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Categorization of artwork images based on painters using CNN

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Abstract--Artworks and paintings has been an integral part of human civilization since the dawn of the Stone Age. Paintings gives more insight about any subject compared to the scriptures and documents. Archiving of digital form of paintings helps to preserve the artworks of different painters. The anticipated work is aimed for the classification of painters' artworks. The artworks of Foreign & Indian painters are considered for the proposed work. The foreign painters' artworks are obtained from [14]. At present, the Indian painters' artwork dataset is not readily available. The images were downloaded from the specific genuine website [13]. Conventional Neural Network is used for Feature learning and classification. Around 20k images of artworks is used for the experiment and got an average accuracy of 85.05%.

Keywords--Neural Network, Deep Learning, Convolutional Neural Network, Painting Classification, Painter Identification

1. INTRODUCTION

The oldest paintings are known to be created by Neanderthals which are dated to be almost 40,000 years old, which were basically cave paintings. From the prehistoric times, we have made huge leaps in modernization of paintings. It is known that cave-paintings were the first form of expressing emotions and recording events alike. It has also helped a great deal to preserve the essence of civilizations for the upcoming generations. It is a well-known phrase that "A picture is worth a thousand words". [1] Supports this thought very much, as a result of which there is an increase in the use of multimedia in the field of teaching these days. Many a time patients are asked to draw out their emotions rather than telling or transcribing it, which most of the times work out to be the best passage of their thoughts across to the doctor. Generally to convey a fact or an event, instead of writing the sequence of events, a picture can describe both the situation as well as the emotions of the snapshot taken in time. Paintings are quite an effective source of information that can convey the day to day survivals and livelihood of the people. Paintings lets us get a glimpse into the lives of the Neanderthals and effortlessly it passes the teachings of one civilization to the other [3]. Just like archival of documents are getting new attention from different sectors of scientists, archival of paintings is also getting notable heads [2]. Archival of paintings and artworks are crucial, as they pass on the civilization's culture effortlessly indeed. [4] Digitization of paintings has been a very significant step for most of the museums. As today's generation will tend to focus more on a digital clone of an object than the physical object itself,



digitized paintings and artworks may get their attention more than the paintings hung in the museum collecting dust. Although digitization might take away the essence of the painting that could only be praised by visually admiring the brushstrokes and the intrinsic usage of colours. Later better digitization techniques may overcome this barrier as well. With the increasing amount of digital content day by day, another overhead of sorting those artworks and archiving them properly comes into the picture. One medieval way is to ask an expert to sort the paintings manually. It will be very tedious and time consuming. This can be automated using machine learning.

Automation of segregating images based on the style of paintings, usage of colours or sketching methods is a very important task. As a painter's work is persistent in style, stroke etc. throughout their artworks, it is possible to classify the images according to the respective painters. For example, we can take into consideration that the way Pablo Picasso usually paints or sketches an eye, the same style can be easily inferred from all his works. Although a great number of digitized artworks of foreign painters is readily available, the challenging task was to collect digitized artworks of Indian painters, apart from Raja Ravi Verma and M F Husain, or Maqbool Fida Husain, for whom number of artworks found were almost 100. In the past in many works features were extracted using image processing algorithm where the researchers were extracting spatial and frequency domain features for classification of images in various domains [16]. The proposed work is done for sorting the artworks of different painters. The anticipated work has given an encouraging result with an accuracy of 83.03% for foreign painters and 100% for Indian for a pair of Indian painters. The proposed work is done using Conventional Neural Network, i.e. Inception V3, similar to the one used in [5]. The accuracy of 84.2% has got for classifying Indian and Foreign painters. Most of the researchers worked extensively on foreign painters' artworks as huge digitized data for their artwork is readily available. So in this proposed work is done for classifying both Foreign and Indian painters.

2. LITERATURE REVIEW

Most of the prior works have previously focused different Machine Learning techniques to segregate the paintings. Some of the works among them have implemented different CNN models as they are usually seen as more suitable for the purpose of Identification or Classification of images in particular. [6] has experimented with Naïve Bayes Classifier, Linear Discriminant Analysis, Logistic Regression, K-Means Clustering and Support Vector Machines for classifying the paintings. The main objective is to test different methods to classify paintings from 5 artists. Naïve Bayes Classifier gave best results with an accuracy of 65%, and Histogram of colours were used for classification.

