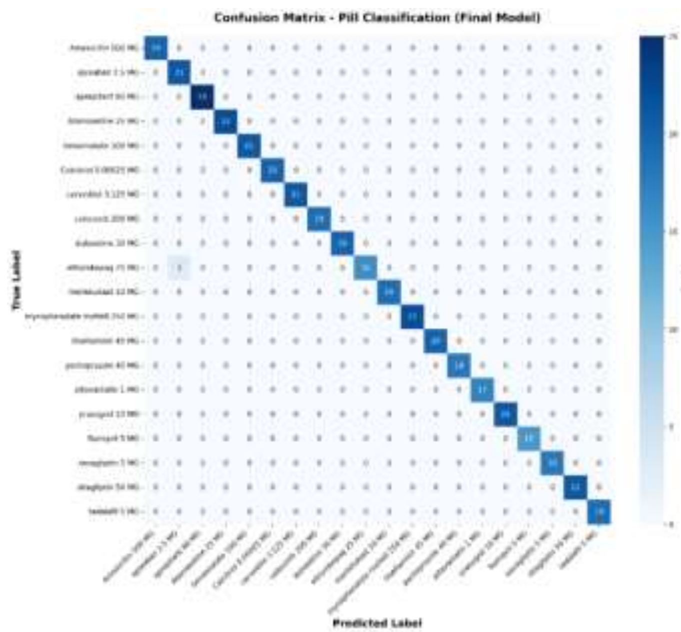

Fig3: Confusion Matrix

The confusion matrix shows the classification results of the proposed pill identification system. Most of the predictions are distributed along the diagonal, showing that the system is accurate in many classes of pills. There are a few errors between visually similar pills, which is expected in image classification tasks. Overall, the classification results show the effectiveness and accuracy of the proposed system.

V.CONCLUSION

This paper introduces a deep learning-based smart pill identification of the system that will improve medication safety through automated image recognition. It used a low recreational size MobileNet-based convolutional neural network that was capable of retrieving visual features such as color, shape, texture and imprint patterns, which enabled effective training with transfer learning at a cost of low computational intensity.

It was integrated into a web application based on Django, which allows uploading the image of the pill and receiving identification results with relevant medical information. In an attempt to enhance safety, a confidence -system was added to mark questionable forecasts as UNK, thus reducing the chances of being mistaken. In addition, a medication - advising element provides general advice to promote informed usage.

On the whole, the suggested system proves that it is possible to deploy lightweight deep learning models and utilize them in the healthcare assistance-related applications and to introduce a scaling framework to provide additional improvements to automated medication support systems.

REFERENCES

[1] Rajeswarappa, Y. Lasya, B. V. Sivaiah, S. M. Sameer, M. Navya, and V. Varun Kumar, "AutoMediVision: A Deep Learning System for Accurate Pharmaceutical Pill Identification", 2025.

[2] R. Vishnukirthik, P. Karthikeyan, and S. Arun Kumar, "DeepPill: Web Framework for Automatic Pill Recognition and Recommendation System", in Proc. Int. Conf. on Smart Computing and Systems Engineering, 2022.

[3] M. Al-Hussaeni, et al., "CNN-Based Pill Image Recognition for Retrieval Systems", in Proc. IEEE Int. Conf. on Biomedical and Health Informatics, 2023.

[4] Y.-Y. Ou, et al., "Automatic Drug Pills Detection Based on Convolutional Neural Network", IEEE, 2018. DOI: 10.1109/ICOT.2018.87058.

[5] S. Sakthimohan, et al., "Detection and Identification of Pills Using Machine Learning Models", in Proc. Int. Conf. on Emerging Trends in Computing Technologies,2021.

[6] P. Bodakhe, et al., "Deep Learning–Based Object Detection for Pharmaceutical Pill Identification Under Environmental Variations", in Proc. Int. Conf. on Image Processing and Computer Vision, 2022.

[7] S. Borude, et al., "Drug Pill Recognition System Using Deep Learning", in Proc. Int. Conf. on Healthcare Informatics and Smart Systems, 2021.

[8] Kwon, et al., "Pill Detection Model for Medicine Inspection Based on Deep Learning", in Proc. Int. Conf. on Machine Learning Applications, 2022.

[9] Y. Zhang, et al., "Deep Learning System for Recognizing Pills in Images", IEEE Trans. Multimedia, 2023.

[10] A.Alahmadi, et al., "A Computer Vision – Based Pill Recognition Application 'Bridging Gaps in Medication Understanding for the Elderly", 2024.