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A Machine Learning Approach to Detect the Adulterants in Turmeric Powder

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***Abstract* - The popular spice turmeric powder is used in many dishes and offers several health advantages. However, it is frequently contaminated with less expensive materials, producing a product of lower quality, and possibly posing health risks to consumers. The initial deficiencies after the economic crisis in Sri Lanka started a black-market for turmeric as prices were increase steeply. Fake powders also made an appearance in the Sri Lankan market. Food adulteration is a frequent crisis which has been a concern over decades now. Thus, it is vital to discover the possibility of the composition of original turmeric powder among the turmeric powders in the market. There is a great possibility of the adulteration of Turmeric in powdered forms and mixing other ingredients with powdered turmeric is easy. Distinguishing these other ingredients mixed powdered turmeric is not easy. Due to the rise in demand in customers, the manufacturers tend to keep up the production but by adulterating turmeric powders using different methods and these powders have several health effects. This study intends to construct a machine learning-based fraud detection web application that can precisely identify adulterants in turmeric powder samples using microscope pictures to solve this issue. Machine learning has emerged as a powerful tool for detecting adulterants in various food products and has shown promising results in recent years. In this research, we propose a machine learning-based fraud detection web application to detect adulterants in turmeric powder samples using microscope images. The application will utilize transfer learning, specifically the MobileV2Net, to improve the accuracy of adulterant detection.**

Keywords: Machine learning, Prediction, Intelligent, analyze, CNN (Convolutional Neural Network), Machine learning, Food quality, Turmeric powder, Data Augmentation, Deep learning, Adulterated Turmeric powder.

I. INTRODUCTION

In the food and pharmaceutical sectors, spices are particularly valuable and significant. Because of this, it is crucial to identify and group spices according to their purity. Profiteers fraudulently make different fake spices for sale with no concern for the overall well-being of humanity; their only incentives are economic advantage and profit.

Turmeric is a commonly used spice with numerous medicinal properties and an expensive spice used in the culinary arts. Turmeric is one of the best nourishing spices in the world and has natural antioxidants properties. Turmeric is an essential item in the Sri Lankan household because of its unique, distinctive golden shade and strong smell. In Sri Lankan Turmeric Cultivation the farming of the handed down roots died almost decades ago during the civil war of Sri Lanka. After that situation the country heavily relied on importing turmeric. But along with the financial crisis which the Sri Lanka faced turmeric were sold as an expensive item and shortages of turmeric is reported with the import controls which are being imposed by the government.

Additionally, turmeric has been useful in many industries such as cosmetics and pharmaceuticals industry. Turmeric is mostly available in the market in powdered form. Turmeric's top export destination from Sri Lanka includes France, the United Kingdom, India, and Germany. Different countries require turmeric of different quality levels based on their needs. In the recent past, due to the major issues which Sri Lanka facing it impacted for both turmeric supply and turmeric exportation. As a result, cultivators were unable to meet the expected turmeric quality standards of different countries.

In the market original turmeric powder is being with various inorganic and organic powders mixed to gain economical value from the turmeric powders by the marketers. Various methods are being used by the marketers to make this fake turmeric powders. Cancers, Stomach disorders and food

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toxicity are some of the most common health issues faced due to the adulterant's turmeric powders. These adulterated turmeric powders are hard to identify with the pure eye. Good quality turmeric powder is saffron colored. If the turmeric powders in the market have dull color, it is most likely to be of lower quality. Most common methods which are used in the market to make adulterated turmeric powders are mixing the original turmeric powders with Aniline dye, Metanil yellow, Chalk, Rice flour and Chickpea flour.

In the turmeric market, it is crucial to identify and group turmeric according to the purity level. Because of this Profiteers fraudulently make fake turmeric powders by mixing different organic and inorganic ingredients and sold them with no concern for the overall well-being of humanity; their prior objectives are economical advantage and profit. So being a common adulterated spice, with various substances added to increase the quantity and appearance of the turmeric. By using Machine Learning, it can help to identify and determine the adulterants used in the spice ensuring the highest quality of turmeric is being exported and sold in the market As well.

Detecting adulterants in turmeric powders in turmeric powder microscope image samples using Machine learning based web application is focused on this research. In Sri Lanka, testing the adulterants of turmeric using microscope images is time consuming and cost intensive task as it requires expensive equipment and laboratory facilities.