The idea behind the research work of [7] is to identify a painting or an artwork even after adding various graphical transformations to it. They created dataset of 10 images and added all possible transformations to it. For the purpose of classification AlexNet, VGG Net and a smaller version of the similar VGG Net is used. A comparative study is done between Scale Invariant Feature Transform (SIFT) and the classifiers mentioned earlier, where the latter one beats the former by a margin of 13.6%. In [8] the classification is done on the dataset provided by Rijksmuseum, which contains a magnanimous 12,641 unique artists and among them 21 artists have more than 1000 artworks. A retrained ResNet classifier is used for the purpose of classification and got a test accuracy of 90%. However, in addition they have compared their classifier to a VGG Models and SVM as well. [9] has experimented with different ResNet models and [10] [11] [12] gives an in-depth review of various CNN models for the purpose of classification of Images. As CNN outperforms when it learns the feature by itself and also classifies the images with good accuracy.

3. DATA COLLECTION

Standardized dataset for Indian painters are not readily available, so the images were downloaded for creating the dataset [13]. The dataset of Indian painter's artworks consists of 4 main Indian artists viz. Abanindranath Tagore, M F Husain, Nandalal Bose and Raja Ravi Verma. While creating dataset, the proposed work also considered various domain related artworks, different

painting styles and types which includes oil and water paintings. The details of painters and the total number of art works collected manually are mentioned in Table 1 and 2

Table .1: Images for Indian painters
(Manually Collected)

Name of the Artist	Number of art Images
Abanindranath Tagore	14
M F Husain	79
Nandalal Bose	17
Raja Ravi Verma	48

Graphical transformations are not applied to increase the dataset of Indian painters' artworks as it may change the essence of the painting. The artwork would also lose the meaning which the artist has tried to convey through his artwork. Some of the foreign painter's artworks were also downloaded manually from [13].

Table .2: Images for Foreign Painters
(Manually Collected)

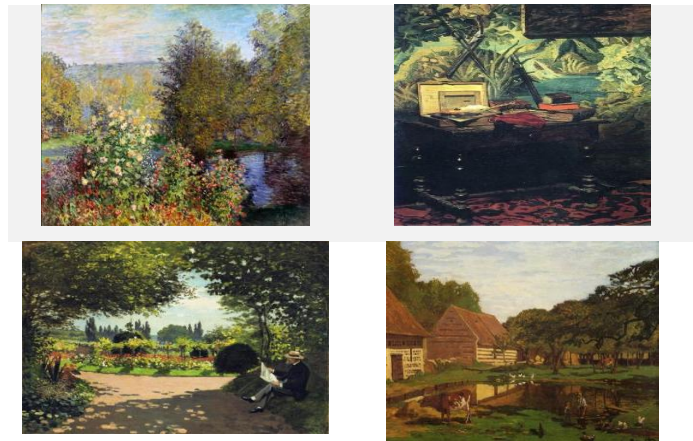
Name of the Artist	Number of art images
Claude Monet	370
Edvard Munch	188
Leonardo Da Vinci	204
Van Gogh	538

Table. 3: Images for foreign painters

Name of the Artist	Number of art images
Albrecht Durer	828
Boris Kustodiev	633
Camille Pissarro	887
Childe Hassam	547

Claude Monet	1334
Edgar Degas	611
Eugene Boudin	555
Gustave Dore	753
Ilya Repin	539
Ivan Aivazovsky	577
Ivan Shishkin	520
John Singer Sargent	784
Marc Chagall	765
Martiros Saryan	575
Nicholas Roerich	1819
Pablo Picasso	762
Paul Cezanne	579
Pierre Auguste Renoir	1400
Pyotr Konchalovsky	919
Raphael Kirchner	516
Rembrandt	776
Salvador Dali	479
Vincent van Gogh	1889

To create the dataset crowdsourcing was not done because it may hamper the uniformity of the images and also it is difficult to check the authenticity of the images. [14] has provided a total number of 89,000 images of foreign painters' artwork and for the proposed work around 19000 images of artworks by 23 painters are used for classification. A sample images of selected artists are shown below.

