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Improving Currency Authenticity Verification Via Gan And Image Enhancement Techniques

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ABSTRACT

Currency counterfeiting has become one of the threats to the economy of a country. This is more severe in cash based economies while systems relying on more sophisticated forms of currency are less prone to loses due to counterfeiting. For any of the economies to be stable, there universality of acceptance of one standard currency. This in turn ensures absence of the phenomenon of currency counterfeiting. Such techniques how ever are expensive as well as labor intensive. The primary focus of this paper then is to analyze deep learning algorithms, specifically GAN Ensemble Models, in the counterfeiting of Indian currency. However, the methodology proposed in this paper has put aside economics, and focuses instead on physics and computer vision techniques such as Contrast Limited Adaptive Histogram Equalization (CLAHE). It focuses on enhancing image quality in an efficient manner. Experimental results reveal that the accuracy achieved by GAN networks enhanced by CLAHE surpassed the results achievable from regular CNN models with a margin of more than percent which means that such methods are capable of being implemented in practice as viable and cost effective solutions to the emerging problem of counterfeiting.

Keywords: GAN, CNN, CLAHE

INTRODUCTION:

Paper currency has its downsides and one of them is its general recognition which is always hindered with wear and constant circulation. Other issues such as damage also make the recognition harder. Institutions and organizations tend to focus and rely plain sizes and widths of the paper bills or based on its saturated hues. In reality, such methods are not very practical. There also exist advanced methods of Computerised Neural Networks (CNNs) which aim to automatically classify features as well as the images themselves. However, the limitations of existing hardware as well as the Support Vector Machine (SVM) framework tend to bottleneck the speed and flexbility of such systems.

The aim of this research is to investigate the robustness of Generative Adversarial Networks (GANs) model which comprized of Generator and Discriminator models. One of the advantages of GANs is the ability to develop algorithms without needing to answerthe questions of how to stratify or label the data, which makes it useful for various problems. The research also highlights the drawbacks of current methods and explains the

benefits and opportunities of using GANs in currency recognition with a great focus on counterfeit detection and recognition.

GAP IDENTIFIED BASED ON LITERATURE SURVEY:

Betrayal of Staten Island lenders cues adverse listings of prospective property mortgagors, which in turn prompts Seek and Desire. They then default on their loans as currencies are exchanged and handed to them. To this day, a variety of automated systems rely on these methods with different success rates. The security measures in place to stop counterfeiting are a significant advancement, but as technology advances, so does the threat posed by fake replicas. The literature also puts forward significant discrepancies in performance levels of fraud detection methodologies. Most of these are paper or static setups and their primary constraint for premature deployment is the integration cost with financial institutions. Nevertheless, a very sizable market exists simply due to the sheer volume of counterfeit bills.

Tackling these gaps concerning the gap based on literature survey. This paper proposes a multiinstance deep learning framework for the detection of counterfeit Indian currency. Further, the images obtained were subjected a series of preprocessing procedures, such as the removal of black bars surrounding images, rotation and resizing of images with the purpose to generate better balanced datasets. Apart from these unique features of this methodology we also aim at constructing reachable benchmarks whilst relying on technology available at a broad range of automatic, moderate and low associations owing to the imagery matching at the heart of the algorithmic process. The vision at the core remains the concept of portable fake currency identifying nano devices, embedded within loose change and currency wallets, rebutting counterfeit curtailment techniques.

PROBLEM STATEMENT:

Counterfeiting money is a high threat in cash economies. Low availability which is related to cost and need of advanced niusi techniques greatly limit current methods. Deep learning models on the other hand at the same time does not have sufficient data sets, does not pre-process well and does not operate well in the real world.