An improved method for identifying adulterants in turmeric powder can be found by combining machine learning and image analysis approaches. The machine learning algorithms can detect patterns and traits that are suggestive of adulteration by examining photos of turmeric powder samples, and they can indicate potential problems for additional research. This technology can greatly increase the detection process's accuracy and dependability, lessen the need for manual inspection, and help find more advanced adulterants that conventional inspection techniques would overlook. A quick nondestructive method is very important and a needed fact today when detecting the adulterants in food items. So, researchers all around the world have discovered many successful methods such E- nose, spectroscopy, Image processing, Computer vision and IoT to detect the adulterants. However, these techniques cope with vast amounts of data which contain so much irrelevant information which decreases the effectiveness and speed of a detection system. Data analysis methods are very significant, and it is a challenge for researchers to extract accurate data and analyzing the data in practical life.

To cope with the vast amount of data, several data analysis techniques have been created, including PLSR, KNN, CNN and SVM and Fuzzy and EDT and others. As a successful machine learning algorithm, deep learning has acknowledged extensive research and is currently gaining greater attention from a variety of places. Transfer learning, coping with the enormous quantity of data, and achieving improved performance and greater precision have all been demonstrated as substantial benefits of DL.

In most of the studies studied, convolutional neural networks have been acknowledged as the essential techniques that could automatically study deep characteristics of input images for ensuing classification tasks. CNN can effectively analyze the substantial quantity of data gathered by the technologies for evaluating the quality and safety of food.

In this study, an improved version of Convolutional Neural Network is used to categorize turmeric microscope photos to detect the adulterated powders through a mobile application.

II. LITERATURE OF REVIEW

The literature survey will provide an overview of the recent research works in the area of machine learning approaches in microscope image detection. Recent and past studies demonstrate the potential of machine learning bases approaches for various applications related to turmeric and highlight their ability to improve the quality and safety of turmeric products.

Identifying the adulterants of the turmeric powder through microscope images which is done by a highly qualified person usually specialist still takes 30-60 minutes to verify whether the powder is mixed with which adulterants and what compositions which is a very time-consuming task. Further the specialist might need to take multiple samples.

Detecting fake powders could be considered as one of the critical issues for the food industry and consumers alike. So, the traditional methods can be taken as time consuming and often require extensive training and expertise. It is necessary to investigate the capabilities of machine learning and transfer learning to create an automated method for identifying the adulterants in turmeric powder using microscope image samples.

Determining the effectiveness of the machine learning algorithms in accurately predicting the fake powder composition using microscope image samples, and how this technology can be applied in the food industry to improve the quality control and ensure consumer safety.

For several reasons, it is crucial to identify turmeric powder adulterants utilizing microscope pictures. First,

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turmeric, a regularly used spice with a few health advantages like anti-inflammatory and antioxidant qualities, should be mentioned. When dangerous compounds are added to turmeric powder, it might have negative health effects on consumers. Second, adulteration can also result in commercial fraud and unfair market rivalry. Third, because adulterants might be challenging to spot with the unaided eye, visual inspection is not always successful in identifying them. To ensure consumer safety and ethical business practices, it is possible to detect adulterants in turmeric powder using machine learning and image analysis approaches.

In the area of Computer Vision and Machine Learning field, identifying the microscope images, and processing them for various purposes such as fraud detection on the microscope image samples is a rising field. Many studies have identified that using CNN can identify and extract features and patterns effectively from microscope images. These techniques can be used for detecting the fraudulent turmeric powder samples accurately which is being mixed with other powders. Mostly CNN architecture like LeNet, AlexNet, VGGNet, ResNet and InceptionNet is being used for identifying and classifications. These models are being trained with numerous datasets. Also, these models are being evaluated based on performance metrics such as precision, F1-Score and confusion matrix.

Y.Jiang [9] used CNN technology to identify and classify fake and real milk powder microscope image samples. He has classified the microscope image samples into three main categories as genuine, diluted and substituted which resulted 99.67% higher accuracy.

