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Classification & Detection of Banknotes Using Machine Learning

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Abstract: ***The only valuable resource in our country is bank currency, which is why money launderers inject fake notes that mimic genuine notes into the financial system to create imbalances. When the market is demonetized, there is a discernible quantity of counterfeit money floating about. In most cases, a human cannot easily tell the difference between a genuine note and a counterfeit one, even when many of the features of a counterfeit note are the same. Automated systems must be accessible at banks or ATMs in order to identify bank currency authenticity. Since counterfeit banknotes are meticulously crafted, an effective algorithm that can determine whether a note is real or false must be created in order to create such an automated system. In this study, we use a dataset from the UCI machine learning repository to apply the CNN algorithm. In order to put this into practice, we used machine learning algorithms and evaluated how well they performed using a range of quantitative analytical metrics.***

Keywords: CNN, Pre-Processing, Feature Extraction, Training, Testing.

I. INTRODUCTION

In India, where the Reserve Bank of India (RBI) has the only authority for creating money, counterfeit note detection devices represent a significant technological achievement. High-value denominations such as the 500 and 2000 rupee notes are the focus of these systems, which utilize advanced image processing algorithms to verify the validity of currency notes. The method evaluates security elements such as optically changeable ink, latent images, security threads, and watermarks. The problem of counterfeit money, which jeopardizes the financial system and increases inflation, is addressed by this strategy.

Access to these detecting equipment for the general population is still difficult, though. Since banks keep the majority of detecting equipment, it is challenging for the general people to confirm the validity of their bank notes when conducting routine transactions. This emphasizes the need for counterfeit detection methods that are easier to use, more accessible.

A innovative method for detecting counterfeit involves extracting and analyzing the small print on money notes using digital image processing techniques. This entails capturing digital images of the notes and modifying them to exhibit their unique security features. By comparing these characteristics with verified, authentic notes, the program enables money verification even for those without specialized knowledge or equipment.

Since counterfeit money is still a problem, developing detection systems that are both accessible and effective is essential. Using image processing technology, a more inclusive approach might shield the economy from counterfeiting and give those who are most in need of financial stability.

II. FACTORS

Using a variety of variables and methods, machine learning is used to identify and recognize banknotes, producing results that are dependable and accurate.

Here are some important things to think about:

1) *Extracting Features:* Identify pertinent features Identifyable characteristics that set banknotes apart should be extracted. Colour, texture, security threads, watermark patterns, and other distinctive qualities are examples of these attributes.
2) *Gathering Data:* Assemble a varied dataset: Assemble an extensive collection of pictures or other pertinent information on different banknotes from different nations, denominations, and states. It takes this varied dataset to build a strong machine learning model
3) *Preprocessing:* Prepare and clean the data: Clean up the photographs, adjust the colors, and take care of any noise or distortions to prepare the dataset. Preprocessing enhances the model's capacity to identify features and patterns.

4) *Selecting a Type:* Choose an appropriate model: Select a machine learning model according to the difficulty of the issue. Convolutional neural networks, or CNNs, are widely used for numerous image recognition applications, including the identification of banknotes.
5) *Training:* Educate the exemplary person: Utilizing the pre-processed dataset, train the machine learning model. During training, the model learns to associate specific banknote classes with specific properties.
6) *Validation and Testing:* Evaluate the model. Analyze the model's performance on a separate validation dataset to ensure that it generalizes to new, untested data with effectiveness.
7) *Exaggeration:* Data augmentation: Adding adjustments like flipping, scaling, and rotation will make the training dataset more diverse. As a result, the model is better able to generalize to other orientations and scenarios.
8) *Segmentation and Localization:* Locate and separate banknotes: Use methods for segmenting and localizing banknotes in a picture. This is especially crucial when workingwith pictures that have several items in them.
9) *Class Imbalance:* Address the disparity in class: Use strategies like oversampling or under sampling to balance the class distribution if there are underrepresented classes of banknotes in the sample.
10) *Real-time Processing:* Take into account the needs for real-time: If real-time system operation is required, speed and efficiency should be maximized in the model and processing pipeline.
11) *Security Aspects:* Recognize security features: Teach the model to identify certain security elements, such holograms or color-shifting inks, that are exclusive to each banknote.
12) *Continuous Learning:* Put it into practice by: As new banknote designs are announced, update the model often to maintain accuracy and dependability.
13) *Deployment:* Use the model to deploy Combine the learned model with a system that can recognize and verify banknotes in practical situations. Developers may use machine learning models to build a reliable and accurate system for the identification and detection of banknotes by taking these aspects into account.

