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DETECTING COUNTERFEIT INDIAN CURRENCY WITH HYBRID CONVOLUTIONAL NEURAL NETWORKS

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ABSTRACT: -

This paper highlights the serious issue of Indian currency counterfeiting and its adverse impact on the economy and public trust. The proposed solution to tackle this problem is the development of an efficient counterfeit detection system. The study introduces a novel approach that employs Convolutional Neural Network (CNN) and MobileNet, Alexnet, Resnet algorithms for identifying counterfeit currency. The CNNs are deep learning models with exceptional image processing capabilities, inspired by the human brain's visual processing system. The proposed system captures high-resolution images of banknotes, pre-processes them to extract essential features such as watermark patterns, security threads, and serial numbers. A vast dataset containing genuine and counterfeit currency samples is used to train the CNN architecture. The trained model effectively differentiates between genuine and fake banknotes based on these distinct features. The experimental results demonstrate the system's robustness and high accuracy in detecting counterfeit currency, making it a valuable tool for financial institutions, banks, and law enforcement agencies. This research contributes to the ongoing efforts to safeguard the Indian currency's integrity and maintain public trust in financial transactions.

Keywords: CNN, MobileNet, AlexNet, ResNet deep learning, image processing.

I. INTRODUCTION

In recent times, the rise in counterfeit currency has emerged as a significant global challenge for financial systems. India, with its expanding economy and growing cash transactions, faces a heightened risk of counterfeit currency circulation. The demand for effective methods to detect fake notes has never been more critical. Traditional verification approaches often struggle to keep pace with the evolving tactics of modern counterfeiters. As technology progresses, our strategies to combat financial fraud must also evolve. This has prompted the exploration of innovative methods, with Convolutional Neural Networks (CNNs) emerging as a promising avenue for detecting counterfeit Indian currency.

Counterfeit currency not only jeopardizes a nation's economic stability but also erodes trust in its financial institutions. Recognizing the severity of this issue, researchers and technologists have turned to artificial intelligence, particularly CNNs, to create robust systems capable of accurately distinguishing between genuine and counterfeit currency. The design of CNNs is inspired by the human brain's visual processing capabilities, making them adept at tasks involving pattern recognition.

The distinct characteristics of Indian currency, including its vibrant colors, intricate designs, and security features like holograms and micro printing, make it well-suited for CNN-based detection systems. The complexity of differentiating authentic currency from counterfeit notes necessitates a sophisticated model capable of learning and identifying subtle visual cues. Leveraging CNNs involves a multi-stage process that promises enhanced accuracy and efficiency in combating counterfeit currency

II. LITERATURE REVIEW

Sharma and Singh (2018) introduced a novel method for detecting counterfeit Indian currency notes using the Convolutional Neural Network (CNN) in the 2nd International Conference on Inventive Systems and Control (ICISC). Their deep learning-based system learns the feature map of corresponding Indian currency notes using datasets for 2000- and 500-rupee notes. The system can detect counterfeit currency in real-time and classify whether the Indian currency note is genuine or fake, highlighting its effectiveness in addressing the significant issue of counterfeit currency in India.

Yadav and Gupta (2019) discussed the use of a Convolutional Neural Network (CNN) for detecting fake Indian currency in their paper. The system identifies counterfeit currency by examining currency images. The CNN is trained using an 80-20% training and test split, with each layer receiving the same learning rate of 0.001. The authors emphasized the importance of detecting counterfeit money, particularly in light of advancements in printing and scanning fields that have exacerbated the counterfeiting issue.

Rathi and Agarwal (2018) applied CNNs, a class of deep neural networks designed for image recognition tasks, to detect counterfeit Indian currency notes in the 2nd International Conference on Trends in Electronics and Informatics (ICOEI). The convolutional layers of the network are particularly effective in capturing spatial hierarchies and patterns within images, making them well-suited for the intricate features found in currency notes. The dataset used for training and validation likely includes authentic and counterfeit samples, allowing the model to learn distinctive patterns associated with genuine currency notes.

III. OBJECTIVE

The goal is to create a reliable automated system that can identify counterfeit Indian currency using Convolutional Neural Networks (CNNs). This process involves training the CNN on images of both genuine and counterfeit currency, which allows for precise detection. This system plays a crucial role in preventing economic fraud by identifying counterfeit currency, thereby maintaining the credibility of the monetary system. This innovative approach leverages the power of deep learning to ensure the authenticity of currency in circulation, contributing significantly to the security and stability of the economy. The system's robustness and accuracy make it a valuable tool in the ongoing fight against counterfeit currency, demonstrating the transformative potential of artificial intelligence in addressing complex real-world challenges.

