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A Drug Pill Recognition System for Visually Impaired People with Voice Assistant

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Abstract: The loss of faculties like eyesight or memory is a common effect of ageing, which is a natural process. Seniors who are visually impaired have more difficulty performing daily tasks, which can occasionally put them in danger. One of the most significant causes has to do with misusing medications or just forgetting to take them. Elderly people health care is prioritized because these mistakes seriously endanger lives and health. In literature many automated systems were proposed which recognize a drug pill by the imprint code i.e. the text carved on the pill but there are many drugs pill which can have same imprint code carved on them so it is necessary to consider the color, size and shape of pill too to recognize it effectively. This paper presents a drug pill recognition system which considers the pill imprint code, shape, size and color by using convolutional neural network and provides voice assistance to visually impaired people. The system's accuracy is 99%. The suggested system also prompts patients to take their medications at the appropriate times.

Keywords: *Deep learning, Drug Pill Recognition, Elderly People, Imprint, Neural Network*

1. Introduction

Older people have trouble because ageing results in the loss of abilities like vision and memory. Medication is one that is widely recognized. Elderly adults frequently neglect to take their prescriptions as directed or do so incorrectly, which can seriously harm their health. However, once they are aware of the scenario, their confidence is undermined, necessitating the provision of assistance in order to make things right. On the basis of recent technological advancements, such as mobile devices, a novel approach to the system is proposed. This remedy is a part of a larger, still-in-development tool support for the elderly. It uses computer vision techniques to assist elderly people identify pills in an effort to increase independence and confidence. Those who are blind or have vision impairment in their senior years frequently take the wrong drugs or forget to take them. As a result, it's expected that patients who misuse medications and have visual impairments will incur large financial losses. Nevertheless, it's possible that these people won't have enough access to this kind of support.

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Elderly individuals often face several challenges when it comes to taking their medications correctly and on time. These challenges can have significant implications for their health and well-being. Here are some of the common difficulties they encounter:

- Memory Issues: Memory decline is a natural part of aging, and seniors may have trouble remembering to take their medications as prescribed. They might forget whether they've already taken a dose or struggle to recall the timing of their next dose.
- Difficulty Reading Medication Labels: Visual impairments make it challenging for seniors to read small print on medication labels. They may struggle to identify the name of the medication, the dosage instructions, and the expiration date.
- Identifying Medications by Sight: Many seniors rely on visual cues to differentiate between different medications based on the size, shape, or color of the pills. Visual impairment can make it impossible for them to visually distinguish one pill from another.

In order to address these problems, this paper presents the need for a technique for chronic vision impaired individuals. The proposed approach can assist in ensuring that patients with chronic vision impairments take their medications in a safe manner. The paper presents how well visually challenged people can distinguish between medication pills. Main objectives of this work can be stated as:

- To create a system for the elderly people that is going to help them to take needful medication on time.

- To generate a pill recognition system that accepts and gives an audio output of the name of the pill, purpose of the pill etc. so that the visually impaired person may recognize it.
- To express dose and frequency of use for advised drugs could enhance understanding, especially among patients with limited literacy.
- To supply related functionalities to make possible safe medication use, many related tools have been developed and evaluated.
- To modify the classification of drugs based on user interaction.

2. Related Work

In Literature, work is carried out on automatic pill detection system, some of the prominent works are presented in this section.

Paper [1], presents a tool for assisting elderly persons in identification of pills. This tool is computer vision-based system aiming the identification of pill. By considered the dimension, shape, and colour of image for identification of pill.System [2] applies a deep learning approach to recognize drugs and help patients to take their medications on time by using notification service. In [3] the You Only Look Once (YOLO) algorithm is used for identification of drug pill.In paper [4][5], author proposed a deep learning algorithm using limited training data and used database expansion method. Proposed algorithm was able to detect multiple pills in single image by using two step structure. In paper [6], author applied Convolutional Neural Network(CNN) classifier, ResNet the for identification of randomly placed drugs proposed system. In paper [7], In this paper MLP and SVM classifier are used for automatic classification of pill images using their color and shape. Paper[8] make use of IOT based system for recognition of pills. In [9] emphasis on speech recognition analysis is presented by authors.

This paper proposed a mobile based automated drug pill recognition system using CNN and voice assistance to assist the visually impaired person as well as elderly person.

3. Research Methodology

The training phase and the testing phase are the two stages of the drug pill recognition system. Fig.1 depicts these phases in detail.

