Image Recognition and Classification by Using an Integrated Solution of Singular Value Decomposition and Linear Discriminant Analysis Algorithm

Anwar Hussain*, Muhammad Haris*, Abid Badshah, Ahmad Ishaq, Waseem Afsar

University of Swabi

Abstract

In this paper we proposed a classification algorithm, that use two methods of machine learning called Singular Value of Decomposition that is basically dimensionality reduction method, that takes useful information/features from dataset (images) and the second is Linear Discriminant Analysis (LDA) is a method used in image processing, pattern recognition and machine learning to find a linear combination of features that characterize or separates two or more classes of objects or events. In addition, we apply this algorithm on large image dataset and further use for gender classification problem. For example, face recognition and classification between male and female will be applied.

Key words: Machine learning, Image processing, Singular value decomposition, Linear discriminant analysis, Image classification.

Mr. Abid Badshah, University of Swabi Pakistan, +92 343 970995, abidbadshahcs@gmail.com

1. Introduction:

Image recognition and classification observe numerical properties of images features or pixels and then arrange it into groups. Classification algorithms have two types of processing, preparing phase and testing phase. In preparing phase, the features of image are segregated and then store that features and on this notable feature it classifies images. In the succeeding testing phase, the algorithm categorizes images through threshold line. The training phase is a serious part of the classification method. Classification of supervised learning is the algorithm selects an important pixel in image and based on these pixels it takes decision and classify it into groups. Unsupervised classification makes clusters of same data i.e. red color have different clusters. The following diagram shows the stages used in a predictable image classifier.

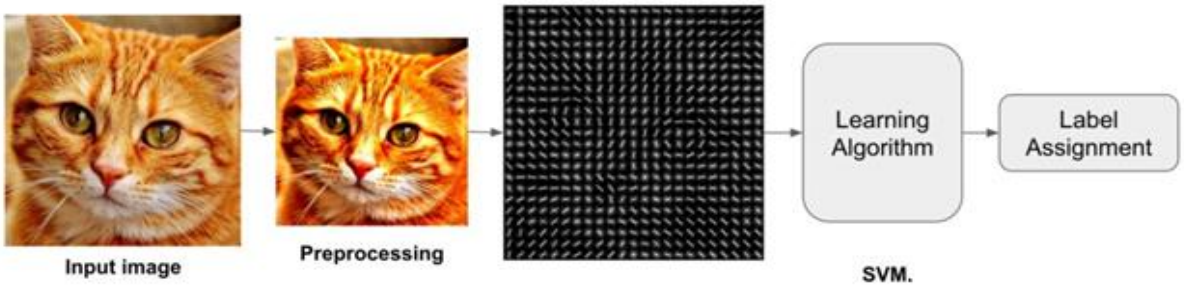

Figure 1: Image classifier

We have to train algorithms to classify the difference between data/images. In this work we have used two integrated algorithms, singular value decomposition which is used for dimensionality reduction and linear discriminant analysis (LDA) is used to classify two different classes. This type of classification is also called binary classifier. We train algorithm by several images contain in dataset and then test some images through these trained algorithms. A major role of the research is integrated solution of machine learning and image processing in same project. Earlier, the research work was only about image recognition. The goal of this project is to seal break of machine learning methods in image processing. This paper is only the work which makes to use the dataset of Cat and Dog but this work can be more suitable for classification of gender in humans.

2. Materials and methods:

The goal of this study is to use the conclusions and results obtained in a meaningful way based on the data and facts collected above, to improve the accuracy and success rate of algorithms. We have planned that the ultimate goal of learning algorithm is below:

- Preprocess the given data or images.
- Process image by processing methods to decrease the dimensions of image/data.
- After image processing train the algorithms SVD and LDA to draw a threshold line between different classes and make a comparison graph.
- After training the algorithms take new images which will completely different from training dataset to find accuracy, error and success-rate of test set.

