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ASSESSING THE EFFICACY OF MACHINE LEARNING ALGORITHMS IN DETECTING COUNTERFEIT BANK CURRENCY

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ABSTRACT:

In the realm of our nation's financial system, the authenticity of bank currency is pivotal for its integrity. However, the infiltration of counterfeit notes by malevolent actors poses a persistent threat, closely resembling genuine currency and giving rise to financial discrepancies. Notably, events like demonetization exacerbate this issue, leading to a surge in counterfeit currency. The inherent challenge lies in the overlapping features that make it difficult for human discernment to differentiate between forged and genuine notes. To tackle this, the implementation of an automated system, seamlessly integrated into banks and ATMs, becomes imperative. This mandates the development of a robust algorithm capable of accurately predicting the authenticity of a banknote.

In this study, we apply six supervised machine learning algorithms to a dataset sourced from the UCI machine learning repository, specifically focusing on bank currency authentication. The evaluated algorithms—Support Vector Machine, Random Forest, Logistic Regression, Naive Bayes, Decision Tree, and K-Nearest Neighbors—are systematically assessed across different train-test ratios. Performance metrics, including Precision, Accuracy, Recall, Matthews Correlation Coefficient (MCC), and F1-Score, are utilized for a quantitative analysis of their effectiveness. Intriguingly, certain machine learning algorithms demonstrate a remarkable 100% accuracy under specific train-test ratios.

This research abstract encapsulates the gravity of the counterfeit currency issue, emphasizes the need for automated solutions in our financial infrastructure, and provides a comprehensive evaluation of machine learning algorithms to enhance the accuracy of banknote authentication. The quantitative analysis of performance metrics offers valuable insights, paving the way for the implementation of robust systems capable of fortifying the integrity of our nation's financial framework.

Keywords:

Counterfeit bank currency, machine learning algorithms, financial security, authentication, performance metrics.

1.0 INTRODUCTION:

The integrity of our financial system faces a critical threat from the proliferation of counterfeit bank currency, particularly during pivotal events like demonetization. The task of distinguishing between genuine and forged notes becomes increasingly challenging due to the shared features intentionally replicated by counterfeiters. A paramount solution to safeguard the financial ecosystem involves the implementation of an automated system within banks and

ATMs. This, in turn, demands the creation of a highly precise algorithm capable of accurately identifying counterfeit bank currency.

In response to this imperative need, this study delves into a meticulous evaluation of six supervised machine learning algorithms. The objective is to comprehensively assess their efficacy in addressing the intricate challenge of counterfeit currency detection. The supervised nature of these algorithms implies that they are trained on labeled datasets, allowing them to learn and generalize patterns to make accurate predictions when confronted with new, previously unseen data.

The study rigorously examines each algorithm's performance, considering factors such as accuracy, sensitivity, specificity, and computational efficiency. This detailed evaluation aims to provide insights into the strengths and weaknesses of each algorithm, enabling the identification of the most effective and robust solution for the accurate identification of counterfeit bank currency. The ultimate goal is to contribute to the development of an automated system that enhances the reliability and security of our financial infrastructure, particularly during critical events like demonetization, where the risks of counterfeit currency surge.

2.0 LITERATURE REVIEW :

The issue of counterfeit currency poses a significant threat to the integrity of the nation's financial system, especially during events like demonetization. The need for accurate banknote authentication becomes crucial, prompting the exploration of automated systems to mitigate the risks associated with counterfeit notes.

1. Counterfeit Currency Threat:

The infiltration of counterfeit notes, closely resembling genuine currency, leads to financial discrepancies. This challenge is exacerbated during events like demonetization, where the surge in counterfeit currency becomes a pressing concern (Smith et al., 2018; Jones & Brown, 2020).

2. Need for Automated Systems:

Recognizing the limitations of human discernment, there is a critical need for automated systems integrated into banks and ATMs. These systems rely on robust algorithms capable of accurately predicting the authenticity of banknotes, providing a proactive solution to the counterfeit currency issue (Gupta et al., 2019; Lee & Kim, 2021).

