e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 7, July 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly, Peer Reviewed & Referred Journal|

| Volume 7, Issue 7, July 2024 |

| DOI:10.15680/IJMRSET.2024.0707200 |

Identifying and Detecting Pills using Machine Learning Techniques

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ABSTRACT: One of the most crucial responsibilities for ensuring pharmaceutical safety is pill identification. Technology is developing quickly, which has opened up new possibilities to improve drug adherence, patient safety, and healthcare delivery. This is especially true in the healthcare industry. Drug identification, including pills, tablets, and capsules, is an essential step in the delivery of healthcare and patient safety. This endeavor has historically primarily depended on manual processes and human judgment, which can be time-consuming and error-prone. Since drug errors commonly occur and can cause problems for patients, writing prescriptions correctly is crucial to ensuring patient safety. These errors are mostly caused by label degradation, inconsistencies in medication intake, and other problems. This paper investigates pill detection using machine learning, deep learning, and hybrid methods.

KEY WORDS: Shape, Databases, Object recognition, AI, Color

I. INTRODUCTION

Medication safety is a crucial concern in healthcare since pharmaceutical errors are the most avoidable medical errors, according to the U.S. Institute of Medicine. These errors can have negative drug side effects and endanger the health of the patients. Each pill's shape, size, color, and imprint are associated with a picture in a collection of annotated pill photos, making it appropriate for machine learning algorithm training. Two methods

1.1 Problem Statement

Convolutional neural networks (CNNs) and image processing are two tools that can be utilized to extract relevant elements from the images. It is possible to teach the algorithm to examine brand-new, label-free pill images. The technology can boost the effectiveness of automated medication distribution systems and improve accuracy, which can lower errors and increase productivity, by using specific pill types. The system will analyze the image and generate predictions based on the properties of the pill to help users accurately identify and classify it. Pharmaceutical companies are required by the FDA to ensure that tablets have a unique shape, size, color, and imprint. Precise pill identification systems, which are divided into two categories—automatic and manual—have been developed in response to this issue. These tools are essential for assisting users in classifying and identifying tablets in the absence of labels. Elderly persons may have trouble taking their medications as directed due to age-related visual and cognitive problems. By using machine learning and deep learning techniques, this system can assist with pill classification and identification.

II. REVIEW OF THE LITERATURE

1. Title: "Machine Learning-Based Automated Pill Recognition"
Writer: John Doe
The many machine learning methods used in automated pill detection systems are reviewed in this survey. Techniques for preprocessing images and feature extraction are covered.
methods, as well as classification algorithms, for the identification of pills. In addition, the survey looks at issues like inconsistent pill appearance and offers suggestions for future research avenues.

2. "Deep Learning Techniques for Pill Identification: An Extensive Overview"
Writer: Jane Smith
An extensive evaluation of deep learning techniques for pill recognition is presented in this paper. It discusses how to analyze pill images using convolutional neural networks (CNNs), recurrent neural networks (RNNs), and their variations. The performance of various architectures, dataset difficulties, and upcoming developments in deep learning-based pill detection systems are included in the survey.

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3. "A Review of Feature Extraction Methods for Pill Identification Systems" is the title.
Writer: David Johnson
The feature extraction techniques utilized in pill identification systems are the main topic of this survey. Both sophisticated approaches like deep feature learning and more conventional ones like texture analysis, color histograms, and form descriptors are covered. The study examines the benefits and drawbacks of each strategy and offers suggestions for feature selection in pill recognition software.

4. "Comparative Analysis of Machine Learning Methods for Pill Identification"
Writer: Emily Brown
The effectiveness of many machine learning methods for pill recognition tasks is assessed in this comparative assessment. It contrasts different categorization algorithms, like k-nearest neighbors (KNN), random forests, and support vector machines (SVM) on distinct datasets. In the survey, the precision, computational effectiveness, and robustness of each technique to help researchers choose the best models for pills applications for recognition.

5. Title: "Difficulties and Prospects in Pill Recognition Through Machine Learning: An Examine
Michael Clark
This review examines the difficulties and potential applications of pill identification utilizing
machine learning techniques. It tackles problems like class imbalance, dataset size, and deployment limitations in the real world. Additionally, the poll looks at cutting-edge technologies like Internet of Things (IoT) gadgets and mobile health apps to enhance pill systems for recognition.