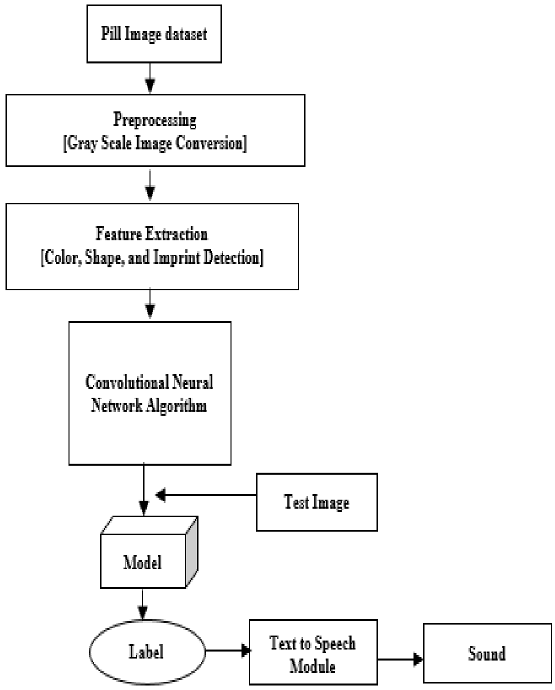

Fig.1. Drug Pill Recognition and Voice assistance system

The image is sent for pre-processing during the training phase, followed by Feature Extraction phase. During feature extraction color, shape and imprint of pill is extracted by using different methods. The image prediction is carried out by CNN. The pill's accuracy and loss are determining through trained model. The prediction model is the training phase's ultimate output. During testing stage, the unlabeled pill is pre-processing and forwarded to trained model to classify the image. The predicted label is converted in to speech using text to speech module. Acquiring images and classifying pills based on their color, shape, and imprint are some of the steps taken by this proposal. The detail description of drug pill recognition system is as follows:

3.1 Preprocessing

In Pre-processing step, the color image is converted in to gray scale image i.e. the intensity of red, green, blue pixels are regulated and represented by single intensity value for all pixel in image.

3.2 Feature Extraction

In this module colour detection, shape detection and imprint detection of image is done.

For colour detection, the output of pre-processing phase i.e. a grey scale is passed to Gaussian filter to make it blur and for removal of outliers and noise. In second stage a mean filter is used to smooth the image. At last colour contrast is enhanced and colour of pill is extracted using histogram equalization as shown in fig.2

Fig. 2. Colour Detection

For detection of pill shape, Sobel filter on gray scale image is applied and edges are extracted to know the shape. As shown in fig. 3.

Fig. 3. Shape Detection

Some of drug pill come up with imprints i.e. characters/words are carved on them which help to narrow down the recognition process. A canny edge detection algorithm with dilution operation is used for edge detection. Scale Invariant Feature Transform (SIFT) is used to detect imprints from drug pill as shown in fig. 4.

Fig. 4. Imprint Detection

3.3 Convolution Neural Network(CNN)

CNN's have been extensively used to classify images. The four important layers in CNN are shown in fig. 2:

1. Conv 2D: A 2-D convolutional layer transforms a 2-Dinput into sliding convolutional filters. By moving the filters vertically and horizontally along the input, computing the dot product of the weights and the input and then adding a bias term, the layer convolves the input.
2. Maxpooling: Max Pooling is a pooling operation that determines the highest possible value for patches of a feature map and uses that information to produce a down-sampled (pooled) feature map. It is frequently applied following a convolution layer. It is similar to the convolution layer in that the maximum of the input region taken that the kernel overlaps rather than the dot product of the input and kernel.
3. Flatten:The input is flattened using flatten. The resultant2-Dimensional arrays from pooled feature maps are all flattened into a single, lengthy continuous linear vector. To classify the image, the flattened matrix is fed as input to the fully connected layer.
4. Dense: The simple layer of neurons known as the dense layer receives input from every neuron in the preceding layer. Based on the results of the convolution layers, a dense layer is used to categories the images. The number of neurons in a layer varies. Each neuron in a dense layer receives one output from the preceding layer, which is fed to all of the layer's neurons.

3.4 Text to Speech

The text is converted into speech using an algorithm that uses CNN's classification results. The input, which is a text, goes through a preprocessor, an encoder, a decoder, and finally, using avocoder, converts it into audio. The android.speech.tts. text to speech library is utilized for text-to-speech implementation.

4. Results and Discussion

The "Pharmaceutical Tablets" Dataset from www.kaggle.com is used to obtain experimental results. This dataset consists of 20,000 jpeg images with dimensions of 227 by 227 pixels which applied to 5 layer CNN where 20% of the data is used for testing and 80% of the data are used for training. Here, the model is trained and tested using a 10-fold cross validation technique. To assess the effectiveness of the system, different evaluation measures likeaccuracy, precision, recall, and f1-score are computed. In testing Phase 2085 pill images were used and the system correctly predicted 2073 samples, yielding 99% accuracy. The confusion matrix for the 2085 test samples is displayed in Fig.5.