Researchers have used CNN method to detect adulterants in the pharmaceutical industry also. A recent study by S.J Kim [10] proposed a study to identify the adulterants and detect counterfeit drugs by classifying them using their shape, texture, and other microscopic features. This research has been able to achieve 99.4% accuracy using the CNN method.

Much research is being done in the field of forensics also. In research by C.Sun [11], he has used a CNN method to classify the banknote microscope image samples. The microscope image samples have been classified under two main categories which are genuine and fake. This researcher has been able to get about 99.75% higher accuracy in detecting fraudulent banknotes.

Liu.et.al. detected an adulterant in Chrysanthemum tea in the research. The research has proposed a method of applying deep neural networks directly on the raw image. The study resulted that the computer vision with deep learning can be a multipurpose method to detect the evaluation of food quality. The research's sample size was constrained as it was their initial effort to use the DNN for food quality monitoring. The best prediction accuracy was 90% and 63%, respectively. Unlike the research we here been proposed to use CNN (Convolutional Neural Network) with computer vision and planning to use about 5000 image samples plan to increase the accuracy.

Research has been proposed a system to detect the adulterated food products using image processing [6] and they have identified that turmeric is being adulterated by adding Kesari dhal. If taken frequently this will lead to stomach disorders. In this research they have been used a multispectral imaging system to display the amount of fraud turmeric powder composition. They captured dissimilar data of adulterated turmeric powder and noise has been reduced while doing analog to digital alteration using filters.

The study [7] proposed a system to detect the adulterants in the saffron which uses sunflowers to make adulterated Saffron. This research focuses on ANN back propagation. The performance of this system shows that the fraud saffron detects it adequately. The classification accuracy is 86.87% success rate with Artificial Neural Networks. E-nose of the system might provide sensible parting of the saffron. The proposed system is designed to use CNN much more complex system with a gated pooling system providing more accuracy.

The proposed system here shows a method to detect the adulteration of coconut milk with water. They preprocessed the dataset by eliminating futile spectral bands. The LDA algorithm was used in the feature extraction stage. During the classification stage, they have applied the KNN model. On a public dataset made up of the FTIR spectra of several samples of coconut milk, trained the suggested system and assessed its performance. With a classification accuracy of 93.33%, the suggested approach was successful in detecting and quantifying adulteration in coconut milk. The results demonstrate that FTIR spectroscopy and ML are reliable methods for identifying adulteration in coconut milk. These methods offer a quick, automated, and nondestructive method for determining the quality of coconut milk [8]. Here their accuracy is 93.33% but we are planning to grow the accuracy of the proposed system using CNN algorithm detecting the adulterants.

The major aim of the research [5] is to enhance an effective system to detect the visible faults in and grading the lemon using upgraded CNN algorithm. The photos were preprocessed and then classified using CNN. The CNN (Convolutional Neural Network) is used with data augmentation and a pooling technique. Additionally, to compare the proposed method, LBP (local binary patters), KNN (K- nearest neighbor), DT (Decision Tree) ANN (Artificial Neural Network), SVM (Support Vector Machine)

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and has been used to compared and the results shows that CNN has higher accuracy.

III. RESEARCH OBJECTIVES

A) Developing an image processing-based fraud turmeric powder detection using microscope image samples to ensure the quality of the turmeric powder

The main goal of this is to ensure the proper quality is distributed around the country so that appropriate composition of the original turmeric powder is distributed in the market. Through this research, this will be contributed to the development of an effective and accurate and easy method for fraudulent turmeric detection, which is necessary to ensure the proper safety of turmeric powders.

Using Machine Learning technologies for the classification of fraud turmeric powders, consumer suppliers can easily detect the adulterants. This method is a non-invasive and non-destructive method of analysis. Traditional methods such as chemical tests or visual inspections many not always reliable.

To achieve the specific objective of finding the original turmeric powder and mixed fake turmeric powder samples following resources may be helpful.

- To develop a smart web application to identify the fraudulent amount of turmeric powder using microscope image sample image dataset over 3000 were collected under different categories. They were original turmeric powder samples, the original turmeric powder-95% with rice flour-5% image samples, the original turmeric powder-90% with rice flour-10% image samples, original turmeric powder -85% with rice flour-15%, 100% rice flour powder.
- To evaluate the performance of the developed system in detecting adulterants in real word samples.
- To optimize the system for high accuracy and efficiency in detecting adulterants turmeric samples.

