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AI-Powered Real-Time Counterfeit Detection and Currency Recognition with Voice Assistance for Visually Impaired Users

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ABSTRACT—

Counterfeit detection and Currency recognition are essential functions in financial inclusion, especially for the visually impaired, who are disadvantaged to a major extent in safely and independently dealing with cash. Driven by the growth of artificial intelligence (AI) and computer vision technologies, number of studies have been published that suggest solutions to overcome these disadvantages. This survey paper gives an in-depth overview of current techniques in currency recognition and forgery detection based on AI, with an emphasis on assistive technologies to enhance accessibility in finance. We classify existing methods, deep learning models, and edge-based solutions. Important performance metrics like accuracy, inference time, diversity of the dataset, and deployment approaches (offline vs. cloud) are comprehensively compared. The survey also captures typical issues like limited coverage of datasets, bad generalization to actual conditions, reliance on connectivity over the internet, and absence of adequate multimodal feedback for users. Lastly, we also addressed possible future research like incorporating haptic feedback, widening support for regional languages, and enhancing counterfeiting detection using sophisticated imaging technologies.

Keywords—Currency Recognition, Fake Currency Detection, Visual Impairment, Edge AI, Assistive Technology, TensorFlow Lite, NVIDIA Jetson Nano, IoT, Computer Vision, Financial Inclusion.

INTRODUCTION

Detection of counterfeiting and identification of currency are important roles in ensuring financial security and convenience, especially for the low vision and blind who cannot handle cash independently. The ability to correctly identify currency notes and identify counterfeit notes is essential to enable financial inclusion and avoid fraud risk during day-to-day transactions. Despite the rapid adoption of electronic payment processes, cash is still the overall mode of transaction in most developing nations with underdeveloped digital networks. The last decade has seen rapid progress in artificial intelligence (AI), computer vision, and edge computing, which has resulted in the creation of numerous assistive technologies. These systems try to close the gap by making real-time currency identification and forgery detection possible through AI techniques.

The introduction of light-weight CNN, edge deployment tools like TensorFlow Lite, and embedded boards like NVIDIA Jetson Nano has further boosted the development of practical solutions. This survey paper provides a detailed overview of already published research in the field of AI-based currency authentication and forgery detection, with special emphasis on those applications directed to visually impaired users. It is our intention to present an overview of current techniques, compare their performance, and highlight the open issues that need resolution. In addition, this survey intends to guide future work by presenting a critical review of current approaches and suggesting directions for improvement.

In subsequent sections, we will summarize the dominant approaches and methods in the literature, provide comparative performance comparisons, and conclude by summarizing the shared challenges and future research avenues in this significant domain.

LITERATURE SURVEY

Nisha Patil, Minal M. Ingale, Anuprita V. Shirsath, Karan R. Bagga, Divesh S. Patil in their paper entitled “Visual Currency validator An Android App Empowering the Visually Impaired with Image Processing and Deep Learning for Fake Currency Detection”, (2024) presents an Android app developed for facilitating accessibility for people with visual disabilities in recognizing Indian Rupee (INR) denominations and distinguishing between authentic and counterfeit notes in a real-time setting. Image processing steps are employed utilizing images taken by the phone camera, as well as converting RGB images to grayscale images, and extracting features such as the watermark, the serial number, the portrait, and the security thread. These steps are incorporated with a CNN-based classifier. The dataset included a collection of images of real and counterfeit INR notes which came from multiple denominations and were taken by a camera. The app is deployed on the Android platform and is set to provide the user with text-to-speech feedback. To demonstrate functional capability, users touch the display of the screen, the app captures and processes an image, and if the "feature intensity" is above a threshold of 75% the note is classified as real. If the intensity is below threshold, the note is classified as counterfeit. At this time, the app will announce the denomination and whether it is real or fake through text-to-speech feedback. The performance of the various steps are described qualitatively, where low processing time, cost-effective, and reliable execution capabilities in real-time applications are discussed. However, thorough quantitative metrics are not clearly described in the summary with the only description, threshold for intensity is 75% and above. Strengths include an inclusive design tailored for visually challenged users, deployed on Android and in real-time, simplicity of use, and cost-effectiveness. cost. [1]

