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Literature Survey on Revolutionizing Fake Currency Detection: CNN-Based Approach for Indian Rupee Notes

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Abstract: ***The proliferation of counterfeit currency poses a significant challenge in various economies, including India. To address this issue, several studies have proposed innovative image processing and machine learning techniques for detecting counterfeit coins and banknotes. Leveraging digital image processing, these studies aim to enhance the security measures against counterfeit currency through accurate and efficient recognition systems. Techniques such as preprocessing, segmentation, feature extraction, and clustering are employed to identify fraudulent currency. The use of Support Vector Machines (SVM), k-means clustering, and Convolutional Neural Networks (CNN) facilitates the recognition and classification of genuine and counterfeit currency. Moreover, these studies explore the application of spatial coding, component-based recognition, and deep learning algorithms to improve the accuracy and robustness of counterfeit detection systems. By developing real-time recognition systems capable of identifying counterfeit currency, these research efforts contribute to combating financial fraud and safeguarding economic integrity.***

Keywords: Counterfeit Currency, Image Processing, Machine Learning, Security Measures, Preprocessing, Segmentation.

1. INTRODUCTION

These papers collectively contribute to the field of currency authentication and recognition through innovative image processing techniques. "An Image-Based Approach to Detection of Fake Coins" proposes methods for counterfeit coin detection, while "Machine-assisted Authentication of Paper Currency: An Experiment on Indian Banknotes" focuses on enhancing

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security measures for Indian currency. "Detection of Counterfeit Coins and Assessment of Coin Qualities" explores techniques for identifying counterfeit coins and assessing their quality. "Variable-length Signature for Near Duplicate Image Matching" introduces a novel approach to near-duplicate image matching. "Ancient Coin Recognition Based on Spatial Coding" presents methods for recognizing ancient coins using spatial coding techniques. "A Study on Diverse Recognition Techniques for Indian Currency Note" investigates various recognition techniques tailored for Indian currency. Lastly, "Survey of Currency Recognition System Using Image Processing" offers a comprehensive overview of currency recognition systems, providing valuable insights into existing approaches in the field. In the realm of currency authentication and recognition, these papers collectively offer a diverse array of methodologies and insights. "An Image-Based Approach to Detection of Fake Coins" delves into the intricate details of detecting counterfeit coins, emphasizing the importance of image analysis in this process. Meanwhile, "Machine-assisted Authentication of Paper Currency: An Experiment on Indian Banknotes" sheds light on the specific challenges faced in authenticating Indian currency, proposing experimental approaches to address them effectively. "Detection of Counterfeit Coins and Assessment of Coin Qualities" extends this exploration by not only detecting counterfeit coins but also assessing their quality, providing a more holistic view of the counterfeit currency landscape. Concurrently, "Variable-length Signature for Near Duplicate Image Matching" introduces an innovative technique for near-duplicate image matching, offering potential applications beyond currency recognition, such as in forensic investigations or document verification. Each of these papers contributes to the broader understanding of currency recognition systems, offering unique perspectives and methodologies. From exploring ancient coin recognition techniques based on spatial coding to conducting a comprehensive study on diverse recognition techniques tailored for Indian currency, these papers collectively enrich the discourse on currency authentication and recognition through image processing techniques.

2. LITERATURE SURVEY

Binod Prasad, C. S. Patil, R. R. Karhe, and P. H. Patil [2], The paper introduces an Indian coin recognition system utilizing artificial neural networks (ANNs). The system aims to recognize Indian coins of denominations `1, `2, `5, and `10 with rotation invariance and classify them based on their value. It addresses the need for a robust recognition system capable of handling noisy environments. The approach involves preprocessing, feature extraction using Discrete Wavelet Transform (DWT), and classification using ANN...
Laavanya, M., and V. Vijayaraghavan [3], Counterfeit currency notes pose a significant threat to the economy of a country, necessitating the development of reliable detection systems. In this research, Ayush Antre et al. propose a system that employs Convolutional Neural Networks (CNNs) for accurately distinguishing between real and fake currency notes. The system operates in real-time, processing images of currency notes to determine their authenticity. Agasti, Tushar, Gajanan Burand, Pratik Wade, and P. Chitra [4], the paper addresses the challenges faced by visually impaired individuals in identifying Indian currency notes, especially after the demonetization initiative in India. It proposes an automated system based on Convolutional Neural Networks (CNNs) to assist visually impaired individuals in currency recognition. Tele, Gouri Sanjay, Akshay Prakash Kathalkar, Sneha Mahakalkar,