IV. SCOPE

The potential of using Convolutional Neural Networks (CNNs) in the detection of counterfeit Indian currency is vast. This approach capitalizes on the sophisticated image recognition abilities of CNNs to identify complex patterns and security features that are unique to genuine currency. By doing so, CNNs can significantly improve the precision of counterfeit detection.

This provides a strong and automated solution to tackle the growing problems associated with the circulation of counterfeit currency. As the prevalence of counterfeit currency continues to rise, it poses significant threats to the economy and the financial security of individuals. Therefore, the need for an effective and efficient detection system is more critical than ever.

CNNs, with their advanced image recognition capabilities, offer a promising solution. They can be trained to recognize the minute details and patterns that distinguish genuine currency from counterfeit ones. This includes various security features embedded in the currency notes, which are often overlooked by the human eye.

Moreover, the automation of this process eliminates human error and increases the speed of detection, making it a highly efficient method. This is particularly beneficial in a country like India, where cash transactions still form a significant part of the economy.

In conclusion, the use of Convolutional Neural Networks in the detection of counterfeit Indian currency represents a significant advancement in this field. By leveraging the power of this technology, we can ensure the integrity of our currency system and safeguard our economy against the detrimental effects of counterfeit currency circulation.

V. MOBILENET

MobileNet is a streamlined deep learning framework crafted for rapid neural network execution on mobile and edge devices, which often have restricted computing power. Created by Google's team in 2017, MobileNet seeks to optimize a trade-off between precision and computational efficiency. This makes it an ideal choice for tasks like image categorization and object recognition within the mobile environment.

The central advancement of MobileNet is its implementation of depthwise separable convolutions. Unlike traditional convolutional methods that utilize one filter across all input channels and incur substantial computational demands, depthwise separable convolutions operate in two phases: depthwise convolutions, employing individual filters for each input channel, followed by pointwise convolutions that merge the depthwise convolution outcomes through 1x1 convolutions. This two-part process markedly decreases both the parameter count and computational burden while maintaining the accuracy of the model.

MobileNet offers flexibility, enabling users to tailor the model dimensions according to their computational limits. Utilizing a parameter known as the "width multiplier," users can adjust the count of channels within each layer, influencing the balance between accuracy and the scale of the model. Additionally, the architecture incorporates methods such as comprehensive depthwise separable convolutions, linear bottlenecks, and a streamlined classifier to enhance performance.

Consequently, MobileNet has emerged as a favored option for in-device machine learning tasks, facilitating activities such as local image recognition on smartphones and other edge devices with constrained computing capabilities.

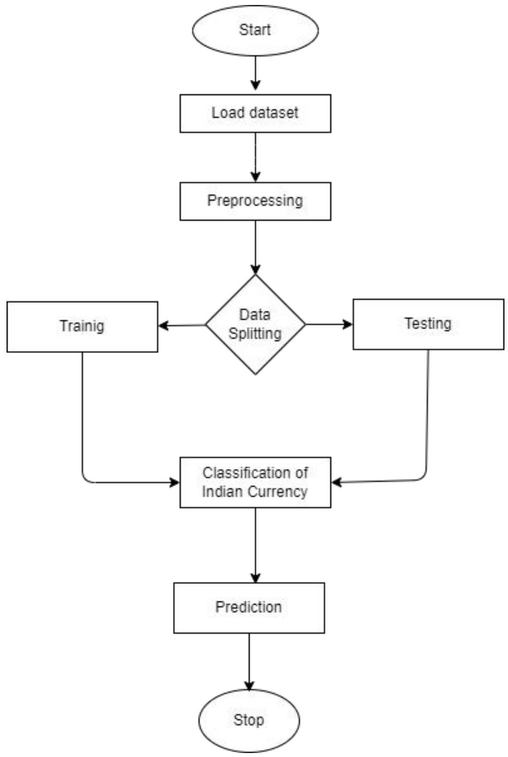


Fig-5.1 Flow Chart of process of MobileNet Algorithm

MobileNet is a model that filters images using convolution, similar to traditional CNNs, but it employs a unique approach. It utilizes depthwise and pointwise convolutions, which differ from the standard convolutions performed by conventional CNNs. This modification enhances the predictive efficiency of CNNs, making them suitable for mobile platforms. The innovative convolution methods employed by MobileNet significantly decrease the time required for comparison and recognition, offering swift and efficient responses. Therefore, MobileNet is favored for image recognition tasks.