- Proposed model for our method is:

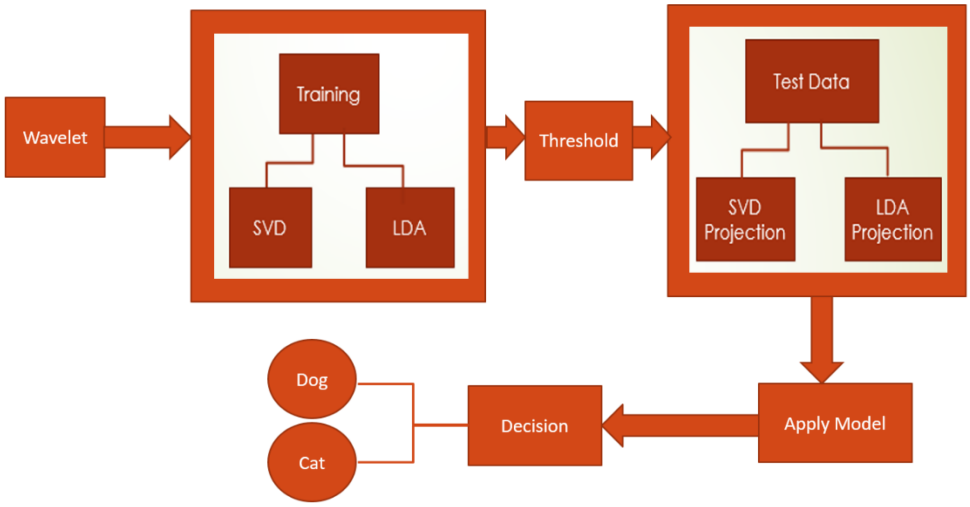

Figure 2: Proposed model

3. Results and discussion:

Load dataset that contains sample of Cat and Dog. Then train the algorithm on this dataset after that load test images which will be totally different from training images. Then test it and find the success rate and errors. The table 1st shows overall testing and training data with success rate and error.

Table 1st: Overall testing and training data

Name of Variable	Numerical data and size	Name of Variable	Numerical data and size
Img. CAT	Uint8 (80*4096)	Cat R	Double (32 * 32)
Img. DOG	Uint8 (80*4096)	Dog R	Double (32 * 32)
CAT-wavelet	Double (80*1024)	Test R	Double (32 * 32)
DOG-wavelet	Double (80*1024)	Threshold line	18.2189
K= No. of features	20	Success Rate	81.250
Test images	16	Error Number	3

This test is to check the trained algorithm that it works correctly or not. We allocate 16 images of two classes i.e. Cat and Dog to check that the algorithm is classifying it or not. Result will be totally different from previous outputs.

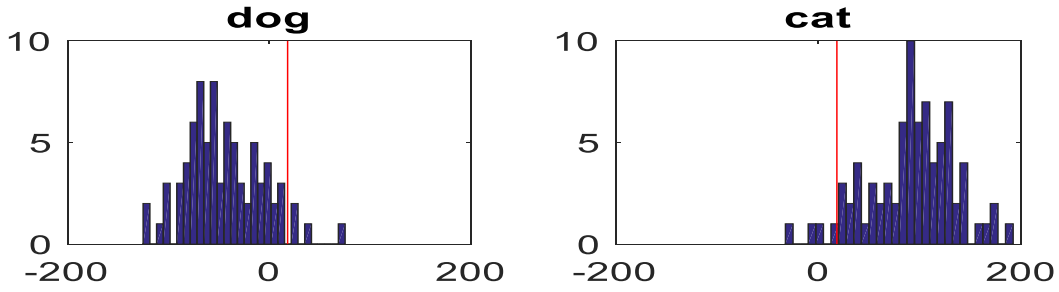

Figure 3: Features of histogram

The histogram shows threshold line that classify images of cat and dog. The algorithm then get decision on test images that this image belong to cat or dog.

The images that is not recognized by algorithm.