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Bharat Sahoo, and Vaishnavi Dhamane [5], the paper proposes a neural network classification technique for detecting counterfeit Indian currency notes. The study highlights the use of image processing and neural networks to automatically identify and distinguish between genuine and fake currency notes. Key security features of Indian currency, such as the security thread, RBI Logo, and identifying marks, are extracted using image processing methods. These features are then used to generate a combined score for distinguishing between real and counterfeit currency. Darade, Sonali R., and G. R. Gidveer [6], The paper addresses the issue of counterfeit Indian currency notes in the context of the rapid growth of the Indian economy. Despite strong security features endorsed by the Reserve Bank of India (RBI), counterfeit money remains a major problem due to advancements in color printing technology. The proposed model employs a three-layered Deep Convolutional Neural Network (Deep ConvNet) to efficiently detect counterfeit Indian currency notes, achieving an accuracy of 96.6 Kumar, S. Naresh, Gaurav Singal, Shwetha Sirikonda, and R. Nethravathi [7], the paper presents a computer vision-based approach for detecting fake Indian paper currency. The methodology involves extracting currency features and developing datasets for currency detection. The authors utilize the ORB (Oriented FAST and Rotated BRIEF) algorithm and Brute-Force matcher approach for feature extraction, enabling accurate detection of Indian banknotes. The system achieves an average accuracy of up to 95.0% when tested on various denominations of Indian currency. Suresh, Ingulkar Ashwini, and P. P. Narwade [9], Counterfeiting of currency poses a significant threat to both individuals and the economy. Current fake currency detectors are limited to banks and corporations, leaving common people and small businesses vulnerable. In this project, the authors propose a software-based system to detect and invalidate fake Indian currency using advanced image processing and computer vision techniques. Kulkarni, Anushka, Prachi Kedar, Aishwarya Pupala, and Priyanka Shingane [10], the paper addresses the issue of counterfeit Indian currency notes through the utilization of Convolutional Neural Network (CNN). Despite advancements in printing technology, counterfeit money remains a significant problem, impacting the economy. The proposed method involves training a CNN to identify fake Indian currency notes by analyzing their images. The model achieves high validation and training accuracies of 97.52% and 94.25%, respectively, for detecting counterfeit ₹2000 and ₹500 notes.

Summary

1. Title: "Fake Currency Detection Using Convolution Neural Network":- The article discusses a study focused on detecting counterfeit currency using Convolutional Neural Networks (CNNs), a form of deep learning. The researchers developed a system to distinguish between real and fake currency notes, addressing a significant economic threat. With high accuracy, their model demonstrates potential for use in banks, financial institutions, and businesses handling cash transactions. The study involved creating a dataset of real and fake Indian rupee notes, capturing images under various conditions to train the CNN model. The model underwent testing, showing a high level of accuracy in identifying counterfeit notes, highlighting its efficacy and potential to prevent financial losses due to counterfeit currency.

2. Title: "Detection of Fake Currency Using Image Processing and Neural Networks": - The paper proposes a neural network classification technique for detecting counterfeit Indian

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currency notes. The study highlights the use of image processing and neural networks to automatically identify and distinguish between genuine and fake currency notes. Key security features of Indian currency, such as the security thread, RBI Logo, and identifying marks, are extracted using image processing methods. These features are then used to generate a combined score for distinguishing between real and counterfeit currency. The proposed method demonstrates high accuracy in detecting fake currency notes, with a perfect detection rate of 100% and a low mean square error value of approximately 1%. The long- term goal is to expand the application of this technique to other countries and integrate it into a mobile app for broader public use.