Pagalla Bhavani Shankar in paper titled "Detecting Counterfeit Indian Currency with Hybrid Convolutional Neural Networks", (May 2024) discusses the significant problem of counterfeit Indian currency detection, which is seriously detrimental to the economy and puts public trust at risk. The authors present a hybrid models based on integration of multiple CNN models—namely MobileNet, AlexNet, and ResNet—to distinguish between authentic and fake banknotes. The system analyzes high-resolution scans of Indian currency notes, pulling out important security features like watermark patterns, security threads, and serial numbers to identify genuine notes from forgeries. Although the paper lacks specific detail on the size and make-up of the dataset, it verifies the use of a dataset with both authentic and fake samples. The deployment is intended for image-based inference in which images are taken and examined by the trained hybrid CNN model with a purpose of real-world applicability. Experimental finding show strong system stability and high accuracy but without precise performance measures such as accuracy percentages, precision, or recall being exactly detailed. The major advantages of the method are that it can use multiple deep learning architectures to properly extract features and classify them. [2]

Abraham Eseoghene Evwiekpaefe and Habila Isacha, in their paper “A Visually Impaired Mobile Application for Currency Recognition using MobileNetV2 CNN Architecture” (2024), present an Android app that assists individuals with low vision users in Nigeria identify naira denominations and tell currency apart from non-currency. They used a dataset of 3,615 images (eight denominations and one non-currency class), resized to 224×224. They applied transfer learning with MobileNetV2 and data augmentation, training for 60 epochs before converting the model to TensorFlow Lite for mobile use. The app, created in Java with Android Studio, captures images through the phone camera and gives text and audio feedback. Evaluation with an 80/20 split achieved 98% accuracy, with precision and recall mostly above 0.95, and perfect classification for ₦50. While some misclassifications happened in the non-currency class, the system showed strong lightweight performance. Its advantage include accurate performance, efficient mobile use, and integrated audio support. [3]

Mrs. P. Sangeeta, P. Sravya Vani, T. Pallavi, B. Ravi, and T. Kavya, in their paper titled “Currency Recognition for Visually Impaired Using Image Matching Algorithms” (IJCSPUB, Vol. 13, Issue 2, May 2023), propose a real-time currency recognition system to help people with eyesight impairment to recognize Indian banknotes. The framework scans currency and provides audio feedback in English to assist users in identifying denominations without visual cues. The authors implemented the SIRB algorithm (consisting of SIFT, SURF, and ORB feature detectors) to increase matching for images or images taken with a mobile device if there was noise. Their system provides an initial preprocessing of images, feature extraction, and improves matching with a learned dataset, which improves accuracies and robustness compared to previous methods. The framework has been implemented in Python using OpenCV and gTTS for audio output. The authors report successful recognition of Indian currency of ₹10, ₹20, ₹50, ₹100, and ₹500. The main advantages of the system include high accuracy, able to also effectively work with shaky mobile images, and simplicity of audio outputs for the user. The authors list the next steps to include an Android application and expanding the audio dataset using other languages such as Hindi and Telugu which would help with usability to a larger group of visually impaired users. [4]

Arvind Mukundan, Yu-Ming Tsao, Wen-Min Cheng and Hsiang-Chen Wang in the article entitled "Automatic Counterfeit Currency Detection Using a Novel Snapshot Hyperspectral Imaging Algorithm"(February 2023) discusses the vital task of counterfeit currency detection, which threatens modern financial security systems. The authors introduce a advanced approach that utilizes snapshot hyperspectral imaging to increase the reliability and speed of counterfeiting. The method involves taking hyperspectral images of banknotes and processing them to detect subtle counterfeit features not discernible in conventional imaging methods. The test dataset contains a set of real and fake currency images. The output of the algorithm proposed is measured by performance indicators as accuracy, precision, recall, and F1-score, and improvements by several folds are reported against conventional methods. The advantages of this method are that it can identify invisible counterfeit features and that it could be applied in real time within financial institutions. [5]

Pham, Tuyen Danh, Young Won Lee, Chanhum Park, and Kang Ryoung Park wrote “Deep Learning-Based Detection of Fake Multinational Banknotes in a Cross-Dataset Environment Using Smartphone Cameras for Assisting Visually Impaired Individuals” (2022). The research addressed the challenge of generalization across datasets. Models that had been trained on one currency needed to identify fakes in other currencies. Their approach utilized Retinex-based preprocessing followed by YOLOv3 for banknote detection. They then implemented a number of CNN classifiers (ResNet-18, GoogleNet, and Inception-ResNet-v2) later fusing scores and features and used optimizers including SAM. Their dataset included real and fake images of USD, EUR, KRW, and JOD banknotes in naturally occurring situations. They were not engaged in mobile deployment, their training and evaluation used images from smartphones. Their system currently achieved 99.29% detection with YOLOv3 and some fusion configurations achieve accuracy rates as high as 89.11%. Performance metrics dropped substantially for images of the JOD case due to the quality of the images used in the method. What is working in their favor is that it is the first multinational cross-dataset method, fusion for robustness, and their models have been made available to the public. [6]