Key Challenges

• There is lack of one comprehensive, well-structured repository that has Indian currency images of both real and fake currency

• The different models performance suffers as a result of the imaging issues faced that are inadequate and inconsistent of the currency

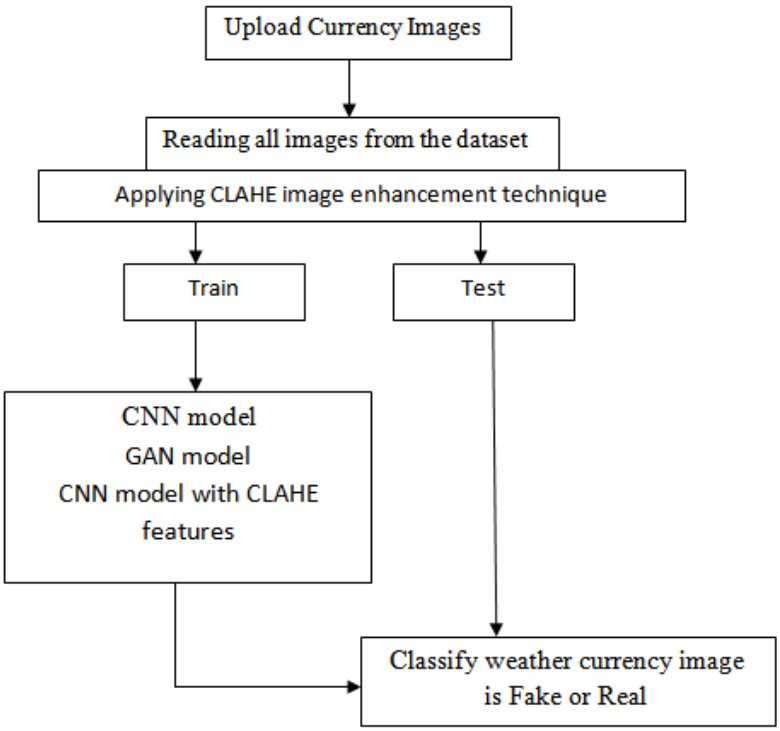
• Developing cost effective and scalable methods which can accurately and consistently on counterfeit currency detection

• Existing models such as CLAHE only have minimum utilization.

PROPOSED METHOD:

The proposed methodology seeks to further improve the detection of counterfeit currency through adoption of Hybrid framework of GAN and CLAHE. GAN consists of two components that are based on CNN, which are the Generator who performs the task of feature extraction whilst the Discriminator performs classification. As a pre-processing strategy, CLAHE is used to increase the clarity of images by improving the overall contrast and providing more detail from the images of currencies. This enriched dataset is then utilized in training the standard CNN as well as the GAN models. The performance of these models is later evaluated and compared based on several basic parameters such as accuracy, precision, recall, and F1 score. The CLAHE-enhanced GAN does best with performance metrics achieving accuracy of about 100%. This cost-effective approach guarantees great dependability suggesting that it is fit for bulk applications involving counterfeit detection.

ARCHITECTURE:



DATASET:

The dataset consists of real and fake Indian currency notes collected from public platforms such as GitHub. It has two categories with subfolders in it, one marked as real currency images and the other as fake. The images in each folder consist of several images of various samples. CLAHE is used as preconditioning step in order to enhance details and contrast of images before they get into training. Out of the total, 80% is used for training and 20% for testing so as to ensure the model is adequately tested. The small scale dataset is able to be trained effectively through the use of enhanced features which allow for real and fake currencies to be distinguished with accuracy.

METHODOLOGY:

• Data collection and preparation:

• Managed a custom database containing images of real Indian currency notes and fake notes images.

• Images were sorted into two folders: Real and Fake.

• Image Preprocessing:

• Used CLAHE technique for better contrast adjustment and enhance the visibility of the notes.

• Rescaled and randomized the dataset for consistency.

• Dataset separation:

• Divided the dataset into 80% for training and 20% for validation objectives.

• Model development:

• Trained a baseline CNN model for the first time to identify fake currency notes.

• Built a GAN-based framework with fully connected layers built as a generator and a discriminator.

• Training and evaluation:

• Trained prepared datasets with attention based CNN and GAN networks.

• Performance was tested with different metrics like True positive rate, specificity, F-measure alng some more metrics.

• Implementation of CLAHE:

• CLAHE augmentation was performed on the dataset followed by retraining the GAN based CNN model.

