

INDIAN BANKNOTE DETECTION USING PCA

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ABSTRACT

This paper gives a quick strategy to perceive an assortment of Indian banknotes at various scales. In this procedure, the PCA, LDA and sparse representation techniques are used at highlight extraction arrange and pursues with MLP neural systems, LVQ, and SOM in characterization. At last, the use of inadequate grid portrayal technique and mix of both SOM and LVQ neural systems would prompt the best proficiency with the exactness of 91.15% in acknowledgment of Indian banknotes especially the well-used ones.

1. INTRODUCTION

In the present innovative and developing world, the human life is winding up progressively motorized and the everyday exercises are performed by a mix of mechanical and computerized advances and without a doubt by learning the way of human and social orders' improvement. The impacts of these advancements are clear as for the ventures and reserve funds in business issues. These days, a large portion of the financial tasks are directed in motorized ways and there is no decision yet utilizing the new and cutting edge innovations for expanding the exactness and speed of issues because of the high volume of this activity. The programmed candy machines have made a gigantic jump toward this path contrasted with the regular frameworks with the target setting aside the paces of cash got and paid to clients. In ordinary financial procedures, these machines do the cash move, receipt and instalment just as different administrations, for example, getting the instalment bill, giving the ledgers and move assets between various records in countless exchanges. In spite of the improvement and far reaching in such manner, the cash move in these machines is as yet done physically and through the work in this procedure. The banknote acknowledgment is one of the most significant applications in banking and business exercises. However, there is no open framework for doing the best possible acknowledgment in numerous countries [1].



Fig 1: The complexities of banknote recognition

Be that as it may, the visual acknowledgment of banknotes is alongside difficulties, for example, torn piece of banknote and worn and messy banknote notwithstanding the adjustments in splendour of picture and its revolution. Because of the referenced issues, the proposed strategy for perceiving the banknotes ought to be impervious to these difficulties. This paper explores a few strategies for perceiving the Indian banknotes with various shooting edges and at last a technique which is impervious to banknote revolution and its tear and wear is chosen as the last strategy. This article incorporates the accompanying areas: Section 2 gives a concise survey of techniques which were applied for banknote acknowledgment previously. Segment 3 acquaints the system with perceive the banknote in this paper and characterizes various techniques for example acknowledgment in this paper; Section 4 introduces the outcomes lastly Section 5 gives the end.

2. RELATED WORKS

C D E Figure 1. The complexities of banknote acknowledgment (from the left, A B, C, D, E). Different techniques have been read for banknote acknowledgment so far [2]. Five diverse neural systems are applied for programmed acknowledgment of banknotes³. In this technique, one of the systems is applied for deciding the course of banknote and the others for deciding the sort of banknote. The Quaternion Wavelet Transform (QWT) is used for removing the highlights of banknotes [4]. The summed up Gaussian Density (GGD) is applied to catch the measurable attributes of QWT coefficients. The neural system is utilized as a classifier in the structure of the banknote grouping. Trial results show its viability and the proposed technique gets a higher acknowledgment rate in the banknote grouping. The utilization of probabilistic neural systems is proposed to perceive the banknote with the target taking care of the issues of banking system [5] and it has had the option to accomplish the ideal outcome in perceiving and arranging different sorts of banknotes and particularly invalid and fake banknotes. The half breed neural system comprising of perceptron neural system and range based neural system are likewise applied⁶. The utilization of Fuzzy Hamming separation has a decent choice power [7]. The Gaussian blend model dependent on limiting the hazard blunder is applied to diminish the acknowledgment mistake of banknotes and it is demonstrated that the acknowledgment mistake can be decreased for Chinese banknotes by changing the quantity of Gaussian models [8]. The highlights of banknote surface are extricated by Hidden Markov Model (HMM) and after that, the banknotes are perceived by a comparability measure [9]. The Mexican banknotes are perceived depends on the shading and surface features [10]. The Local Binary Patterns are applied for removing the surface highlights. [3]. Presenting the Proposed Algorithm The examined and shot pictures are taken from an assortment of Indian banknotes including 320 pictures of 8 kinds of Indian banknotes and 40 front and back pictures of every banknote. A portion of the banknotes are typical and others harmed. All pictures are changed over into the elements of 90*64 and dim level in pre-preparing. K approval with k-5 is applied to make testing and preparing sets. In addition, the applied techniques are analysed on a trial set of turned banknote pictures so as to watch the impact of pivot on the banknotes. A few strategies are contrasted to perceive the banknotes in this paper. The primary strategy applies the PCA method