3. Title: - "Indian Fake Currency Detection Using Computer Vision":- The paper presents a computer vision-based approach for detecting fake Indian paper currency. The methodology involves extracting currency features and developing datasets for currency detection. The authors utilize the ORB (Oriented FAST and Rotated BRIEF) algorithm and Brute-Force matcher approach for feature extraction, enabling accurate detection of Indian banknotes. The system achieves an average accuracy of up to 95.0% when tested on various denominations of Indian currency.

4. Title: "Fake Currency Detector":- Counterfeiting of currency poses a significant threat to both individuals and the economy. Current fake currency detectors are limited to banks and corporations, leaving common people and small businesses vulnerable. In this project, the authors propose a software-based system to detect and invalidate fake Indian currency using advanced image processing and computer vision techniques. The system is designed to authenticate Indian currency notes of denominations ₹500 and ₹2000 by examining various security features. Three main algorithms are employed: one for general feature extraction and comparison, one for authenticating bleed lines, and another for verifying the number panel. The system aims to provide a quick and accurate means of currency authentication, potentially replacing manual methods.

5. Title: "An Automated System for Indian Currency Classification and Detection Using CNN":- The paper addresses the challenges faced by visually impaired individuals in identifying Indian currency notes, especially after the demonetization initiative in India. It proposes an automated system based on Convolutional Neural Networks (CNNs) to assist visually impaired individuals in currency recognition. The system utilizes sound notifications to aid visually impaired individuals in recognizing various denominations of Indian currency notes. Different CNN models such as VGG16, AlexNet, and MobileNet are applied to datasets of Indian banknotes for feature extraction and currency recognition. The proposed model is implemented using TensorFlow and evaluated against established CNN architectures using transfer learning.

6. Title: "An Indian Coin Recognition System Using Artificial Neural Networks":-The paper introduces an Indian coin recognition system utilizing artificial neural networks (ANNs). The system aims to recognize Indian coins of denominations `1, `2, `5, and `10 with rotation invariance and classify them based on their value. It addresses the need for a robust recognition

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system capable of handling noisy environments. The approach involves preprocessing, feature extraction using Discrete Wavelet Transform (DWT), and classification using ANN. Median and Wiener noise filters are employed for image enhancement in the presence of noise.

7. Title: - "Fake Currency Detection Using Convolution Neural Network":- Counterfeit currency notes pose a significant threat to the economy of a country, necessitating the development of reliable detection systems. In this research, Ayush Antre et al. propose a system that employs Convolutional Neural Networks (CNNs) for accurately distinguishing between real and fake currency notes. The system operates in real-time, processing images of currency notes to determine their authenticity. A dataset comprising images of real and counterfeit currency notes of various denominations was collected and utilized for training and testing the proposed model. The CNN architecture consists of convolutional layers followed by max-pooling layers, with a final output layer providing the probability of the input image being real or fake. Experimental results demonstrate high accuracy in both training and testing phases, indicating the effectiveness of the proposed methodology.

8. Title: "Real-Time Fake Currency Detection Using CNN":- Counterfeit currency presents a significant threat to a nation's economy, necessitating effective detection systems. Navaneethan K R et al. propose a method for real-time detection of fake currency using Convolutional Neural Networks (CNN). With the rise of counterfeit notes in India, the need for accessible detection systems has become more pronounced. The proposed technique aims to detect counterfeit banknotes by analyzing security features such as watermarks, latent pictures, and security threads.

Findings

1. **Authors:** Ayush Antre, Om Kalbhor, Pratik Jagdale, Ganesh Dhanne, Prof. Nilesh R. onawane

Citation: e-ISSN: 2582-5208 Volume: 05/Issue: 04/April- 2023
Methods: CNN (Convolution neural network)
Advantages: High Accuracy (training accuracy of 97.72% and a testing accuracy of 92.31 %.)