• Reissued the model was observed and there was definite improvement in performance accuracy to 100% with the new CNN model.

• Result visualization:

• Depicted the models and their results through graphs and charts and also presented explanations.

• Featured the improved performance of the GAN over the basic CNN model.

• Prediction and Deployment:

• Verified real time predictions of currency with the already trained GAN in case of global financial crisis.

• Sent different images through input and made predictions, displayed the images indicates the predictions made and also the expected predictions.

EVALUATION:

Precision:

$$\text{Formula: Precision} = \frac{\text{True Positives}}{\text{True Positives+False Positives}}$$

Recall (Sensitivity):

$$\text{Formula: Recall} = \frac{\text{True Positives}}{\text{True Positives+False Negatives}}$$

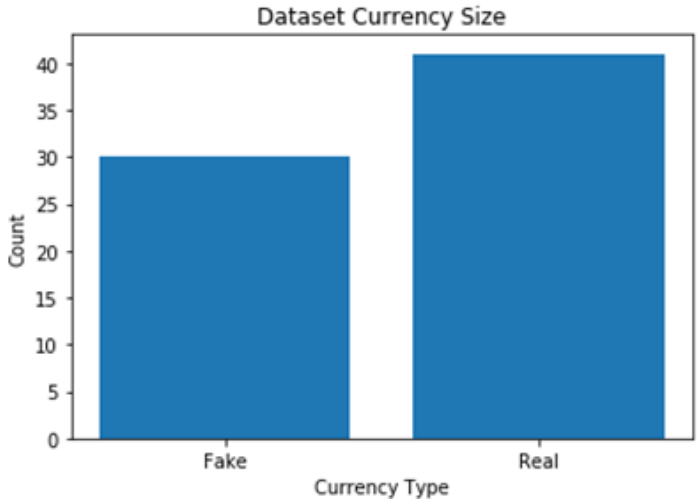
F1 Score:

$$\text{Formula: } F1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision+Recall}}$$

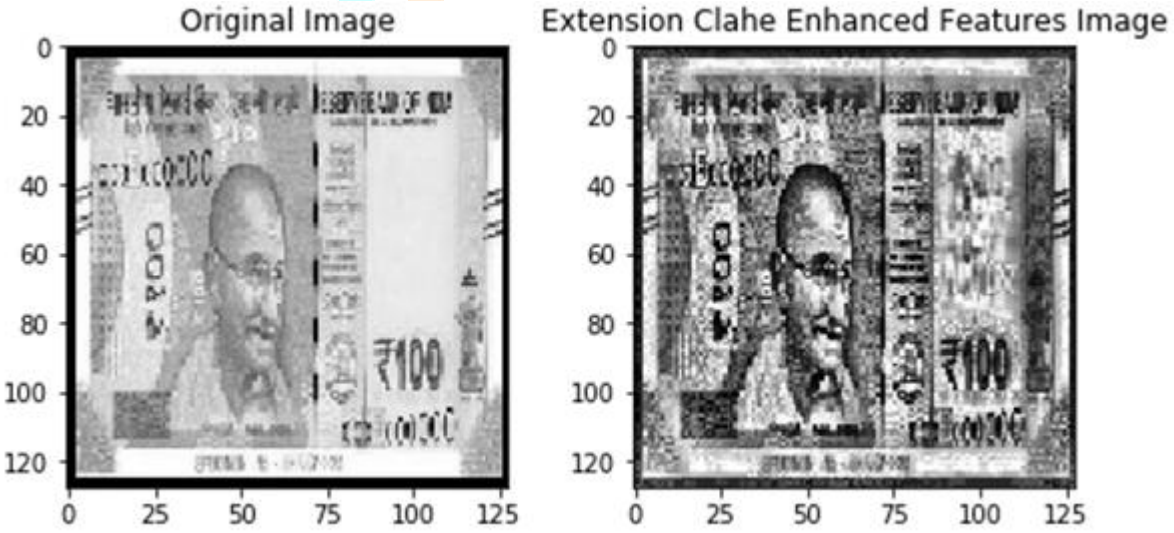
Accuracy:

$$\text{Formula: Accuracy} = \frac{\text{Correct Predictions}}{\text{Total Predictions}}$$