after information pre-preparing to decrease the measurements, and afterward the Euclidean least separation basis is used to perceive the banknotes. In the subsequent technique, an LVQ system is applied for characterization in the wake of utilizing a blend of PCA and LDA so as to diminish the measurements. The third technique uses MLP to organize. The quantity of highlight vectors sent to this neural system is equivalent to $C-1$ in which C is the number of classes. The fourth strategy at first applies a SOM neural system to deliver a lower-dimensional state space, and after that applies the PCA in each of made group to decrease the information size. In the wake of decreasing the measurement, an LVQ neural system is applied for conclusive arrangement. At last, the fourth technique at first uses the sparse portrayal to improve the pictures and after that characterizes the banknotes by joining two MPL and LVQ neural systems.

3.1 Principal Component Analysis

The Principal Component Analysis (PCA) is one of the most significant approaches to lessen the excess so as to encourage the information handling and order. This change is generally utilized in information examination for measurement decrease. This element decreases the information size just as keeping the fundamental data of picture. Thusly, the new arrange tomahawks are characterized for information, and the information depend on these new organize tomahawks. The primary pivot ought to be toward the path where the information difference is maximal (for example toward a path wherein the information scattering is higher). The subsequent hub ought to be opposite to the principal hub such that the information fluctuation is maximal. Thus, the following tomahawks ought to be opposite to every single past hatchet such that the information has the most extreme scattering in that direction [11].

3.2 Linear Feature Transformation Methods

LDA is one of the renowned techniques to set up the differentiation between the highlights and straight decrease of administered highlight measurements. In old style LDA, the between class and intra-class covariance lattices are determined as follows in Equations (1) and (2). Where, N is the complete number of tests; N_i is the quantity of tests in class I . μ_i is the mean of class I . I is the quantity of classes, and X_{ni} is the example n_i of class I .

$$S_w = \frac{1}{n} \sum_{j=1}^c \sum_{x \in c_j} (X - \bar{X}_j)(X - \bar{X}_j)^T \dots\dots\dots(1)$$

$$S_b = \frac{1}{n} \sum_{j=1}^c (\bar{X}_j - \bar{X})(\bar{X}_j - \bar{X})^T \dots\dots\dots(2)$$

Follow (SW)

measures the between class solidarity and the follow (Sb) computes the intra-class differentiation. Follow Function alludes to the qualities on the primary corner to corner of landing square framework. The motivation behind LDA is to get the change lattice of W such that the Fisher condition is expanded [12] [Equations (1), (2) and (3)].

$$J(W_{LDA}) = \frac{W_{LDA}^T S_b W_{LDA}}{W_{LDA}^T S_w W_{LDA}} \dots\dots\dots(3)$$

3.3 Sparse Representation

The inadequate portrayal is a technique which demonstrates the entire information of sign straight mix is few essential sign, called molecules, as an ideal lexicon. Along these lines, each sign is shown as a mix. The sparse portrayal has different applications, for example, clamor decrease, pressure, design arrangement and highlight extraction. The strategy to discover the lower number of fundamental variables called sparse encryption. In this strategy, the information vectors are communicated as direct blend of lower parts of an over-complete grid. Inadequate encryption is a fruitful strategy in highlight choice and can evaluate the sign with lower measurement. Not at all like PCA, this isn't essential for base units to be symmetrical parts and there is likewise the probability of selection [13].

Table 1 demonstrates the Euclidean aftereffects of measurement decrease utilizing PCA and Euclidean separation technique for acknowledgment. This strategy would have the option to perceive 100% of banknotes by expanding the quantity of highlight vectors by 150. Be that as it may, the expanded number of chosen vectors has no critical effect on the outcome in exploratory set 2.

4. RESULTS AND DISCUSSION

At first, PCA and the acknowledgment dependent on the base separation diminished the measurement. It is seen that 96.75% of banknotes are perceived by most extreme 6 element vectors in Experimental Set 1.

