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# A Novel Technique For Classification of Images: A boon to Digital India Project

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**ABSTRACT**
The present age of information explosion is envisaging incredible development in both communication medium and hardware escalation. This in turn, is engendering a huge volume of digital signals in the form of images, videos, audio and texts, which proves to be challenging in terms of storage and broadcast. Even though, several breakthroughs in the price and performance of digital hardware and firmware have been put into practice, the demand for high data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. This research work proposes a novel method of classifying Natural images into different categories. From the results, it is concluded that classification of Natural images on the basis of various parameters can provide a better reference for application developers and will prove boon to Digital India project in terms of search engine application.



## 1. Introduction

It is rightly said that, "An image is worth ten thousand words". But one needs to know how to analyze the picture to gain any understanding of it at all. Present-day images include hefty information that necessitates much storage space, huge transmission bandwidths and extended transmission times, therefore it is beneficial to classify and compress the image by analyzing only the indispensable information to reconstruct the image effectively and precisely. Throughout the history of humankind great efforts have been placed towards the research and development of intelligent systems. Although the beginnings were set early in antiquity, the development and proliferation of electronic computational systems have paved the way towards the development and application of Artificial intelligence. [1]

The basic function of novel image classification system is to separate natural images into different classes and provide addition ease to search engine application by reducing its load. The paper proposes a unique method in view of "Digital India Project". An ideal system should be able to discern various images with no hesitation just like a human being. Unfortunately, sometimes the categorization task is hard and indistinct even for a human. This makes the problem even more challenging for computers. In this research work, a novel classifier for natural image classification system is proposed and analyzed. The sub-classes involved in the classification are Coast, Forest, Mountain, Highway, Open Country and Street. Given an image, the classifier extracts and analyzes some of the most pertinent features and combines them in order to create an opinion. The numerous features which affect the image classification system were individually tested and analyzed.

Each single parameter taken into consideration has been tested and tweaked changing thresholds and input parameters so that its precision is as high as possible.

Then the aggregate classifier was tested in order to evaluate the global performance of the system on the data set. A common dataset of physically labeled Natural images has been used as test set. This set has been later on resized to perform the same tests on resized images. In the best case, the performances achieved are at par or far better than previous works. Summarized steps in order to classify an image are

- Extract different features that give an individual classification.
- Combine them together using a classification method in order to boost the performance of the single classifier.
- Compare the output and assign the image to a category.

## 2. Natural Image

Natural images refer to photographs of persons, objects or scenes, normally recorded by a camera. They generally contain many Colours and irregular shaped objects. It is very unlikely to find any considerably large region with consistent Colour. Natural images are considered as the images like Coast, Forest, Mountain, Highway, Open Country and Street etc. Most of the photographs were downloaded automatically from different photographic websites and some are directly captured by the digital camera. The images were then labeled as Natural if belonging to one of the following categories:

- Coast
- Forest
- Mountain
- Highway
- Open Country
- Street

## 3. Need of Advance Image Classification System

During past some decades, products and services such as TVs, video monitors, photography, motion films, copying devices, magazines, brochures, newspapers, etc. have steadily evolved from monochrome to Colour.

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With the increasing use of Colour products and services, there is an emergent demand for "brighter" and further "Colourful" Colours in numerous applications. Due to this growing demand, display and printing of Colour imagery that is visually pleas¬ing has become a very important topic. In a typical Colour copier application, the goal is to render the scanned docu¬ment in such a way that it is most pleasing to the user.