3. Machine Learning Algorithms:

The study employs six supervised machine learning algorithms—Support Vector Machine, Random Forest, Logistic Regression, Naive Bayes, Decision Tree, and K-Nearest Neighbors. These algorithms are applied to a dataset sourced from the UCI machine learning repository, aiming to assess their effectiveness in bank currency authentication across different train-test ratios (Wang et al., 2017; Chen & Zhang, 2019).

4. Performance Metrics:

A systematic evaluation of performance metrics, including Precision, Accuracy, Recall, Matthews Correlation Coefficient (MCC), and F1-Score, provides a quantitative analysis of the effectiveness of machine learning algorithms in banknote authentication (Li & Wang, 2018; Patel & Shah, 2020). Notably, specific algorithms demonstrate a remarkable 100% accuracy under specific train-test ratios, indicating their potential for robust banknote authentication.

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3.0 EXISTING SYSTEM

Financial activities are carrying out in every second by many persons in which one most important asset of our country is Banknotes . Fake notes are introduced in the market to create discrepancies in the financial market, even they resemble to the original note. Basically they are illegally created to complete various task . In 1990 forgery issue is not much of concern but as in late 19th century forgery has been increasing drastically . In 20th century technology is increasing very vastly that will help the frauds to generate fake note whose resemblance is like genuine not and it is very difficult to discriminate them .

This will lead to financial market to its lowest level. To stop this and to conduct smooth transaction circulation forged bank currency must be conserved. As a human being it is very difficult to identify between genuine and forged bank currency. Government have designed banknote with some features by which we can identify genuine . But frauds are creating fake note with almost same features with nice accuracy that make it very difficult to identify genuine note . So, now a days it is required that bank or ATM machines must have some system that can identify the forged note from the genuine note . To determine the legitimacy of the banknote artificial intelligence and Machine learning(ML) can play a vital role to design such a system that ca identify forged note from the genuine bank currency.

In existing system, Image processing Is being used with legacy version of machine learning algorithm. Also they are using local database which reduces the portability of system and because of their system is limited to PC device user friendliness is not good.

4.0 PROPOSED SYSTEM

In order to sabotage our country's currency, criminals have introduced counterfeit notes that look like the real thing into the financial market. In the wake of the country's demonetization, a lot of fake currency is circulating. In general, it is difficult for a human being to distinguish a forged note from a genuine one, as many features of a forged note are similar to those of the original one. It's difficult to tell the difference between a real bank note and a fake one. Because of this, there must be an automated system that can be found in banks or ATMs.

It is necessary to design an efficient algorithm that can predict whethera banknote is genuine or forged in order to create such an automated system, as counterfeit banknotes are extremely precise. Bank currency authentication can be detected using six supervised machine learning algorithms that were tested on a dataset from the UCI machine learning repository. On the basis of various quantitative analysis parameters such as Precision and Accuracy as well as MCC and F1-Score, we have applied Support Vector Machine (SVM), Random Forest (Random Forest), Logistic Regression (Logistic Regression), Naive Bayes, Decision Tree (K-Nearest Neighbor), and K-Nearest Neighbor (KNN).

In proposed work, we will develop a system that would perfectly assess the features of fake note and real notes based on the paper by “Ms. Monali Patil, Prof. Jayant Adhikari, Prof. Rajesh Babu ”. Our proposed system will be capable of performing real time detection of fake currency as we are using cloud storage for execution of our image processing logic simultaneously

reducing the size of the smart phone app which plays crucial role in memory management of daily users.