RESULTS:



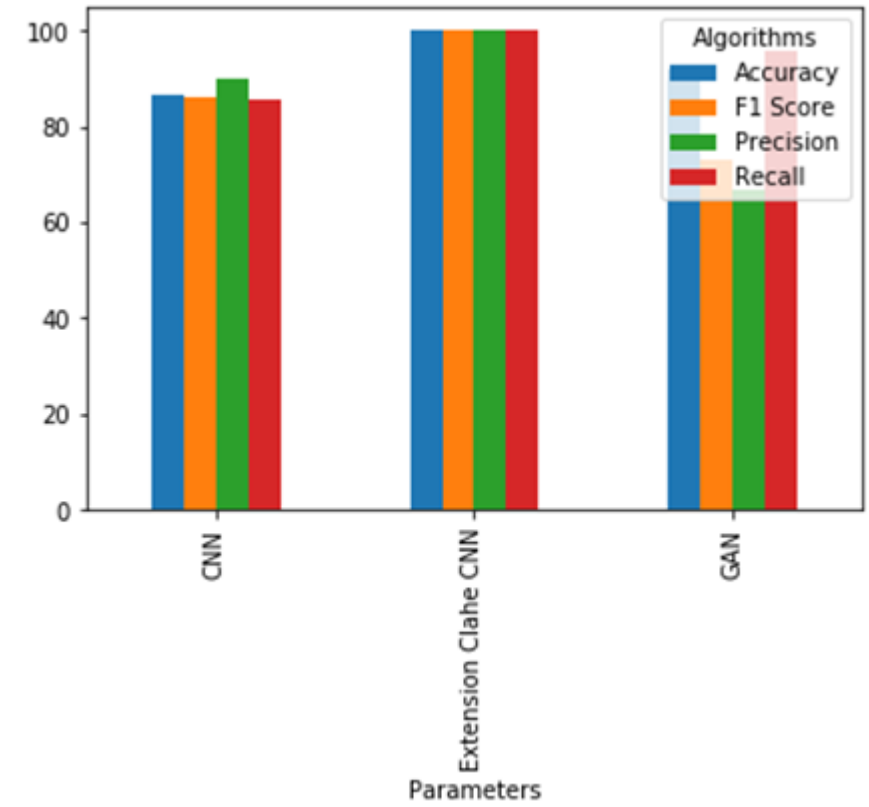
Displaying total images available in the dataset and then in graph x-axis represents currency type as Fake and Real and y-axis represents count.



Displaying normal dataset image and CLAHE image where first image is the normal image and second image is enhanced using CLAHE algorithm

	Algorithm Name	Accuracy	Precision	Recall	FSCORE
0	CNN	86.666667	90.000000	85.714286	86.111111
1	GAN	92.000000	66.666667	95.833333	72.826087
2	Extension Clahe CNN	100.000000	100.000000	100.000000	100.000000

Displaying all algorithms performance in tabular format



Displaying all algorithm performance in graph format where x-axis represents algorithm names and y-axis represents accuracy and other metrics and in all algorithms Extension CNN with CLAHE features got 100% performance

Predict function with INPUT IMAGE path and then in blue colour text on image we can see predicted output as Fake or Real

Real Image

CONCLUSION

The present work offers a viable and economical mean of detecting counterfeit currencies employing GANs incorporated with CLAHE pre-processing techniques. The proposed framework, despite being trained on weak dataset and utilizing poor preprocessing techniques, displays astonishing accuracy in comparison with the conventional CNN models. The GAN modified using the CLAHE method reported an impressive 100% success rate. These findings confirm that the GAN developed using CLAHE possesses practical work value. This work appropriately points out that for successful implementation of deep learning model nuisance removal techniques must also be applied to images, thus presenting a viable and cost-effective means for counterfeiting tackling problems. Future work may consider increasing the size of the dataset and adding new picture processing technologies to increase the trustworthiness of the model as well as its scope of use.

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