Indresh Gupta, Sagar Kamble, Kartik Nisar, Parth Patel, and Prof. Vidya Gogate paper titled “Currency Detector System for the Visually Impaired” (2022) tackles the challenge faced by both sighted and visually impaired individuals when it comes to currency identification as it can lead to their financial loss or making mistakes during purchases on a daily basis. The solution is a deep learning-based Artificial Neural Network (ANN) utilizing Convolutional Neural Network (CNN) layers to extract features from Indian currency notes, and classify those notes among a set of seven identified denominations. The currency detection system is designed as an embedded system housed within a Raspberry Pi 4, that includes a Camera Module V2 used to capture images, and is programmed in Python, with TensorFlow Lite for the deployment of the model. The detected denomination of the currency is then articulated back through an auditory output in the form of a speaker, which denotes the value identified as well as the cumulative sum. The dataset used in the paper is composed of images of Indian currency notes that were taken, pre-processed and tested on, and subsequently used in their training. The results indicate that the currency detection system successfully identifies individual bills and calculates their cumulative value, which are validated against sighted and auditory checkers. In addition, the strengths of this research include providing a portable, real-time detection system, with an auditory output in an appropriate manner. Further research could include adapting the system for other currency denominations, and model robustness, as well as expanding the system with additional assistive functions for those who are either partially sighted or blind.[7]

Ms Trupti Pathrabe and B. Dr NG Bawane paper titles “Currency Recognition System Based on Characteristics Extraction and Negatively Correlated Neural Networks” (April 2021) addresses the problem of allowing blind users to identify Egyptian banknotes without requiring effort on their part (like manually selecting and tuning features) and which is insensitive to lighting variations present in current solutions. The proposed solution employs simple image preprocessing techniques, including grayscale conversion, Gaussian blur operation, segmentation of the blurred image, histogram equalization, and region of interest (ROI) extraction, resulting in solving for the recognized value based on the correlation from the template matched. The image-based neural network was trained on Egyptian currency denominations in pounds with 20 samples per class, resulting in a total of 120 images (scanned) for the Matlab solution and live images used for the mobile camera for the Android application. The Matlab R2012a developed image processing algorithms for the offline test process and an Android application using OpenCV for real-time image processing to recognize the banknote value were proposed to support the blind user with automatic edge detection, feedback from the vibration, and audio announcements of the recognized value. Performance is measured by accuracy; the Matlab system overall has an average accuracy of 89%, with a per-class accuracy of 80%-100% and processing times on average of 10 seconds (Matlab) and 12 seconds (Android). Advantages include easy use, the ability to be deployed in real-time on handheld devices and automated detection without a human strategist being involved, and the usefulness of visually impaired users. Limitations include lower determinations with some notes of low detail (e.g., 50 pounds) and clarity or degree of clarity of the picture. Future work may consider improving robustness to light conditions and other currencies or states of notes. [8]

Rahnuma Tasnim, Sadia Tasnuva Pritha, Annesha Das, and Ashim Dey in paper titled “Bangladeshi Banknote Recognition in Real-time using Convolutional Neural Network for Visually Impaired People” (January 2021) discusses the pressing issue of allowing visually impaired individuals to identify Bangladeshi banknotes independently and correctly. The authors suggest a system on a Convolutional Neural Network (CNN) built upon a proprietary set of data having more than 70,000 images of Bangladeshi banknotes available in all denominations. The system will take high-resolution images acquired in real time and classify the banknotes and give both text and audio feedback to help people with visual impairment. The solution exhibits strong performance with a mean rate of 92% in identifying eight currencies, and is insensitive to the orientation and sides of the notes. The implementation emphasizes application in practical real-time scenarios, guaranteeing low latency and feasibility without the requirement of sophisticated hardware configurations. The approach's major strengths are high recognition accuracy and usability in actual world. [9]

Rakesh Chandra Joshi, Saumya Yadav, and Malay Kishore Dutta is entitled “YOLO-v3 Based Currency Detection and Recognition System for Visually Impaired Persons” (2020), It discusses the problem of visually impaired people in recognizing and managing banknotes, which is essential for independent financial transactions. The authors suggest a standalone, real-time system on YOLO-v3 (CNN) model for instant and accurate identification and detection of currency notes. A custom dataset of 3,720 images of banknotes of various Indian denominations was created and later augmented to 10,000 images using rotation, brightness variation, adding noise, flipping, and removing background, followed by manual labeling using Labeling. The YOLO-v3 network was pretrained on this data, it was made to run in real-time on live video streams, translating identified denominations to audio output for user convenience. Performance metrics indicated an average detection accuracy of 95.71% and recognition accuracy of 100%, with the system being invariant to variations like rotation, scaling, occlusion, illumination, and multiple banknotes in a frame. Strengths are its independent functioning, real-time processing, and reliability in diverse conditions.[10]