To protect consumer health by accurately identifying and removing any harmful substances.

IV. METHODOLOGIES

A) Developing an image processing-based fraud turmeric powder detection using microscope image samples to ensure the quality of the turmeric powder

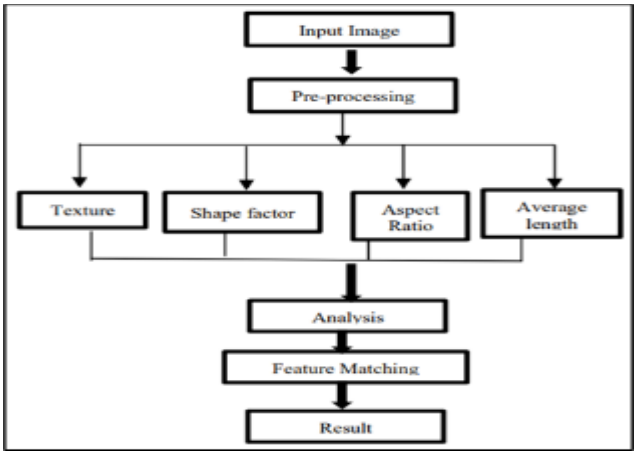

Figure 1: Flowchart

According to Figure.1 it is necessary to collect a large dataset of microscope images of turmeric powder samples. The above collected image samples were classified and labeled as pure turmeric, turmeric with 5% rice flour, turmeric with 10% rice flour, turmeric with 15% rice flour, turmeric with 25% rice flour. Then the images which were collected undergo pre-processing techniques such as cropping, resizing and normalization to arrange them for training and testing process.

The main goal of the requirement gathering part is to collect the data on the newest technologies and use it to build the planned research and to identify the newest path to follow in the project. Studying previous research, journals and online articles published relevance to the adulterer food products, all the requirements will be collected. Nevertheless, YouTube videos are also of immense help to identify research related data. To analyze fraud turmeric powders mixed with rice flour, a new dataset needs to be introduced. The System has taken 6 categories into consideration in detecting the adulterants of the turmeric powders. To develop a smart web application to identify the fraudulent number of turmeric powders using microscope image samples image datasets over 3000 were collected under different categories. The Original turmeric powder is collected from home cultivated rhizome and grounded to fine powders under an extreme hygienic environment in-house ensuring there is no pre-adulteration of any kind. And with the supervision of Lab expert, the turmeric powders were mixed with different compositions, and they were categorized into 6 categories and collected samples were placed under the microscope and images were captured using mobile phone. The categories were original turmeric powders, original turmeric powder with 95% rice flour 5%. image samples, original turmeric powder 90% with rice flour 10% image samples, original turmeric powder 85% with rice flour 15%, 75% original turmeric powder with 25% rice flour, 100% rice flour powder.

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Data collection happens through an microscope which is attached with a mobile phone to capture the images with different zoom levels and videos later breaking them into frames. We have recorded over an hour of videos which contain videos of several different samples. Sample image sizes are 314kb to 400kb and all images have a 2880*2480 resolution.

Accuracy of the machine learning model improves with the increasing number of data points in the training set. In this work around 500 image samples were collected from each category under the microscope, each with different powers.

Then the MobileV2Net deep learning model was fine tuned to detect the adulterated turmeric powder samples using pre- processed images.

Then the performance has been evaluated using metrics. To fine tune the model on a new dataset for a specific task it is convenient to use Transfer learning technique. This will help to speed up the process as the pre-trained model has already learned the necessary required features.

Based on the collected microscope image data sets the machine learning model can accurately identify the composition of original turmeric powders in the turmeric powder sample using CNN, TensorFlow and image processing.

Further, moments before analyzing Images should be added to data Model.in modeling, to train a model that needs more GPU power, in this study we use Google Collab and drive to get much gpu power. To organize the dataset, we apply ImageNet. ImageNet is an image database organized according to the WordNet hierarchy, in which each node of the hierarchy is depicted by hundreds of thousands of images. The project has been instrumental in advancing computer vision and deep learning research.