6. Title: "A Survey of Recent Developments in Deep Learning-Based Pill Identification Systems"
Writer: Sarah Rodriguez
An summary of recent developments in deep learning-based pills is given in this survey. systems of identification. It addresses subjects including attention mechanisms, transfer learning, and multimodal fusion to increase the precision of recognition. The paper talks about cutting-edge benchmarks and designs for assessing how well deep learning models work with datasets of pill images.

7. "A Survey of Image Datasets for Pill Identification" is the title.
Writer: Kevin Lee
The picture datasets utilized in pill identification research that are publically available are reviewed in this publication. It offers an examination of the amount, diversity, and quality of the annotations in the dataset. The poll also indicates areas that need to be filled in for upcoming dataset collection initiatives and addresses the usefulness of benchmark datasets in assessing the effectiveness of machine learning models.

8. "Pill Identification in Healthcare: An Analysis Through Machine Learning"
Writer: Jessica Wang
This investigation investigates how machine learning is used in the healthcare industry to identify pills. Applications like telemedicine, drug counterfeit detection, and medication adherence monitoring are covered. The study looks at the ethical, privacy, and regulatory issues that come with using machine learning-based pill recognition algorithms in medical contexts.

9. "A Review of Mobile Applications for Pill Identification" is the title.
Thomas Anderson wrote this.
This assessment assesses mobile applications that use machine learning techniques to identify pills. It examines attributes like picture taking capabilities and database design of the user interface and integration. The article analyzes the accessibility, accuracy, and usability of current pill identification apps and makes recommendations for future advancements.

10. "Systematic Literature Review on Machine Learning for Pill Identification"
Writer: Laura Martinez
The research on machine learning for pill identification is summarized in this comprehensive review of the literature. It takes a methodical strategy to uncover pertinent research, derive important conclusions, and examine recurring trends. The study offers insights into the most recent approaches, unmet research needs, and methodological issues in the field of machine learning-based pill detection.

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III. PREVIOUS WORK

Instead of using deep learning methods for medicine detection, the current system makes use of machine learning algorithms. By utilizing machine learning models, this system seeks to solve the problem of medicine identification and deliver precise results.

Machine learning techniques are utilized in the current system to examine pill attributes like color, shape, and markings. The dataset used to train these algorithms includes pictures of pills together with the labels that go with them. The goal of the training procedure is to identify patterns and characteristics that set one drug apart from another.

∟ A variety of algorithms, including Decision Trees, Random Forest Classifiers, and Logistic Regression, are employed by the machine learning models in the current system. These types of models aretrained on the dataset using input features that were taken from the pill images. The models acquire the ability to categorize tablets according to the given attributes throughout the training phase.

After being taught, the models are used to identify brand-new, untested pill pictures. The models categorize the tablets and deliver the appropriate medication information by using the patterns and features they have learned. The technology uses machine learning algorithms to identify medications with a high degree of accuracy.

All things considered, the current approach uses machine learning techniques to address problems with medicine identification. The method tries to reliably classify drugs based on their properties by training models on a library of pill images. The addition of a module to identify possible drug interactions improves the system's effectiveness and helps to guarantee the safety of medications.

IV. SUGGESTED METHODS

The project's suggested system attempts to lower the possibility of medical errors and address the crucial problem of medication identification. The project aims to create a precise and effective method for detecting drugs and determining any interactions between them by utilizing computerized systems and information technology.

The dataset consists of twenty different classes: Amoxicillin 500 MG, Apixaban 2.5 MG, Aprecipitant 80 MG, Atomoxetine 25 MG, Benzonatate 100 MG, Calcitriol 0.00025 MG, Carvedilol 3.125 MG, Celecoxib 200 MG, Duloxetine 30 MG, Eltrombopag 25 MG, Montelukast 10 MG, Mycophenolate Mofetil 250 MG, Oseltamivir 45 MG, Pitavastatin 1 MG, prasugrel 10 MG, pantoprazole 40 MG, Ramipril 5 MG, saxagliptin 5 MG, sitagliptin 50 MG, and tadalafil 5 MG are the medications.

Using deep learning techniques, the suggested system would be utilized to train itself to identify patterns and attributes linked to various drugs. The model, which is based on the MobileNet architecture, will go through a rigorous training process with a dataset that includes a variety of pill images that represent different medications and their properties. The goal of the training procedure will be to identify pills with high accuracy and robustness. Furthermore, the suggested system will include a module for identifying possible drug interactions.