The process of optimizing a problem by genetic algorithms is a step-by-step scenario like as:

Step1: Load the input dataset.

Step2: Perform pre-processing on input data.

Step3: The input dataset is split into training and testing data.

Step4: Analysing the best objective function value.

Step5: Classify the data which is obtained from step4.

Step6: Following Step 3, 4, 5 for better solution.

VI. ATTRIBUTES

The attribute are the input variables initialized and trained in the MobileNet algorithms in the Convolutional neural network enhancement.

No	Attribute	Description
1	**Image height**	**Image height in numbers**
2	**Image width**	**Image width in numbers**
3	**Batch scale**	**Batch scale in numbers**
4	**Validation**	**Validation in decimal**
5	**Rescale**	**Rescale in decimal**

Table-6.1 Attributes

VII. ALEXNET

AlexNet emerged as a revolutionary convolutional neural network architecture after triumphing in the ImageNet Large Scale Visual Recognition Challenge of 2012. Key characteristics of AlexNet include:

Depth: AlexNet showcased the superiority of deeper architectures in achieving enhanced performance. The considerable depth played a pivotal role in its success, despite the substantial computational resources required for training such a large model.

Architecture: Comprising eight layers, AlexNet utilizes five convolutional layers, some of which are paired with max-pooling layers, followed by three densely connected layers. Additionally, the network architecture is bifurcated, enabling parallel processing across two GPUs.

VIII. RESNET

ResNet is a type of neural network designed to simplify the training of very deep networks by overcoming challenges associated with their depth. Such challenges include: As networks increase in depth, they become harder to train because of vanishing or exploding gradients. Vanishing gradients occur when the derivatives shrink to minuscule values during backpropagation, leading to slow network convergence. Exploding gradients are the opposite, where derivatives grow excessively large, resulting in training instability.

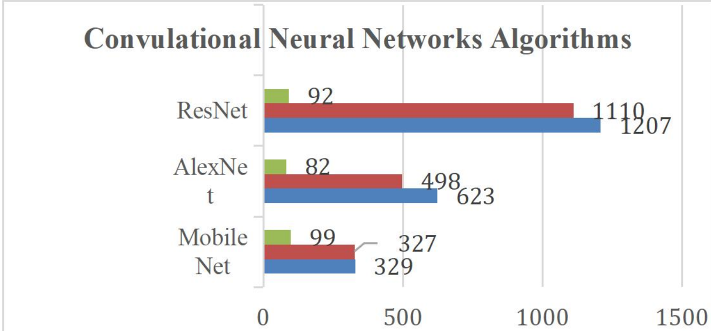
ResNets tackle these issues using residual blocks. Rather than learning the functional mappings outright, ResNets focus on learning the differences, or residuals. Each residual block includes a shortcut or skip connection that bypasses one or more layers, connecting the input of one layer to the output of a later layer, helping to preserve the gradient throughout the network.

IX. RESULTS AND DISCUSSION

By using concepts of Convolutional Neural Network algorithms (MOBILENET, ALEXNET, RESNET) the training phase of Convolutional neural networks is giving the best optimistic solution. By giving training to the attributes as Convolutional neural networks and incorporating the testing data analysis comparison among MOBILENET, ALEXNET, RESNET algorithms the tested results among MOBILENET, ALEXNET, RESNET are as:

Table-9.1 Result Analysis and Comparison of Convolutional Neural Network Algorithms

Parameters	**MobileNet**	**Alexnet**	**Resnet**
No of records (Taken)	**3294850**	**62,385,850**	**12073090**
No. of Records Tested	**3272834**	**62,383,098**	**12061570**
No. of input attributes	**2**	**2**	**2**
No. of Output attributes	**1**	**1**	**1**
Trained & Compiled data	**3272834**	**62,383,098**	**12061570**
Percentage of Optimization	**99**	**82**	**92**



	MobileNet	AlexNet	ResNet
Result in Percentage	99	82	92
Trained	327	498	1110
Input	329	623	1207

Fig-9.2 Graphical Representation of Algorithms.

X. CONCLUSION

In conclusion, the Convolutional Neural Network (CNN) demonstrates promising efficacy in distinguishing between genuine and counterfeit Indian currency. Through extensive model training on diverse currency images, the CNN successfully learns intricate patterns and features, enabling accurate classification. This robust approach holds significant potential for bolstering security measures and combating financial fraud. As a result, the deployment of CNNs in currency authentication stands as a viable and impactful solution to safeguard the integrity of the Indian currency system.

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