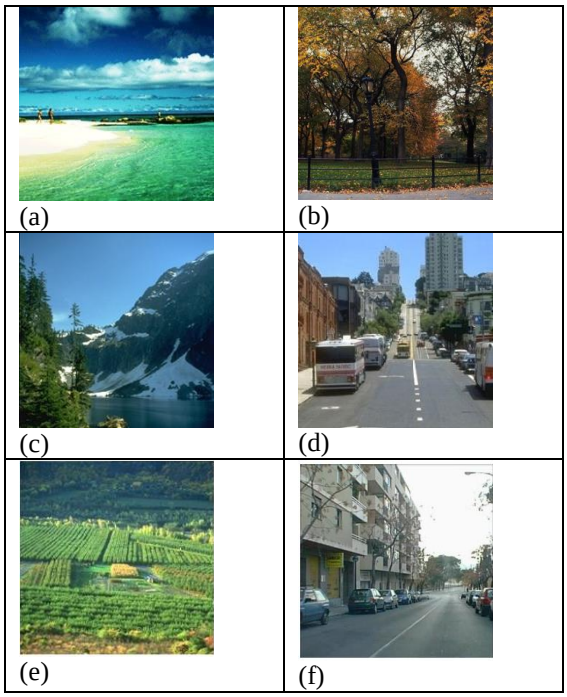


**Figure 1. Natural Images: (a) Coast (b) Forest (c) Mountain (d) Highway(e) Open Country (f) Street.**

Natural pictures differ from artificial graphics in many aspects, both in terms of visual perception and image statistics. Artificial graphics are featured with smooth regions separated by sharp edges. On the contrary, natural pictures are often noisier and the region boundaries are less prominent. In processing scanned images, it is sometime beneficial to distinguish images from different origins (e.g., Artificial graphics or natural pictures), however, the origin or "type" information about a scanned image is usually unavailable. The "type" information is extracted from the scanned image. This "type" information is then used in further processing of the images. High-level image classi-fication can be achieved by analysis of low-level image attributes geared for the particular classes. Once an image has been identified as an Artificial graphic image, further identification of image characteristics can be used to fine-tune the Colouring schemes for more appealing repro-ductions. The most prominent characteristics of a Artificial graphic image include patches or areas of the image with uniform Colour and areas with uniformly changing Colours. These areas of uniformly changing Colour are called sweeps. [12]

Classifiers that can be used to solve a certain classification problem include statistical, structural, neural networks, fuzzy logic, and machine learning classifiers. Several of these classifiers are available in public domain and commercial packages. However, no single classifier seems to be highly successful in dealing with complex real world problems. Each classifier has its own weaknesses and strengths.

This research work contemplates new and improved method for classifying Natural images that overcome the above- referenced problems and others.

The motivation of an image categorization scheme is to divide images into dissimilar classes. A superlative system should be able to distinguish a variety of images with no vacillation just like a human being. Regrettably, sometimes the categorization job is tough and indistinct even for a human. This makes the difficulty even more challenging for Computer systems. In this paper, a novel classifier is developed.

Given an image, the classifier extracts and investigates some of the most relevant features of the Natural image and combines them in order to produce a judgment. The physically labeled images dataset has been created downloading random images from the internet. The images have been chosen with the aim of having an affluent and substantial dataset and it has been tried to shun redundant data. Images compressed with a lossy method such as JPEG have some of their features transformed. Because of this alteration of the pictures, performances of some of the classifiers vary from the ideal case and thus, the error rate is higher in compressed images.

For example, images are usually compressed and resized in the web environment. Due to the interpolation used in the resizing process, the number of unique colours could greatly increase. So the performance of the feature using the number of colours would degrade significantly.

**4. Distinctive Features**

The main step in order to be able to classify an image is to extract statistical features from the raw data. The features that will enable the user to discern between different categories of Natural images. These common features will be then combined in different ways to form an efficient classifier. Following features have been extracted for this purpose:

- Entropy
- Colour

a. Number of Different colours

b. Saturation Average

- Spatial Gray-Level Dependence (SGLD)
- Gray Histogram

**4.1 Entropy**

In order to make meaningful classifier, it is necessary to know the properties of the image. One of the properties is image Entropy; a highly correlated picture will have low entropy. For example a very low frequency, highly correlated image will be compressed well by many different techniques; it is more the image property and not the compression algorithm that gives the good compression rates.[12] If an image has G grey-levels and the probability of grey-level k is P(k) the entropy H2 is

$$H_2 = \sum_{K=0}^{G-1} P(k)\log_2[P(K)]$$

Information redundancy, r, is

$r = b - H_2$

Where b is the smallest number of bits for which the image quantization levels can be represented.

Information redundancy can only be evaluated if a good estimate of image entropy is available, but this is not usually the case because some statistical information is not known.

An estimate of $H_2$ can be obtained from a grey-level histogram. If *h(k)* is the frequency of grey-level k in an image f, and image size is M x N then an estimate of *P(k)* can be made:

$$\tilde{P}(K) = \frac{h(k)}{MN}$$

Therefore,

$$\tilde{H_e} = -\sum_{K=0}^{G-1} \tilde{P}(K) log2[\tilde{P}(k) and\ \check{r} = b - \tilde{H_e}]$$

The Compression ratio $K = b / H_e$

### 4.2 Colour

Colour transitions from pixel to pixel have similar models in natural images. Natural images depict objects of the real world, and in such a context, it is not common to find regions of constant colour because objects tend to be shaded and have texture. In addition, during the process of taking a photograph, some noise is added to the subject and that causes neighbor pixels to have different RGB values (even when they are supposed to have the same colour).