MobileV2 Net architecture in fig.2 is being used to train the model as it is a very light and efficient mobile architecture developed to assist classification, detection and more on images.

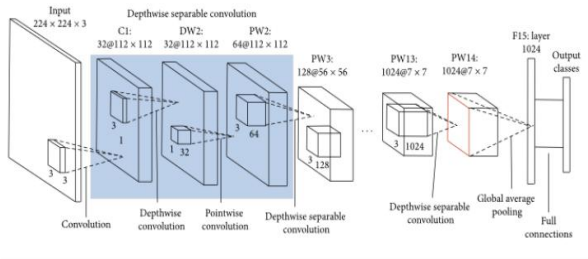

Figure 2: MobileV2Net Architecture

Then, as a MobileV2 net architecture we use [224,224] input shape of images and all images were stored in the Google Collab to create the preprocessing object. This will use image batch size, class list and class mode after successfully running of the preprocessing function in a mobilev2 net architecture and then created the preprocessed object. After training the model as in Fig.3 with good accuracy, we generate the model as a hdf5 file.

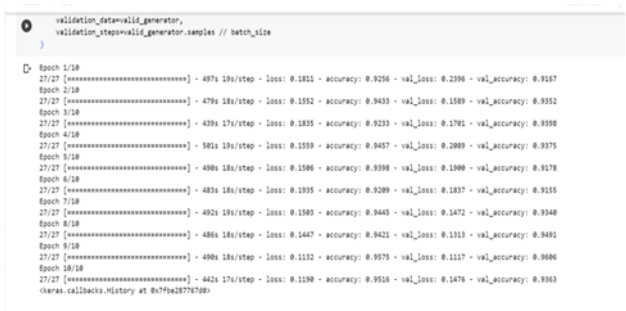

Figure 3: Model Training Epoch graph

V. RESULTS AND DISCUSSIONS

To ensure the web applications fulfilled the requirements and criteria of farmers, consumer suppliers, and manufacturers in Sri Lanka, helping them to improve and maximize the growth of turmeric cultivation, it has been tested on models with a higher degree of accuracy and evaluated for effectiveness in detecting adulterants of the turmeric powder.

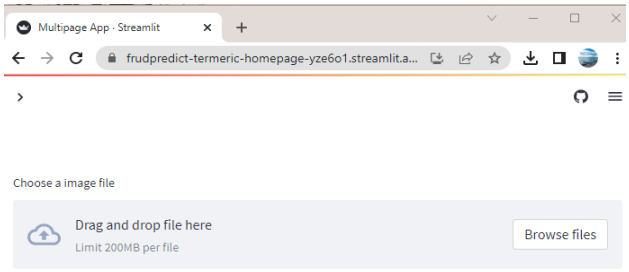

Figure 4: Web application upload file

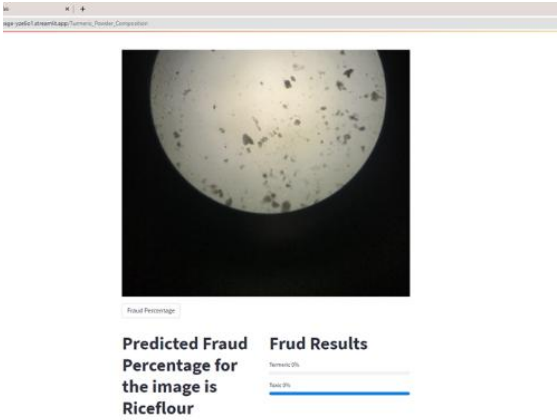

Figure 5: Results I

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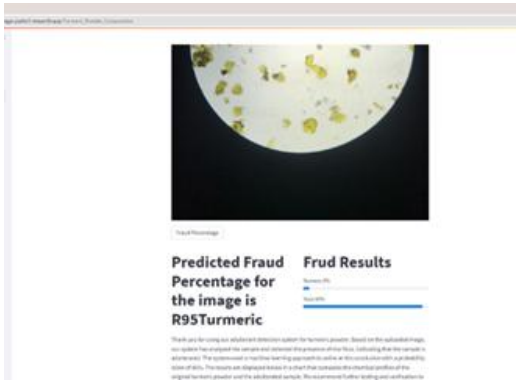

Figure 6: Results II

The expected outcome as in Fig.4, Fig.5 and Fig.6 of the fraud detection component in the web application accurately can detect the adulterants in turmeric powder using microscope images. The application will utilize transfer learning, especially MobileV2Net, to improve the accuracy of adulteration detection, ensuring high quality turmeric is provided to consumers and protecting their health. The research will also contribute to the field of machine learning by providing a new and effective approach for detecting adulterants in food products, which has important implications for food safety and consumer health.