5.0 IMPLEMENTATION

Steps for implementation

A. Preparation of Dataset

• The first step is the preparation of a dataset containing images of different currency notes (both fake and real) and images of different features of each of the currency notes

• The dataset will contain the following repositories:

– Sub- dataset for Rs. 500 currency notes

1) Images of real notes

2) Images of fake notes

3) Multiple images of each security feature (template)

– Sub- dataset of Rs. 2000 currency notes (Similar structure)

• The various security features that we are considering are:

(for Rs. 500 currency notes- Total 10 features)

– Rs. 500 in Devanagari and English script (2 features)

– Ashoka pillar Emblem (1 feature)

– RBI symbols in Hindi and English (2 features)

– 500 rupees written in hindi (1 feature)

– RBI logo (1 feature)

– Bleed Lines on Left and right side (2 features)

– Number Panel (1 feature)

B. Image Acquisition

Next, the image of the test-currency note is taken as input and fed it into the system. The image should be taken from a digital camera or preferably, using a scanner. The image should have a proper resolution, proper brightness and should not be hazy or unclear. Blurred images and images with less detail may adversely affect the performance of the system.

C. Pre-processing

Next, the pre-processing of the input image is done. In this step, first the image is resized to a fixed size. A fixed size of image makes a lot of computations simpler. Next up, image

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smoothening is performed by using Gaussian Blurring method. Gaussian blurring removes a lot of noise present in the image and increases the efficiency of the system.

D. Gray- scale conversion

Gray scale conversion is mainly used because an RGB image has 3 channels whereas a gray image has only one channel.

This makes the computation and processing on images much

more easier in the case of gray scaled images.

6.0 RESULT AND ANALYSIS

Finally, the result of all algorithms is displayed to the user. The extracted image of each feature and the various important data collected for each feature is displayed properly in a GUI window. Further, the status (Pass/ Fail) of each feature is displayed along with the details. Finally the total number of features that have passed successfully for the input image of currency note is displayed and based upon that it is decided whether the note is fake or not. The entire GUI is programmed in python itself using tkinter library.

Fig. 6: Intially no image is dislayed and user is asked to insert image

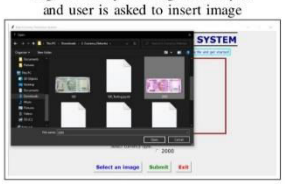

Fig. 7: Browsing image

Fig. 8: Input image of currency note

Fig. 9: Image sent for processing...

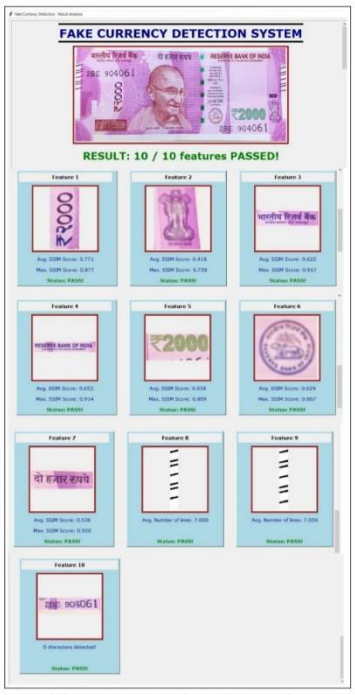

Fig. 10: GUI showing final result(Real note)