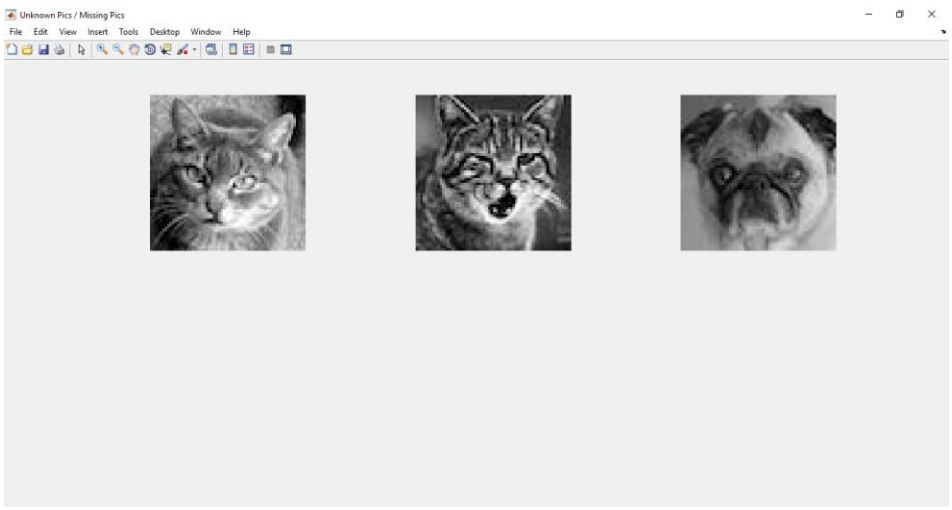

Figure 3: Incorrect classified images

Figure 3 shows the images are not recognized by algorithm. So, this is the error rate of our research work and it effects on our accuracy.

After the threshold value the ultimate outcome shows that what is the success rate and error rate. Error Number (EN) is the variance between Resultant vector (RV) and hidden label (HL).

- *HL*: 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1
- *RV*: 0 1 0 0 0 0 0 0 1 1 0 0 1 1 1 1
- *Accuracy rate (AR)*: 3/16*100=18.75
- *EN*= 3
- *Success rate (SR) in percent:* 100 - (AR) = 100 – 18.75 = 81.25%

We will check the test set on different features i.e. 10, 15, 20, 25, 30 but the better result is on 20 because 20 is the medium selection and there is the better possibility to increase the accuracy by increasing the features but our accuracy is decreasing by increasing on features. Our result of features is given below:

Table 2: Number of features and its result/accuracy

Number of Features	Result/ Accuracy %	Number of Features	Result/ Accuracy %
10	81.250%	25	75%
15	68.75%	30	75%
20	81.25%		

4. Conclusion:

The final objective of this study is to merge singular value decomposition (SVD) and linear discriminant analysis (LDA) algorithm for arrangement outcomes in, to classify well, having high precision and Minimum Squares problem / Least Error Rate. The accuracy of our algorithm is 81.25 %. The accuracy can be enhanced by, give high quality image and Increase the training data. In addition, we apply this algorithm on large image dataset and further use for gender classification problem. For example, face recognition and classification between male and female will be implemented.

5. Acknowledgements:

First, praises and thanks to Allah Almighty, for his showers of blessing throughout my research work to complete the research successfully. I would to express my deep and sincere gratitude to my research supervisor and co-supervisor Mr. Anwar Hussain and Mr. Muhammad Haris for giving us the opportunity to do research and providing invaluable guidance. His dynamism, vision, sincerity and motivation have deeply inspired us. They taught me the methodology to carry out the research and to present the research works as clearly as possible. It was a great privilege and honor to work and study under their guidance. I am extremely grateful for what they have offered me. I would also like to thank them for their friendship, empathy, and great sense of humor. They were always available for help with an encouraging attitude, whenever I got stuck. Their comments and feedback opened new directions in work.

I sincerely appreciate their time and efforts which they have been providing from the start of the project. I will never forget their efforts in reading and giving very useful and in-time feedback on drafts of my project. I extend my deepest gratitude to all the responsible teachers to give me a lot of knowledge and every kind of assistance in the four years of stay in this Institute. I am very thankful for the teaching and administrative staff of our department for their support, especially Dr. Shah Nazir help. Of course, I am thankful to my family for their support, their interest and for always being there, when I needed them most.

6. References

[1] X. Tan, S. Chen, Z.-H. Zhou, and F. Zhang, "Face recognition from a single image per person: A survey," Pattern Recognition, vol. 39, no. 9, pp. 1725–1745, Sep. 2006.