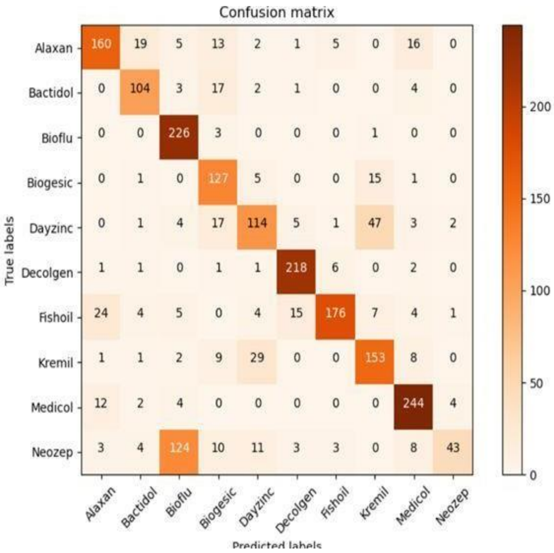

Fig. 5. Confusion matrix

Real time pill recognition is also carried out to validate the model. The proposed system is validatedon 10 actual pill sampleswhere fig. 6. Shows the precision, fig. 7 shows recall, and fig. 8 shows fmeasure are displayed in fig.6, fig. 7 and fig. 8 respectivelyfor each sample.

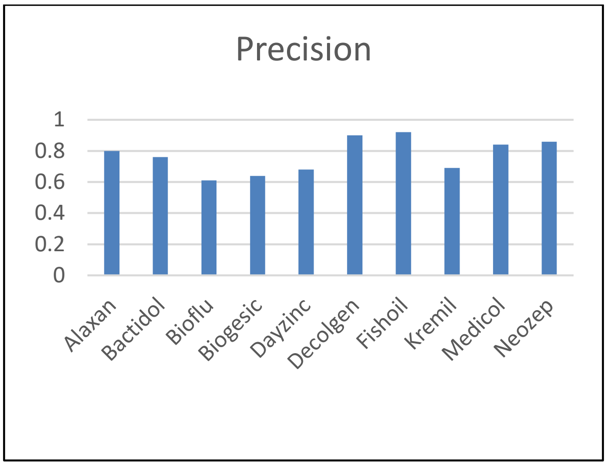

Fig. 6. Precision on 10 Real Time Samples

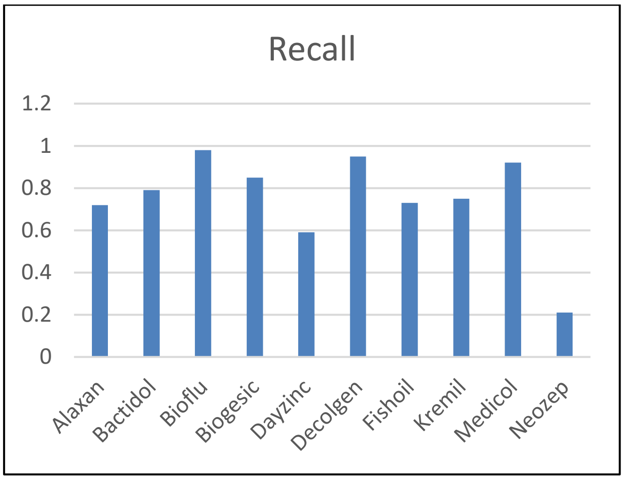

Fig. 7. Recall on 10 Real Time Samples

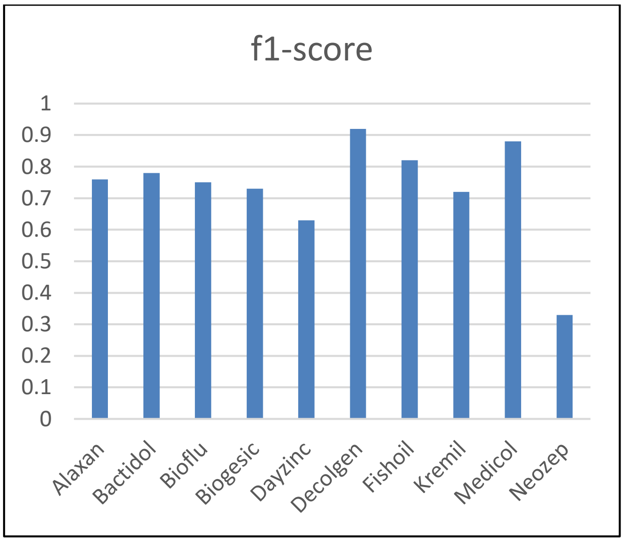

Fig. 8. F-score on 10 Real Time Samples

A system test and system verification application built for Android is developed. Fig. 9 shows the admin modules, Fig. 10 shows the drug pill detection module and fig. 11 shows the drug pill retrieval moduleare of proposed drug recognition system.