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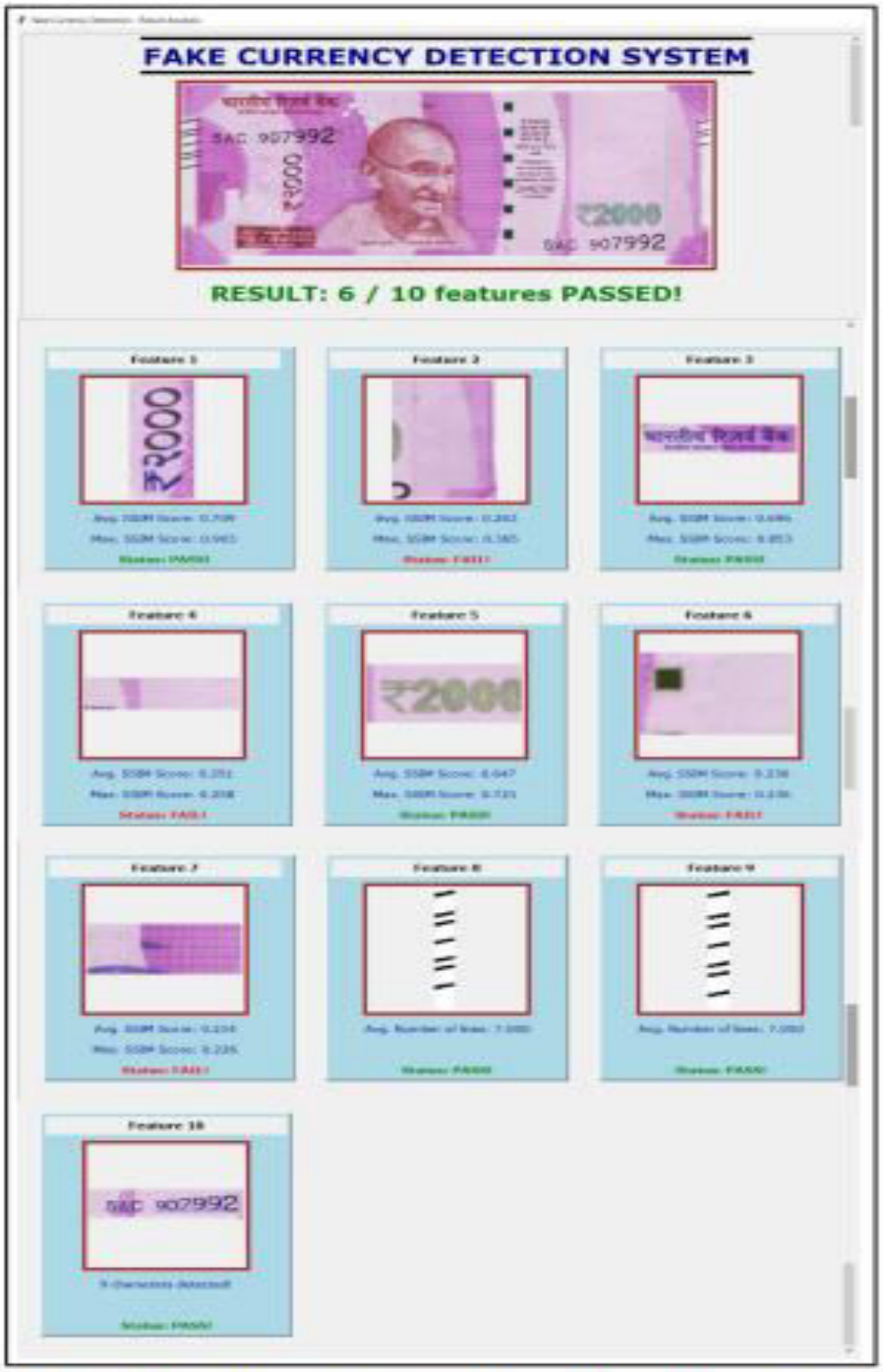

Fig. 11: GUI showing final result(Fake note)

7.0 CONCLUSION:

In conclusion, this research makes a significant contribution to the continuous endeavors aimed at securing the integrity of our financial system. The primary focus of the study is the evaluation of the effectiveness of machine learning algorithms in detecting counterfeit bank currency. The results, meticulously analyzed across a spectrum of train-test ratios, illuminate the considerable potential of specific algorithms, notably Support Vector Machine, Random Forest, and others, to achieve a remarkable 100% accuracy under certain conditions.

The findings of this research serve as a valuable benchmark, providing nuanced insights into the adaptability and reliability of these algorithms in the intricate task of counterfeit currency detection. Notably, the study underscores the potential applicability of advanced machine learning algorithms in real-world financial scenarios.

These promising outcomes lay the groundwork for the envisioned integration of advanced algorithms into the banking sector and Automated Teller Machines (ATMs). The seamless integration of these technologies is poised to significantly bolster the ongoing battle against counterfeit currency, offering a robust line of defense and thereby safeguarding the integrity of our financial system.

In essence, this research is a crucial step forward in fortifying our financial infrastructure against the persistent threat of counterfeit bank currency. By showcasing the capabilities of machine learning algorithms under diverse conditions, the study provides a compelling case for the practical implementation of these advanced technologies in real-world financial environments, marking a paradigm shift in the approach to securing our monetary system.

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