[2] Hameed, N., Shabut, A. M., Ghosh, M. K., & Hossain, M. A. (2019). Multi-Class Multi-Level Classification Algorithm for Skin Lesions Classification using Machine Learning Techniques. *Expert Systems with Applications*, 112961.

[3] M. D. Fernandes, "Is LDA a dimensionality reduction technique or a classifier algorithm?" Towards Data Science, 28-Mar-2017. [Online]. Available: https://towardsdatascience.com/is-lda-a-dimensionality-reduction-technique-or-a-classifier-algorithm-eeed4de9953a. [Accessed: 16-Nov-2017].

[4] Avuçlu, E., & Başçiftçi, F. (2020). The determination of age and gender by implementing new image processing methods and measurements to dental X-ray images. *Measurement*, *149*, 106985.

[5] Tănăsescu, A., & Popescu, P. G. (2019). A fast singular value decomposition algorithm of general k-tridiagonal matrices. *Journal of Computational Science*, *31*, 1-5.

[6] S. Lemm, B. Blankertz, T. Dickhaus, and K.-R. Müller, "Introduction to machine learning for brain imaging," NeuroImage, vol. 56, no. 2, pp. 387–399, May 2011.

[7] "Linear discriminant analysis," Wikipedia. 12-Oct-2017.

[8] Zhu, L., Chen, S., Zhao, H., & Zhang, S. (2019). Classification of UAV-to-ground vehicles based on micro-Doppler signatures using singular value decomposition and reconstruction. *Optik*, *181*, 598-610.

[9] Hu, L., & Cui, J. (2019). Digital image recognition based on Fractional-order-PCA-SVM coupling algorithm. *Measurement*, *145*, 150-159.

[10] Yang, Y., Song, S., Yue, F., He, W., Shao, W., Zhao, K., & Nie, W. (2019). Superpixel-based automatic image recognition for landslide deformation areas. *Engineering Geology*, *259*, 105166.

[11] He, T., & Li, X. (2019). Image Quality Recognition Technology Based on Deep Learning. *Journal of Visual Communication and Image Representation*, 102654.

[12] Ouyang, F. S., Guo, B. L., Ouyang, L. Z., Liu, Z. W., Lin, S. J., Meng, W., ... & Yang, S. M. (2019). Comparison between linear and nonlinear machine-learning algorithms for the classification of thyroid nodules. *European journal of radiology*, *113*, 251-257.

[13] Maitre, J., Bouchard, K., & Bédard, L. P. (2019). Mineral grains recognition using computer vision and machine learning. *Computers & Geosciences*, *130*, 84-93.

[14] Zhang, Z., Liu, H., Meng, Z., & Chen, J. (2019). Deep learning-based automatic recognition network of agricultural machinery images. *Computers and Electronics in Agriculture*, *166*, 104978.

[15] Parraga-Alava, J., Cusme, K., Loor, A., & Santander, E. (2019). RoCoLe: A robusta coffee leaf images dataset for evaluation of machine learning based methods in plant diseases recognition. *Data in brief*, *25*, 104414.

[16] He, T., & Li, X. (2019). Image Quality Recognition Technology Based on Deep Learning. *Journal of Visual Communication and Image Representation*, 102654.

[17] Jiang, D., Wu, K., Chen, D., Tu, G., Zhou, T., Garg, A., & Gao, L. (2019). A Probability and Integrated Learning Based Classification Algorithm for High-level Human Emotion Recognition Problems. *Measurement*, 107049.

[18] Fang, Y., Zhao, J., Hu, L., Ying, X., Pan, Y., & Wang, X. (2019). Image classification toward breast cancer using deeply-learned quality features. *Journal of Visual Communication and Image Representation*, *64*, 102609.

[19] Yu, Y. F., Ren, C. X., Jiang, M., Sun, M. Y., Dai, D. Q., & Guo, G. (2019). Sparse approximation to discriminant projection learning and application to image classification. *Pattern Recognition*, *96*, 106963.

[20] Bostik, O., & Klecka, J. (2018). Recognition of CAPTCHA characters by supervised machine learning algorithms. *IFAC-PapersOnLine*, *51*(6), 208-213.