VI. CONCLUSION

This section will conclude the research by summarizing the key research findings tally with the research aims and research questions. With the rapid development of technology, everything has started to become innovative.

Through this research, this will be contributed to the development of an effective and accurate and easy method of adulterant detection which is necessary to ensure proper safety of turmeric powders.

Using machine learning technologies for the classification of fraud turmeric powders, consumer suppliers and government can easily accurately detect the fraud number of powders mixed with the turmeric powders and this method is a noninvasive and nondestructive method of analysis. Traditional methods such as chemical tests or visual inspections may not always be reliable.

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REFERENCES

[1] A.Jahanbakhshi, Y. Abbaspour-Gilandeh, K. Heidarbeigi, and M. Momeny, “A novel method based on machine vision system and deep learning to detect fraud in turmeric powder,” Computers in Biology and Medicine, vol. 136, p. 104728, Sep. 2021, doi: 10.1016/j.compbiomed.2021.104728.

[2] C. Liu, W. Lu, B. Gao, H. Kimura, Y. Li, J. Wang, Rapid identification of chrysanthemum teas by computer vision and deep learning, Food Sci. Nutr. 8 (4) (2020) 1968–1977.

[3] J. Amin, A. Selwal and A. Sabha, "SAPS: Automatic Saffron Adulteration Prediction Systems, research issues, and prospective solutions," 2021 Fourth International Conference on Computational Intelligence and Communication Technologies (CCICT), 2021, pp. 64-71, doi: 10.1109/CCICT53244.2021.00024.

[4] M. Momeny, A. Jahanbakhshi, K. Jafarnezhad, and Y.-D. Zhang, “Accurate classification of cherry fruit using deep CNN based on hybrid pooling approach,” Postharvest Biology and Technology, vol. 166, p. 111204, Aug. 2020, doi: 10.1016/j.postharvbio.2020.111204.

[5] A.Jahanbakhshi, M. Momeny, M. Mahmoudi, Y.D. Zhang, Classification of sour lemons based on apparent defects using stochastic pooling mechanism in deep convolutional neural networks, Sci. Hortic. 263 (2020) 109133.

[6] Anjana M.P, Pradeepa. K, “Detecting food adulterants using the concepts of machine learning”, International Journal of Applied Engineering Research Vol 14, pp. 25-31, 2011.

[7] P. Goyal, R. Sharma and K. Varshney, "Machine Learning Approaches for Classification of Turmeric Powder Samples," 2021 International Conference on Artificial Intelligence and Data Engineering (AIDE), Jaipur, India, 2021, pp. 1-6, doi: 10.1109/AIDE52484.2021.9459581.

[8] S. Sankar and S. Sankar, "Machine Learning-based Classification of Curcuminoids in Turmeric Rhizomes using Spectroscopic Data," 2020 IEEE International Conference on Computational Intelligence in Data Science (ICCIDS), Chennai, India, 2020, pp. 1-5, doi: 10.1109/ICCIDS49954.2020.9185511.

[9] Y. Jiang, W. Li, J. Li, and Y. Wang, "Deep Convolutional Neural Network for Milk Powder Adulteration Detection," IEEE Access, vol. 6, pp.

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https://doi.org/10.47001/IRJIET/2023.707024

29052-29061, 2018. doi: 10.1109/ACCESS.2018.2845217.

[10] S.J. Kim, Y. Choi, H. Kim, and K. Kim, "Identification of Counterfeit Drugs Using Machine Learning," Journal of Healthcare Engineering, vol. 2019, Article ID 1529140, 8 pages, 2019.

[11] C. Sun, Y. He, Q. Li, and H. Li, "A Convolutional Neural Network for Automatic Banknote Classification," in 2018 IEEE International Conference on Big Data and Smart Computing, 2018, pp. 569-573.

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