It is possible to use these simple features related to colours by extracting and analyzing the following features.

- Number of Different Colours

Some Synthetic images often have more colour combinations. But usually, they tend to have large uniform regions with the same colour. On the Web in particular, graphics with few colours are more popular because they can be compressed in a better way.

The number of Different colours of an image is extracted but it cannot be directly used as metric since the raw number is also dependent on size of the image. Therefore a more accurate metric is used: the rate between the number of Different colours and the number of total pixels.[5] A scan of the pixels matrix is performed in order to count different colours. This value is then divided by the total number of pixels.

$$Different\ Colour\ Ratio = \frac{No.of\ Different\ Pixels}{Total\ Number\ of\ Pixels}$$

- Saturation Average

Natural images depict objects of the real world and highly saturated objects are very uncommon. For example, Coasts, Forests, streets and open country images often have low regions covered with highly saturated colours. Those colours are much less frequent in natural images.. Given RGB values, the saturation level of a pixel is defined as the greatest absolute difference of values between red green and blue.

Saturation = max [abs(red − green), abs(red − blue), abs(green − blue)]

### 4.3 Spatial Gray Level Dependence (SGLD)

Given a pixel, it is paired with all its 8 neighbours. This means that top-left, top, top-right, left, right, bottom-left, bottom and bottom-right neighbour are considered. For each pair (pixel, neighbour) the brightness βp, βn is extracted and the value in position (βp, βn) is incremented. At the end of this step, the SGLD matrix is populated with the information about the brightness similarity of all contiguous pairs of pixels. [13]

### 4.4 Gray Histogram

The gray histogram is the gray scale version of the color histogram.

It symbolizes the distribution of colors in an image, derived by counting the number of pixels of each of all gray intensity. The analysis of this histogram can give an inference of the distribution of area having the same color/brightness.[6]

The method used to build the histogram array is simple. For each pixel in the image, the value of the array at the index corresponding to the pixel brightness (0 to 255) is incremented by 1. The histogram is then normalized by dividing the value of all bins by the number of pixels. Once the histogram is done, a value estimating the smoothness is calculated. This value is higher for synthetic images having a histogram with more spikes.

## 5 Results and Discussion

The classification of images based on semantic depiction is a challenging and vital predicament in image retrieval system. Solitary easy features are extracted from the raw images data in order to utilize the dissimilarity of colour pattern and spatial co-relation of pixels in Natural images.

Table I shows the thresholds of parameters used for classification of Natural images.

These features have poor accuracy if used alone but when considered collectively, it forms a more complex and accurate global classifier with superior precision. These single features demonstrate promising performance with low computational complexity. Since each classifier has its own weakness and strengths, better performances can be achieved using more than one feature together.

**Table1. Threshod values for different Parameters .**

| Class* | Threshold Values | | | | |
|---|---|---|---|---|---|
| | Entropy | Colour | | SGLD | Smoothness |
| | | No. of Diff. Colours | Sat. Avg. | | |
| Coast | 7.39 | 0.1075 | 23.01 | 88.31 | 0.0025 |
| Forest | 7.25 | 0.1030 | 24.17 | 76.12 | 0.0017 |
| Mountain | 7.45 | 0.1040 | 22.87 | 90.12 | 0.0022 |
| Highway | 7.98 | 0.1017 | 23.48 | 107.32 | 0.0023 |
| Street | 8.63 | 0.1065 | 25.92 | 92.33 | 0.0013 |
| Open Country | 7.18 | 0.1083 | 20.03 | 87.35 | 0.0010 |

## 6. Conclusion

This Classifier analyzes each of the mentioned parameter to create an opinion. The error rate is significantly reduced up to 0.1 as compared to the error rates of individual parameter taken separately. Each single parameter described has been tested and tweaked changing thresholds and input parameters so that its accuracy is as high as possible. Then the aggregate classifier was tested in order to evaluate the global performance of the system on the data set. Some base classifiers have been implemented and tweaked for the maximum individual accuracy. Single features are combined together using different algorithms with different performances. In the best case, the performances achieved are on par or slightly better than previous works. The proposed method will definitely prove advantageous to search engine application and will certainly support Hon'ble Prime minister's dream Project of "Digital India".

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