Table 1. Euclidean results of dimension reduction using PCA and Euclidean distance method for recognition

Number of Selected Vectors	Experimental Set 1	Experimental Set 2
1	25%	18.75
2	56.25	25
3	75	37.5
4	84.375	37.5
5	84.375	37.5
6	90.62	34.37
7	96.875	37.5
8	96.875	40.62
9	96.875	37.50
10	96.875	36.51
20	96.875	40.62
100	100	48.78
150	100	50
200	100	50
500	100	50

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Table 2. Applying the PCA and LVQ neural network with 50 neurons

Number of Feature Vectors	Experimental Set 1	Experimental Set 2
5	64.37	38.75
7	62.49	40.14
10	73.09	59.99
20	73.12	57.50
30	85.43	59.65
50	93.32	55.73
100	91.09	53.75
200	95.70	50.62
300	93.79	53.71

Table 2 demonstrates the aftereffects of joining PCA and LDA strategies utilizing LVQ neural system for classes and

Table 3. Applying a combination of PCA and LDQ, and LVQ neural network with 50 neurons

Number of Feature Vectors	Experimental Set 1	Experimental Set 2
5	67.45	35.62
7	69.99	38.12
10	70.62	41.87
20	77.44	58.12
30	92.18	45.31
50	93.08	46.87
100	96.34	52.34
200	91.66	42.31
300	93.73	30.41

Table 3 demonstrates the consequences of applying a mix of PCA and LDQ and LVQ neural system with 50 neurons. Alongside,

Table 4. Applying the PCA and LVQ neural network with 80 neurons

Number of Feature Vectors	Experimental Set 1	Experimental Set 2
5	63.12	40.62
7	63.125	47.5
10	71.62	50.851
20	81.25	47.25
30	97.5	50.41
100	94.37	52.77
200	91.25	52.87
300	64.37	53.12

Table 4 displays the consequences of Applying the PCA and LVQ neural system with 80 neurons, and

Table 5. Applying the PCA and LDA, and LVQ neural network with 80 neurons

Number of Feature Vectors	Experimental Set 1	Experimental Set 2
5	71.5	35
7	72.53	48.12
10	87.25	41.87
20	87.62	46
30	93.12	52.45
50	92.87	56.75
100	90.62	55.62
200	90.37	10:15
300	61.5	25

Table 5 demonstrates the aftereffects of applying the PCA and LDA and LVQ neural system with 80 neurons. It is seen that the blend of LDA and PCA techniques prompts better outcomes, however, when the quantities of vectors are expanded, it would negatively affect the system execution. Besides, If MLP neural system and a blend of PCA and LDA Euclidean aftereffects of measurement decrease utilizing PCA and Euclidean separation technique for acknowledgment as per the quantity of chose vectors equivalent to $c-1$ (C is the number of classes) is utilized, at that point the system is appropriately perceived with an accuracy of 97.50%.

Table 6. Application of SOM and LVQ networks and reduced dimensions with PCA and 50 neurons

Number of Feature Vectors	Experimental Set 1
1	80.12
5	82.01
10	89.6
15	89.07
20	90.42
30	90.7
40	94.7

Table 6 and 7 present the consequences of the use of SOM and LVQ systems and diminished measurements with PCA.

Table 7. Application of SOM and LVQ and reduced dimensions with PCA and 80 neurons

Number of Feature Vectors	Experimental Set 1
1	96.3
5	96.61
10	98.4
15	98.71
20	99.2
30	99.2
40	99.31

Utilizing the sparse portrayal, the exactness of appropriate acknowledgment of banknote pictures particularly the ragged banknotes arrives at 91.15 percent. Likewise, the well-used banknotes with ill-advised arrangements can be perceived as exhibited.

5. CONCLUSION

With the target distinguishing the Indian banknotes, this paper examines four diverse characterization techniques in which the components of banknote pictures are diminished through PCA before pre-handling on them, and afterward, the arrangement is done on them by various strategies. As per the outcomes, it was discovered that the fourth technique for utilizing the blend of SOM and LVQ neural systems and scanty portrayal has had the best execution. Moreover, the utilization of PCA and LDA and the choice of C-1 vector highlights have prompted fitting outcomes. At last, the utilization of PCA and the base Euclidean separation has the most minimal usage time agreeing. of various molecules.