III. MODELS

Models employed were Support Vector Machine, Convolution Neural Network, Decision Tree Classifier, Random Forest Classifier, and K-Nearest Neighbor to ascertain the denomination of the banknotes. For the purpose of identifying counterfeit money, a deep learning model called Alexnet is employed.

A. SVM

Encouragement One supervised machine learning method that is frequently used in regression and classification applications is the vector machine method. It operates by selecting the most effective hyperplane to classify the data or forecast the desired variable. Choosing the right kernel function, adjusting the margin, and fixing the optimization problem are the steps in this approach. SVM has proven useful in a variety of fields, including text and image classification and bioinformatics.

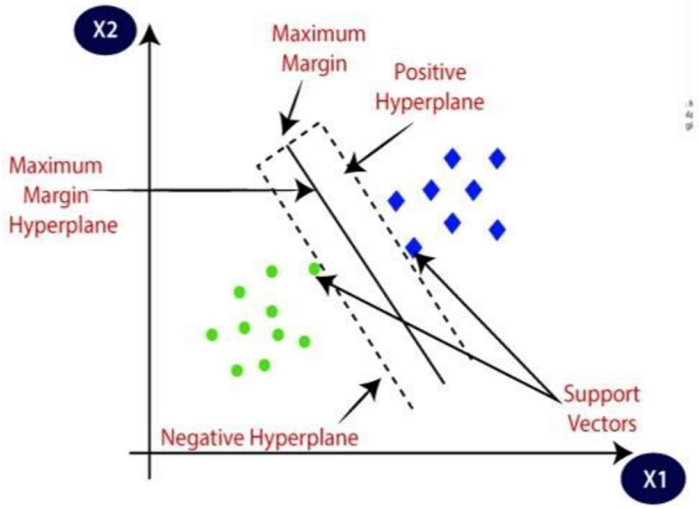

Fig1: SVM

B. CNNA

Convolutional neural network is Convolutional neural networks are one of the main kinds of neural networks used for image identification and classification. Convolutional neural networks are widely used in many domains, such as object identification, face recognition, scene labeling, and others.

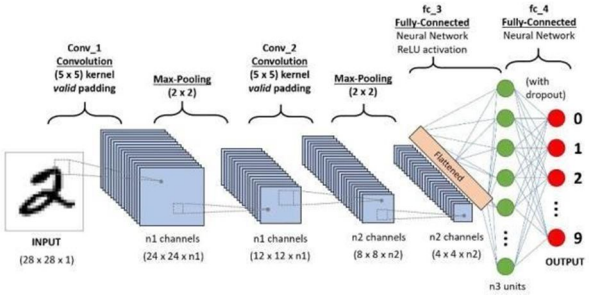

Fig2: CNN

C. DTC

For classification jobs, supervised machine learning techniques like Decision Tree Classification (DTC) are used. The DTC process consists of the following steps: data preparation, performance evaluation, model training, and selection.

Through data segmentation based on key attributes, DTC builds a tree-like structure that supports decision-making. DTCis a well-liked and practical solution for categorizing problems in a variety of areas, including marketing, banking, and healthcare.

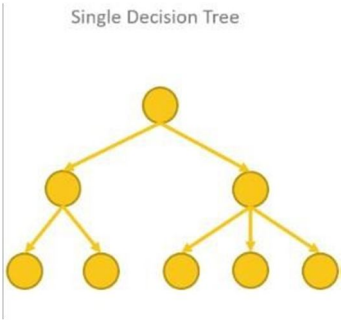

Fig3: DTC

D. RFC

For classification applications, Random Forest Classification (RFC) is a powerful ensemble machine learning technique. The RFC method consists of selecting and prepping the data, training several decision tree models on a randomly selected sample of the data, and merging the results from these models.