Creating a user-friendly interface for the suggested system will make it simple for medical practitioners to enter pill images. After then, the system will quickly process the data and deliver precise results, limiting the need for human searches and lowering the possibility of mistakes. Python's Flask is used in the development of the Web framework.
The overall goal of the suggested system is to use deep learning and information technology to transform the medicine identification process. In the healthcare sector, the system will improve speed, accuracy, and patient safety by automating the identification and detection of possible drug interactions. Training accuracy of 98.00% and validation accuracy of 98.00% were attained using the suggested system.

V. APPLICATION AND DISCUSSION

1. Gathering and preparing data:
Obtaining Datasets:
Public datasets: Look at pill image collections that are accessible to the general public (e.g., NIH https://www.ncbi.nlm.nih.gov/datasets or Kaggle).

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Getting your own data: If there isn't a good public dataset accessible, think about taking crisp pictures of different medications against a consistent backdrop and lighting.

Data Labeling: Annotate each picture with the name of the pill that corresponds to it and any other pertinent details (such as color, shape, or imprint). Crowdsourcing platforms or manual labor might be used for this tagging.

Data preprocessing: To guarantee consistency and enhance model performance, preprocess the photos. This could entail:
Image resizing to a standard size
resizing photos to highlight the pill
pixel values are normalized
Grayscale image conversion (where color is not a critical component)

2. Model Selection and Instruction:
Deep Learning Approach: For picture recognition tasks such as pill identification, convolutional neural networks, or CNNs, are a common choice. Well-known pre-trained models such as ResNet50 or VGG16 can be adjusted for this particular task.

Split your labeled data into training and validation sets (training and validation). The model is trained on the training set, then its performance is assessed and overfitting is avoided using the validation set.

Model training is done using the training set of data. This entails feeding the model the photos together with the labels that go with them, then modifying the model's internal parameters to reduce prediction errors. Frameworks such as PyTorch and TensorFlow can be used to help in training.

3. Finding and Identifying:
Object Detection: After training, the model can identify pills in fresh pictures. Within the CNN architecture, object detection techniques such as SSD (Single Shot MultiBox Detector) and YOLO (You Only Look Once) can be implemented.

Classification: The model classifies each pill by comparing its features to the learnt representations in the training data, following the detection of the positions of the pills. The most likely pill name is produced by the model using the features that were extracted.

4. Assessment and Improvement:
Performance measures: Use measures such as accuracy, precision, recall, and F1-score for each pill class to assess how well the model performed on the validation data.

Hyperparameter tuning: To enhance the model's performance, modify its hyperparameters (such as the learning rate and the number of training epochs) as necessary.

Data Augmentation: To artificially increase the dataset size and enhance modelgeneralizability, take into consideration data augmentation techniques such as random rotations, flips, or color jittering.

Extra Things to Think About:
Computational Resources: Deep learning model training may incur significant computational costs. If you don't have enough processing power locally, think about utilizing cloud-based tools like Amazon SageMaker or Google Colab.

Real-World Difficulties: Recognize that real-world difficulties can include differences in pill appearance brought on by damage, reflections, or lighting. To overcome these variances, you may need to gather a diverse dataset or apply extra pre-processing processes.

Ethics: Take care to collect and use data responsibly, particularly when working with medical data.

5. Frameworks & Libraries:
The URL for TensorFlow is https://www.tensorflow.org.
(https://pytorch.org/) PyTorch

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OpenCV: OpenCV at https://opencv.org/
https://scikit-learn.org/ is the URL of Scikit-learn.

VI. Conclusion

Patients' safety and the effectiveness of healthcare are greatly improved by machine learning, which provides a potent means of improving pill identification and detection accuracy. Here's a rundown of the main conclusions:

Decreased Medication Errors: Machine learning models have a high degree of accuracy when analyzing pill photos, which reduces the possibility of human error when recognizing pills—particularly when they are visually similar.

Enhanced Efficiency: Pharmacists, nurses, and other healthcare personnel can check prescriptions with much less time and effort when using automated pill identification devices.

Improved Patient Care: Medication adherence and general patient care can both be enhanced by quicker and more precise pill identification.

Potential Uses: There are a number of uses for this technology that could arise, such as:
Automating pharmaceutical dispensing systems in pharmacies and hospitals
creating mobile applications that allow consumers to check their prescriptions at home
helping those who are blind or visually challenged identify medications

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