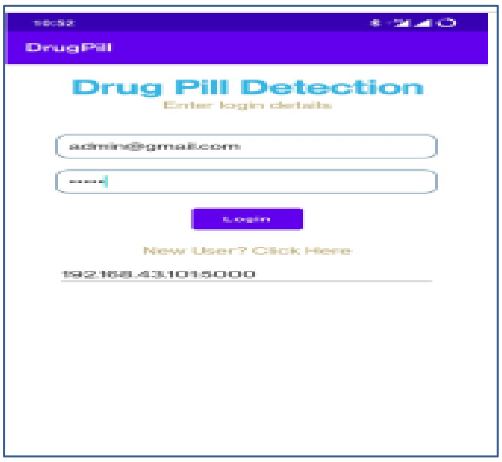

Fig. 9. Admin Module

Fig. 10. Detect Drug Pill

Fig. 11. Retrieve Drug Pill Details

Using the admin username and password, the administrator logs in to the Dashboard in the admin module The Add Drug Pill, View Drug Pill, Scan Drug Pill, and Logout modules are among the four found in the Dashboard. By capturing the image of the pill or choosing it from the server database, the admin can add the pill information.

The user logs in using their username and password in User Module then navigates to the Dashboard page. ScanDrugPill, MyProfile, SetNotification, Logout,etc. are among the four modules on the dashboard. The user can detect the image information according to the input and, after clicking the detect button and receive audio output as shown in fig.10. The user can set notification according to the prescription time using Fig. 11. On the user's device, this serves as a reminder message.

The practical implications of applying a drug pill recognition system for elderly and visually impaired people are significant, as these systems can greatly enhance medication management and safety for these vulnerable populations. Here are some key practical implications:

1. Improved Medication Adherence:

Drug pill recognition systems can help the elderly and visually impaired individuals take the correct medications at the right times. This can lead to improved medication adherence, reducing the risk of missed doses.

2. Enhanced Medication Safety:

By accurately identifying pills, these systems reduce the likelihood of medication errors, such as taking the wrong medication or incorrect dosages. This is especially crucial for elderly individuals who often take multiple medications.

3. Independence and Autonomy:

Such systems empower visually impaired individuals to manage their medications independently, promoting a sense of autonomy and reducing the need for constant assistance from caregivers.

4. Reduction in Healthcare Costs:

Improved medication adherence can lead to better health outcomes and fewer hospitalizations, ultimately reducing healthcare costs for both individuals and healthcare systems.

5. Minimized Health Risks:

The risk of adverse drug interactions and side effects is lowered when individuals can accurately identify their medications. This is particularly important for elderly individuals who may be more susceptible to such risks.

6. Ease of Use and Accessibility:

Developers should ensure that drug pill recognition applications are user-friendly and accessible to those with visual impairments. This includes implementing voice-guided interfaces, screen reader compatibility, and tactile feedback.

7. Regular Medication Reminders:

Many drug recognition apps also include medication reminder features, which can be particularly helpful for the elderly, who may have memory issues.

8. Community and Caregiver Support:

These systems can facilitate better communication between elderly individuals, caregivers, and healthcare providers. Caregivers can remotely monitor medication adherence and receive alerts if medications are missed.

9. Customization and Personalization:

Developers should allow users to customize the app to their specific needs, including the ability to add unique medication instructions and preferences.

10. Integration with Healthcare Systems:

Integrating these systems with electronic health records (EHRs) and telehealth platforms can further enhance healthcare coordination and medication management.

11. Continuous Improvement and Updates:

Developers should regularly update and improve the recognition algorithms and databases to ensure accurate identification of all types of medications.

In summary, the practical implications of applying drug pill recognition systems for the elderly and visually impaired are profound. These systems not only improve medication management but also promote independence, reduce healthcare costs, and enhance the overall quality of life for these individuals. However, it is essential that these systems are designed with accessibility, usability, and user-specific needs in mind to maximize their effectiveness and adoption.

5. Conclusion

This paper recommends an effective drug pill recognition system which is beneficial for visually impaired people or elderly people as voice assistant is also integrated in system in addition to identification of drug pill.This system not only reminds the patient for medication through notification system but also help them in correct identification of medicines by informing the name of pill. This drug pill recognition system can successfully lessen the issue of drug interactions brought on by taking the wrong medications. It also reduces the cost of medical care and provides a secure environment to visually impaired patients. The suggested system also prompts patients to take their medications at the appropriate times. The experimental findings 99% validate the system's efficacy.

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