Challenges:

- Dataset is small
- High Initial Cost

2. **Authors:** S. Suneetha , T. Sai Meenakshi, V. Siva Saran Maruthi , P. U. S. Lakshmi Deepak, G. Venkata ManiManas

Citation: ISSN: 2349-5162 JETIR March 2023, Volume 10, Issue 3
Methods: ANN (Artificial neural network)

Advantages:

- High accuracy in detecting counterfeit currency notes (100% detection rate).
- Low mean square error (approximately 1%)

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Challenges: Detect notes using few features which can led the inaccurate detection of counterfeit notes.

3. **Authors:** David Kumar, Surendra Chauhan
Citation: e-ISSN: 2395-0056 Volume: 07 Issue: 05 | May 2020
Methods: ORB Brute-Force matcher

Advantages:
- Provides a low-cost solution for detecting fake Indian banknotes.
- Achieves high accuracy (95.0%)

Challenges: Training dataset is small i.e 50 image for training and 29 image for testing

4. **Authors:** Aprameya Dash, Maheshwari Mihir Premjibhai , Suyash Chintawar , Kunal Singh Lohiya
Citation: Published year: 2020 Aprameya Dash- 191IT209 Maheshwari Premjibhai- 191IT129 Suyash Chintawar- 191IT109 Kunal Singh Lohiya- 191IT128
Methods: ORB SSIM

Advantages:
- Accuracy 83%.
- Provides a user-friendly interface.

Challenges: Accuracy may be affected by the quality of input images. More Time required.

5. **Authors:** K. Shyam Sunder Reddy, Ramesh G, Raghavendra C, Sravani C, Manleenjot Kaur, Soujanya R.
Citation: E3S Web of Conferences 010 (2023) ICMPC 2023 430 77
Methods: Different CNN models including Sequential Model, VGG16, Alex Net, and Mobile Net are evaluated for currency recognition accuracy.

Advantages:
- The automated system to recognizing Indian currency notes.
- Utilization of CNN models enables accurate classification and detection of currency denominations.

Challenges: Integration of the system into smartphones for real-world application may pose technical challenges.

6. **Authors:** Loveneet Kaur, Rekha Bhatia
Citation: Vol. 5 (5), 2014, 6532-6537
Methods: ANN

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Advantages:
- Utilizes ANN, known for its potential in classification tasks.
- Achieves high recognition accuracy even in noisy environments

Challenges: Handling noise in coin images is a significant challenge, addressed using noise filtration techniques.

7. **Authors :** Ayush Antre, Om Kalbhor, Pratik Jagdale, Ganesh Dhanne, Prof. Nilesh R. Sonawane

Citation: e-ISSN: 2582-5208 volume: 05/Issue: 04/April- 2023
Methods: CNN (Convolution neural network)
Advantages: High Accuracy (training accuracy of 97.72% and a testing accuracy of 92.31 %.)
Challenges: Dataset is small. High Initial Cost

8. **Authors :** S. Suneetha, T. Sai Meenakshi, V. Siva Saran Maruthi, P. U. S. Lakshmi Deepak, G. Venkata ManiManas

Citation: ISSN: 2349-5162 JETIR March 2023, Volume 10, Issue 3
Methods: CNN
Advantages:
- Real-time detection of counterfeit currency using a cost-effective method.
- 80% accuracy
- Low cost

Challenges: Accuracy can affect the accurate note detection.

3. METHODOLOGY

- **Data Collection:** Gather a diverse dataset of images containing both genuine and counterfeit Indian currency notes. Ensure the dataset includes various denominations, conditions, and perspectives to make the model robust for real-world scenarios.
- **Data Preprocessing:** Standardize the images by resizing them to a consistent resolution, such as 300x300 pixels, to ensure uniformity across the dataset. Convert the images to grayscale to reduce computational complexity and normalize pixel values to a range between 0 and 1 to facilitate model training.
- **Model Selection:** Choose a suitable machine learning model for image classification tasks, such as a Convolutional Neural Network (CNN). CNNs are well-suited for image analysis tasks due to their ability to automatically learn features from raw pixel data.
- **Model Training:** Train the selected model using the preprocessed dataset. Adjust the model architecture and hyperparameters, such as the number of layers, kernel sizes, and learning rates, to optimize performance. Use techniques like data augmentation to increase the diversity of training samples and prevent overfitting.
- **Model Evaluation:** Assess the trained model's performance using a separate validation dataset. Measure metrics like accuracy, precision, recall, and F1 score to gauge the model's effectiveness in distinguishing between genuine and counterfeit currency notes.