RFC minimizes overfitting, which raises the model's accuracy. Because of its exceptional accuracy and resilience, RFC is used in many fields, including as image recognition, natural language processing, and fraud detection.

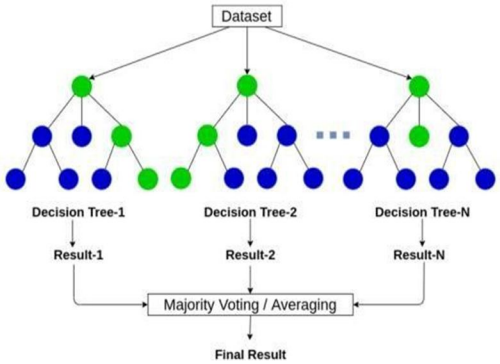

Fig4: RFC

E. KNN

A simple and effective machine learning approach for classification and regression applications is KK-nearest Neighbors (KNN). Selecting the K training set data points that most closely resemble the new data point, classifying it based on the majority class, or, in the case of regression, averaging the values of the K neighbors, is how the approach works.

The process involves selecting the K closest neighbors, calculating the distances between each new data point and each old data point in the training set, and creating a prediction. KNN has several applications, including recommender systems, photo recognition, and anomaly detection.

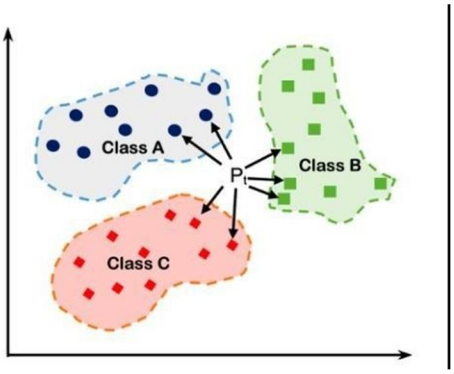

Fig4: KNN

IV. PROCESS OF EXECUTION

V. RESULT ANALYSIS

Fig5 : Fake Rs.2000 input image

Fig6: output image

By observing the above 2 figures, the proposed system is able to classify the value of the currency note and also it is able to detect whether it is fake or real.

VI. CONCLUSION

Our current system's use of machine learning methods to identify counterfeit banknotes has been covered in this study. By classifying the value of the currency note and using image processing to determine if the currency is real or false, the suggested method is scalable as well. Unlike thecurrent system, the new system does not have a complicated method to determine if the data contains counterfeit bank money. More quickly and accurately than the current approach, the proposed system produces results. To determine if the currency in this system is real or phony, we categorize it using the CNN algorithm.

VII. ADVANTAGES

There are several advantages to using machine learning techniques, particularly convolutional neural networks (CNN), for banknote detectionandclassification.

1) *Efficiency and Automation:* Banknote identification and categorization may be carried out automatically via the use of machine learning techniques, doing away with the requirement for human examination. This automation has made banking operations more effective.
2) *Accuracy:* When it comes to image recognition tasks, including banknote identification and classification, CNNs excel. Among other things, they can accurately identify the denomination, serial number, and security characteristics of a banknote and generate categorization results.
3) *Speed:* CNNs are able to quickly analyze large volumes of visual input, which facilitates the easy identification and classification of banknotes. This speed is critical in scenarios where real-time processing is required, such as automated teller machines (ATMs) and cash processing devices.
4) *Enhanced Security:* By accurately recognizing banknotes, machine learning algorithms can help detect counterfeit cash, hence improving security procedures in financial institutions. Customers can be protected fromfraud and financial losses in this way.
5) *Cost-Effectiveness:* In the long run, it could be more cost- effective to use machine learning-based systems for banknote detection and categorization. Although the creation and training of the CNN model may require an initial investment, the automation and accuracy of these systems can lead to cost savings over time by minimizing mistakes and reducing manual labor.
6) *Scalability:* Machine learning models may be trained on enormous datasets that include various currency types from several countries. These models can be easily deployed, scaled to handle several currencies, and taught to adjust to future changes in security measures or banknote designs.
7) *Flexibility:* Machine learning algorithms can easily adapt tonew challenges and changing requirements. As new securityfeatures or techniques are developed, the CNN model may be updated or retrained to incorporate them into its efficacy for banknote detection and categorization.