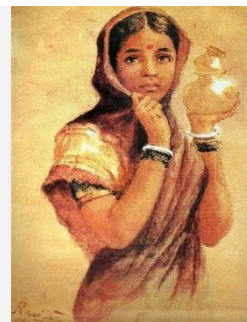
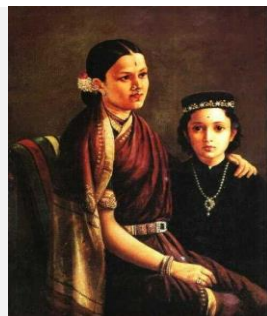
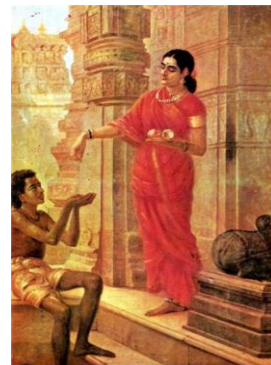
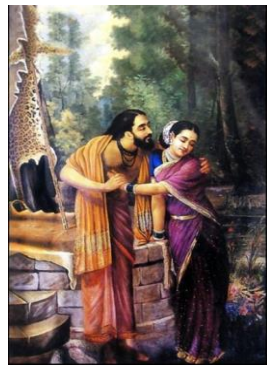
*Foreign Painters:**Claude Monet :**Salvador Dali :**Vincent van Gogh :*



Various domain artworks are considered for the experiment. Above images depicts the diversity of artwork used and also from the different artists for the proposed work.

Indian Painters:

Raja Ravi Verma:



M F Husain:





4. IMPLEMENTATION

In the field of image processing the method of convolution is used to gist down the information contained in an image to an understandable point, effectively compressing the meaning contained within it. Convolutional Neural Network is a part of Deep Learning. The popularity of CNN in the domain of image processing has increased over the years. It is providing better accuracy and many researchers are also getting good results. The word “deep” in deep learning comes from the fact that it usually tends to contain more number of hidden layers compared to a typical Machine Learning algorithm. TensorFlow can not only be used for the purpose of Machine Learning algorithms but instead can be used for any complex calculations that requires more machine resources than general calculation tasks. Developed by Google it is an open source library which has been made free for all.

The anticipated work is implemented using Python and TensorFlow. Classifier used for the proposed work is Inception V3. Inception Architectures [15] have been performing really well in recent times, mainly those more focussed in the domain of the Image Classification. A general schematic of Inception V3 is described in Table 4.

Table .4: A general Inception v3 Model

5x Inception Module A
Grid Size Reduction (with some modifications)
4x Inception Module B
[Auxiliary Classifier]
Grid Size Reduction
2x Inception Module C
Final Output Module

5. EXPERIMENTAL RESULTS

The proposed work is implemented binary classification using CNN. Here one artist is considered as a one class and the other class contains all the available artwork of the other painters, results of these classifications are in Table 5. The binary classification of Indian and Foreign artists is experimented [Table 6]. Similarly, classification of Raja Ravi Verma and M F Husain artworks

were also implemented. The artworks of other painter's image dataset is very less in size. So, the implementation is not possible with CNN.

Binary classification of Foreign Painters' Artworks. Here a particular artist's artwork images are considered as one class and all the remaining 23 painters artwork images are considered as another class. Table 5 describes the average accuracies achieved for the seven painters' artwork images. Accuracy for segregating Eugene Boudin artworks from other painters' artworks is highest when compared to the other artist artwork classification.

Table. 5: Binary classification result of one artist with other artists' artworks

Classes	Average Accuracy
Claude Monet artworks and Other painters artworks	81.05 %
Eugene Boudin artworks and Other painters artworks	90.50 %
Nicholas Roerich artworks and Other painters artworks	87.60 %
Pablo Picasso artworks and Other painters artworks	81.00 %
Rembrandt artworks and Other painters artworks	86.65 %
Salvador Dali artworks and Other painters artworks	79.60 %
Vincent van Gogh artworks and Other painters artworks	74.85 %

Classification of Indian Painters' Artworks.

Due to the lack of availability of digitized versions of many Indian artists artworks, only Raja Ravi Verma and M F Hussain's artworks classification is done. Table 6 depicts the result analysis of Indian artists..