U. Tajane, J. M. Patil, A. S. Shahane, P. A. Dhulekar, Dr. S. T. Gandhi, and Dr. G. M. Phadke article titled, “Deep Learning Based Indian Currency Coin Recognition” (2018), proposes a coin identification system utilizing deep learning through help of transfer learning on AlexNet CNN which uses features such as color, texture, and shape. The study used over 1,600 images of 1–10-rupee coins to train, testing was done with rotated and shifted images from a set and a custom dataset. The study implemented the system in MATLAB and a hardware base with a Raspberry Pi platform, and attained high rate and time taken to response faster than typical recognition applications. [11]

S. A. Bhavani, in the paper titled “Currency Recognition using SIFT”,(June 2017), presents a smart system for automatic currency recognition to help with financial transactions. The work points out the challenges of recognizing currencies due to blurry notes, damage, and complex security designs. It emphasizes the need for simple, efficient, and fast algorithms. The proposed method includes preprocessing steps like converting RGB to grayscale and edge detection using the Prewitt and Canny methods. This is followed by feature extraction using the Scale Invariant Feature Transform (SIFT) algorithm, which is robust against changes in scale and rotation. The classification of currencies is done using Radial Basis Function Networks (RBFN) with correlation coefficients to match input images with features stored in a database. The system was tested on Indian currency denominations (₹10, ₹20, ₹50, ₹100, and ₹500) and showed effective recognition. The work also highlights potential applications in banking and automation systems. [12]

LIMITATIONS

Ref No.	Authors	Paper Title	Limitations Identified
[1]	Patil, Nisha et al. (2024)	Android App for INR Banknote Recognition	No detailed quantitative metrics (accuracy, precision, recall); depends heavily on image quality; possible false positives/negatives; limited to INR only; sensitive to lighting and regional feature extraction.
[2]	Pagalla Bhavani Shankar (2024)	Hybrid CNNs for Indian Currency Counterfeit Detection	Dataset size and composition not clearly specified; no detailed performance metrics (accuracy %, precision, recall); lacks deployment details for mobile/offline use.
[3]	Abraham Eseoghene Evwiekpaefe et al. (2024)	Visually Impaired Mobile App using MobileNetV2	Misclassification of non-currency objects; sensitivity to worn/damaged notes; lacks multi-language audio support; exclusive to Nigerian Naira only.
[4]	Mrs. P. Sangeeta et al. (2023)	Image Matching Algorithms for INR Recognition	Limited to Indian denominations only; currently implemented on Python without Android app; future work needed for multi-language support and mobile implementation.
[5]	Arvind Mukundan et al. (2023)	Hyperspectral Imaging for Counterfeit Detection	Requires specialized hyperspectral imaging equipment (potentially high cost); not clear if suitable for mobile deployment or low-cost applications; lacks discussion of real-world limitations.
[6]	Pham, Tuyen Danh et al. (2022)	Deep Learning-Based Detection of Fake Multinational Banknotes	Accuracy drops significantly for JOD banknotes due to poor image quality; reduced robustness under rotation, occlusion, complex backgrounds, and lighting changes.

Ref No.	Authors	Paper Title	Limitations Identified
[7]	Indresh Gupta, Sagar Kamble, Kartik Nisar, Parth Patel, Prof. Vidya Gogate (2022)	Currency Detector System for Visually Impaired	Complexity of deep networks constrained by hardware requirements on Raspberry Pi; possible inaccuracies in low-lighting conditions; only applicable to Indian currency; system could need added robustness for real-world variability.
[8]	A. Ms Trupti Pathrabe, B. Dr N. G. Bawane (2021)	Paper Currency Recognition System Using Characteristics Extraction and Negatively Correlated NN Ensemble	Lower accuracy for some denominations (e.g., 50 pounds) as a result of low-detail areas; light and image-sensitive; preprocessing manual adjustments needed in some instances.
[9]	Rahnuma Tasnim et al. (2021)	CNN for Bangladeshi Banknote Recognition	Potential issues include dependency on high image quality and limited generalization beyond trained denominations.
[10]	Rakesh Chandra Joshi, Saumya Yadav, Malay Kishore Dutta (2020	YOLO-v3 Based Currency Detection and Recognition System for Visually Impaired Persons	Indian currency only; subject to initial dataset size; might need further optimization for low-end devices; real-time system may not perform well under extreme illumination or occlusion.
[11]	U. Tajane, J. M. Patil, A. S. Shahane, P. A. Dhulekar, S. T. Gandhi, G. M. Phadke (2018)	Deep Learning -Indian Currency Coin Recognition	Concentrated only on coins, not banknotes; trained on small dataset (~1,600 images); might not work on extremely worn or dirty coins; hardware deployment can encounter computational constraints.
[12]	S. A. Bhavani (2017)	Currency Recognition using SIFT	System can fail with blurry or damaged notes; sensitive to complex security designs and variations in scale or rotation in real-world conditions.