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- **Fine-tuning and Optimization:** Fine-tune the model based on performance feedback from the validation dataset. Experiment with optimization techniques such as learning rate scheduling, batch normalization, and dropout regularization to improve the model's generalization ability and robustness.
- **Testing:** Test the optimized model on a separate test dataset to evaluate its effectiveness in real-world scenarios. Measure performance metrics and compare them with the validation results to ensure consistency and reliability.
- **Deployment:** Once satisfied with the model's performance, deploy it for practical use. Integrate the model into a user-friendly application or system, providing an interface for users to input currency images and receive predictions on their authenticity.
- **Continuous Improvement:** Monitor the model's performance in real-world applications and gather feedback from users. Continuously update the model based on new data.

4. RESULTS & DISCUSSION

The survey reveals that various image processing and machine learning techniques have been applied to the challenge of detecting counterfeit currency, with a particular focus on Indian banknotes. Among these methods, Convolutional Neural Networks (CNNs) stand out for their superior performance, consistently achieving high accuracy in distinguishing between genuine and counterfeit notes. For instance, one study reported CNN models attaining validation and training accuracies exceeding 97% and 94%, respectively, in detecting counterfeit ₹2000 and ₹500 notes. This high level of precision underscores CNNs' effectiveness in handling the complex patterns and features necessary for accurate currency recognition. On the other hand, traditional machine learning techniques such as Support Vector Machines (SVM) and k-means clustering, while useful, generally lag behind CNNs in terms of accuracy and real-time applicability. These methods often require extensive preprocessing and feature extraction to perform well, and even then, they may not meet the demands of scenarios where rapid detection is crucial, such as in ATMs or point-of-sale systems. Real-time detection is a significant focus in the surveyed studies, with several highlighting the necessity of instant recognition to prevent the circulation of counterfeit notes. CNNs, with their ability to quickly process large amounts of image data, are particularly suited to this task. Despite these advances, several challenges persist. One major issue is the variability in datasets used across different studies. Many models are trained on limited or proprietary datasets, which may not fully capture the range of counterfeit notes in circulation. This limitation could affect the models' ability to generalize across different types of currency and various counterfeit methods. Moreover, even the best-performing models are not immune to errors, occasionally producing false positives (identifying genuine currency as counterfeit) or false negatives (failing to detect counterfeit currency). These inaccuracies can have serious implications, potentially causing financial loss or undermining trust in the detection systems. Another critical factor influencing the success of these models is feature selection. The accuracy of detection often hinges on identifying key features of the currency, such as the security thread or RBI logo. However, reliance on a narrow set of features might limit the model's adaptability to new counterfeit techniques that exploit different aspects of currency design. As a result, future research should focus on expanding the

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datasets available for training and exploring hybrid models that combine the strengths of CNNs with other machine learning approaches.

5. CONCLUSION

In this research, an effective method for extracting and recognising the properties of Indian rupee notes is presented. The study also includes detection and identification of counterfeit cash. Our future work will focus on faster and more accurate fake currency identification with the use of modern image processing algorithms. Our future scope will include currency denomination conversion. Looking ahead, future research efforts are poised to address these challenges while further enhancing the capabilities of counterfeit currency detection systems. Advancements in machine learning, image processing, and sensor technologies offer promising avenues for improving system performance, scalability, and accessibility. By fostering interdisciplinary collaborations and leveraging emerging technologies, researchers can continue to push the boundaries of what is possible in the realm of counterfeit currency detection, ultimately contributing to a safer and more secure financial landscape.

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