Table. 6: Indian Painters

Artist names	Total number of artwork images	Average Accuracy
Raja Ravi Verma vs M F Husain	48 and 79 images	100 %

Classification of Indian and Foreign Painters' Artworks.

The dataset collected manually for both foreign and indian artists were pooled together for this classification. The dataset was created by randomly selecting images of foreign and Indian painters artworks. 158 and 208 Indian and Foreign artworks are selected respectively from the dataset.

Table 7 shows the classification accuracy.

Table. 7: Indian vs Foreign

Classes	Images of artworks	Average Accuracy
Indian vs Foreign	158 and 203 images	84.20 %

6. CONCLUSION AND FUTURE SCOPE

Preserving the artwork is very essential task. Artwork gives the complete in depth information of any society which is not possible by other means of communication. The anticipated work aimed at classifying the artwork of both Indian and Foreign painter artworks. CNN is experimented for the proposed work. In future model can be improved for increasing the accuracy. Total number of features learned by the model is 131,072. Average pooling, max pooling, concatenation, drop out

and fully connected layers along with soft-max layers are part of the CNN model used for the training and feature selecting. The result yielded by Inception V3 model is very much satisfying and promising result with an accuracy of 84.05%. In future the size of the Indian artwork dataset can be increased. Further this system can be updated to do classify if the picture in consideration is actually a snapshot of the painting or the painting itself.

7. REFERENCES

- [1]. Mayer, Richard E., and Roxana Moreno. "Animation as an aid to multimedia learning." *Educational psychology review* 14.1 (2002): 87-99.
- [2]. Striova, Jana, et al. "Spectral imaging and archival data in analysing Madonna of the Rabbit paintings by Manet and Titian." *Angewandte Chemie International Edition* 57.25 (2018): 7408-7412.
- [3]. Tribhuwan, Robin D., and Maik Finkenauer. *Threads together: a comparative study of tribal and pre-historic rock paintings*. Discovery Publishing House, 2003.
- [4]. Karaszewski, Maciej, et al. "Automated full-3D digitization system for documentation of paintings." *Optics for Arts, Architecture, and Archaeology IV*. Vol. 8790. International Society for Optics and Photonics, 2013.
- [5]. Xia, Xiaoling, Cui Xu, and Bing Nan. "Inception-v3 for flower classification." *2017 2nd International Conference on Image, Vision and Computing (ICIVC)*. IEEE, 2017.
- [6]. Jou, Jonathan, and Sandeep Agrawal. "Artist identification for renaissance paintings." (2011).
- [7]. Hong, Yiyu, and Jongweon Kim. "Art Painting Identification using Convolutional Neural Network." *International Journal of Applied Engineering Research* 12.4 (2017): 532-539.
- [8]. Balakrishnan, T., S. Rosston, and E. Tang. *Using CNN to classify and understand artists from the Rijksmuseum*. Stanford technical report, 2017.
- [9]. Viswanathan, Nitin. "Artist Identification with Convolutional Neural Networks." *transfer* 77 (2017): 89-8.
- [10]. He, Kaiming, et al. "Deep residual learning for image recognition." *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016.
- [11]. Krizhevsky, Alex, Ilya Sutskever, and G. Hinton. "Imagenet classification with deep convolutional networks." *Proceedings of the Conference Neural Information Processing Systems (NIPS)*.
- [12]. Simonyan, Karen, and Andrew Zisserman. "Very deep convolutional networks for large-scale image recognition." *arXiv preprint arXiv:1409.1556* (2014).
- [13]. "Visual Art Encyclopedia" www.wikiart.org Available: <https://www.wikiart.org/>
- [14]. Cs-Chan, "cs-chan/ArtGAN," GitHub, 11-Jul-2019. Available: [https://github.com/cs-chan/ArtGAN/tree/master/WikiArt Dataset](https://github.com/cs-chan/ArtGAN/tree/master/WikiArt%20Dataset)
- [15]. Tan, Wei Ren, et al. "Ceci n'est pas une pipe: A deep convolutional network for fine-art paintings classification." *2016 IEEE international conference on image processing (ICIP)*. IEEE, 2016.
- [15]. Rajput, G. G., and H. B. Anita. "Handwritten script recognition using DCT and wavelet features at block level." *IJCA, Special issue on RTIPPR (3)* (2010): 158-163.