Jupyter Notebook use adds even more benefits by providing an interactive platform for developing, assessing, and documenting machine learning models. It is possible to facilitate straightforward cooperation, result display, andintegration with explanation text.

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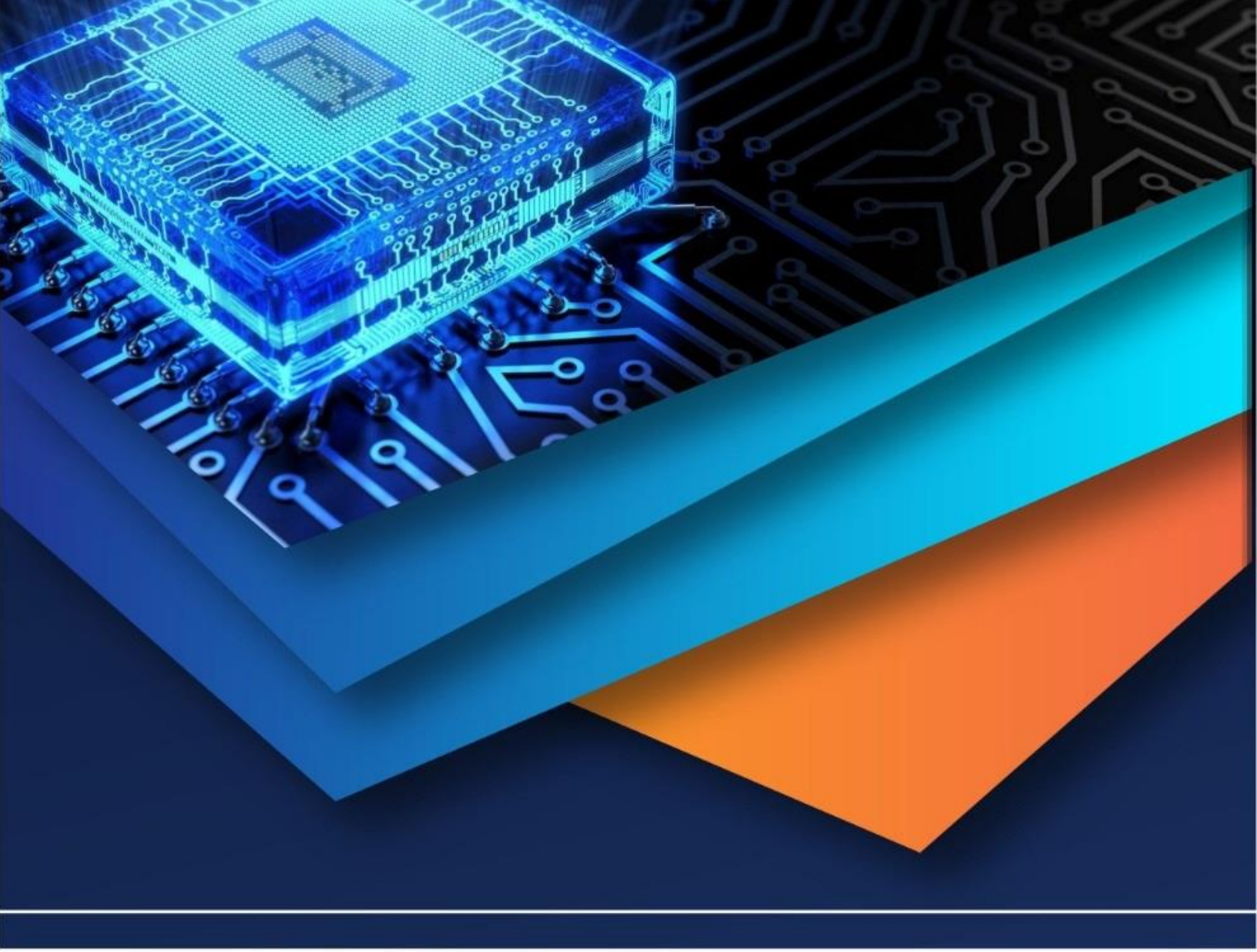

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