DISCUSSIONS

The review of the existing literature on AI-driven currency identification and detection of counterfeits indicates substantial advancement in creating assistive technologies for visually impaired people. Several methodologies have been employed, from standard image processing methods through SIFT, SURF, and ORB feature matching to state-of-the-art deep neural networks like ResNet, MobileNetV2, and fusion CNN-based architectures. The majority of the systems produce high accuracy in controlled conditions or with high-quality images. Yet prevalent limiting factors continue throughout the literature. Numerous methods are prone to poor lighting quality, occlusion, rotation, frayed or creased banknotes, and intricate backgrounds. Various models are based on costly hyperspectral imaging equipment or cloud-based inference, rendering real-time offline usage impractical, particularly for visually impaired individuals in low-connectivity regions. In addition, most solutions are limited to particular currencies or have no multi-language support for feedback audio, limiting their use in multi-regional areas.

To overcome these shortcomings, our proposed method aims at designing a reliable, light-weight, and offline-friendly system that is tailored for real-world usage. We employ a precisely crafted dataset containing diverse lighting conditions, varied orientations, and images of both new and worn banknotes in various denominations. Our approach utilizes a lightweight CNN architecture along with state-of-the-art data augmentation methods for enhanced generalization and insensitivity to environmental variations. Contrary to most surveyed studies, our approach is designed for edge deployment on cheap devices (e.g., Jetson Nano), making it run offline at low latency. We also incorporate a multimodal feedback system (text-to-speech and tactile feedback) to enhance visually impaired user usability across regions and languages. By being concerned with applicability to the real world, cost-effectiveness, and accessibility, our methodology is intended to overcome the limitations most frequently highlighted in current research and toward a more practical and accessible system for counterfeit detection.

FUTURE DIRECTIONS

While AI-based currency recognition and counterfeiting detection has made good headway to date, there are still important gaps and opportunities to address in research. Future work should be directed at making currency recognition and counterfeiting detection systems more robust to practical challenges such as lighting variation, worn or damaged banknotes, rotation, and occlusion. It is also essential to broaden datasets with more currencies, denominations, and contextual representations so that it improves generalizability of the model and reduces dataset bias. Development of lightweight deep learning models for edge devices is also an important area of future work, such as TensorFlow Lite on the NVIDIA Jetson family of platforms, wide users can have real time inference offline and avoid a internet connection and potentially challenging connectivity. Another important direction is improving multimodal accessibility by adding audio, visual, and haptic feedback at a scope that is responsive to individual languages and regional design needs. Each of these areas supports improving accessibility for the widest possible population of people with visual impairments. Research into GAN-based domain adaptation and unsupervised learning is another important area that could help models become robust to unseen counterfeit patterns and potentially different smartphone camera inputs. Alongside specific algorithms, standardized benchmarks and publicly available datasets will further help support ongoing reproducible research and better evaluation across methods. This will further support the transparency so that the field can begin to leverage comparative research.

CONCLUSION

Recent advances in research on currency recognition and counterfeit detection for the visually impaired have achieved remarkable results by using deep learning, image processing and machine learning research[1]–[12]. While traditional methods such as template matching and SIFT-based recognition [4], [8], [12] provided beginning solutions to the problem, new approaches that leverage CNN architectures, such as YOLO-v3 and MobileNetV2, and hybrid deep networks [3],[6], [10] have led to substantial improvements in accuracy, real-time detection, and resistance to variations in rotation, illumination, scaling, and occlusion. Many systems today are also equipped with audio tactile feedback and built on embeddable platforms (e.g., Raspberry Pi) [7], [11], and some studies have also reported work towards detection for multiple currencies using cross-dataset validation and hyperspectral imaging [5], [6]. Limitations still exist with respect to light sensitivity, quality datasets, hardware specifications, and support for currencies and denominations, and continued research in these areas should include studies focusing on multiple disturbance and sensory inputs, dataset expansion, robustness, automatic counting, counterfeit detection, and lighter models for mobile and embedded use, all of which translate to practical solutions for consumers that are useful, accurate, and easier to use from a consumer perspective.

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