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A Rule Based Approach for Classification of Shades of Basic Colors of Fabric Images

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Abstract

This paper presents a rule based approach to classify the different shades of basic colors of fabric images. The RGB color features are extracted. The mean and standard deviation of shades of red, green and blue colors are computed. A rule base is designed taking into account, the mean and standard deviation values. We have considered ten shades of each of the basic colors. We have got maximum recognition rate of 98% for red color and minimum recognition rate of 97.07% for blue color. The overall recognition rate of 97.64% is obtained.

Keywords: *Rule based RGB features, Fabric images, and Feature extraction*

1. Introduction

Today, computer vision and image processing (CVIP) techniques are widely used in industry, biological science, material science, medical science and the like. Computer vision applications in the field of textile are taking momentum. The textile industry occupies a vital place in the Indian economy as well as in the international textile economy and contributes substantially through its exports earnings. Textiles exports represent nearly 30 per cent of the India's total exports. India is the world's second largest producer of textiles after China. The different forms of textiles are fabrics, agro-textiles, geo-textiles, green chemistry, medical textile etc. India is one of the largest producers of cotton yarn around the globe, and also there are good resources of fibers like polyester, silk, jute, denim, wool *etc*. Connected with fabric, there are many applications possible, such as, fabric characterization, quality control, quality assurance, pattern identification, count estimation, fabric content identification, cost estimation, defect detection etc. The different fabric materials exhibit different textures and colors. The color of the fabric material plays an important role in apparel industry, fashion designing, *etc.*

Texture is one of the most important features used in identifying objects or regions of interest in an image. When objects have similar textures and colors, the identification becomes complex. The fabric materials are available in different shades of colors and named for convenience of a common man, such as dark blue, light blue, medium blue, peacock blue, navy blue, *etc.* We have considered the basic colors, namely, red, blue and green. The shades of these colors have varying hue and saturation. These color features become important in recognition. Some shades of basic colored fabric images and their names are given in Figure 1.

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Figure 1. Shades of basic Color Fabric Images

The work is carried out to classify the different shades of basic colors of fabric images. The RGB mean and standard deviation features are deployed. The clue of dominant color is used, in devising the rules. A rule based approach is developed to classify the given image color into appropriate shades.

The paper is organized into five sections. Section two contains the literature survey, carried out related to this work. Section three contains proposed methodology, feature extraction and rule based approach to classify the different shades of the basic colors in fabric images. Section four contains results and discussions. Section five gives the conclusion of the work.

2. Literature Survey

To know the state-of-the-art of computer applications, we have carried a literature survey. Following is the gist of papers cited during the survey of the literature.

[Puji Yosep Subagiyo, 1994] has presented a method for classification of Indonesian textiles with ethnic-group characteristics and various material attributes. This paper discusses identification, naming and systematic classification for weaving/ non-weaving and coloration techniques. The classification system provides the implications for structural materials and technical studies.

[J. Lewis Dorrity, *et al.*, 1996] have proposed an approach for real-time fabric defect detection and control in weaving process. A fuzzified wavelet transform algorithm with adoptive noise rejection and online learning is used to extract features. A knowledge-based inference engine is called upon to declare the defect categories. An off-line learning is introduced to maximize the detectability and identifiability measures.

[Prinya Tantaswadi, 1999] has presented a paper on machine vision for automated visual inspection of cotton quality in textile industries using color isodiscrimination contour. The automated visual inspection is carried out by analysis of cotton image. To inspect the quality of cotton, the cotton images are analyzed for impurities using this isodiscrimination contour. The issues of signal processing and illuminations are discussed in the paper. A method for improving speed of image processing is also proposed.

[Fujiwara, Hisanaga, *et al.*, 2000] have proposed a method for removing the intensity variations caused by textures on textile surfaces using wavelet shrinkage. A method is proposed for visual inspection for textile inspection surfaces; selectively removing the intensity variations caused by textures on textile surfaces. Once the intensity variations caused by textures on textile surfaces are selectively removed, the remaining processes of inspection are carried out.

[Costa, Manual F. M., *et al.*, 2000] have presented a paper on automated evaluation of patterned fabrics for defects detection. This work is developed for a textile industry on request and consists of automation of the process of defect detection on different kinds of fabrics. The evaluation is made on comparison with reference sample. The settled system acquires the fabric images under proper illumination, stores and processes them in order to sort out automatically the desired information.

[Arivazhagan, S., L. Ganesan, *et al.*, 2006] have presented a paper on fault segmentation in fabric images using Gabor wavelet transform. Gabor wavelet transform is applied to detect the defects in fabrics. Defects can be automatically segmented from the regular texture by applying the proposed method. It is shown that it can also be applied to detect defects on surfaces and materials that have regular periodic texture.

[B. K. Behera, *et al.*, 2007] have proposed a method for characterization and classification of fabric defects using discrete cosine transformation and artificial neural networks. In this method, discrete cosine transformation technique is adopted to characterize the defects and back propagation algorithm based artificial neural network is used to classify the various fabric defects.

[Semnani, Dariush, *et al.*, 2009] have proposed a method for detecting and measuring fabric pills using digital image processing techniques. This work provides a technique for detecting pills and also measuring their heights, surfaces and volume. An algorithm is developed, which finds pills and then measures their average intensities by three criteria, namely height, surface and volume.

[Obiazi, A. M. O. 2009] has presented a novel approach for determination of the insulation classification of Nigerian cloth fabrics. In this approach, the temperature rise, which electrical machines safely withstand, is determined by the limiting temperatures of the insulating materials used in them.

[Zhang, Junmin, *et al.*, 2010] have presented an approach for identification of animal fibers with wavelet texture analysis to extract fiber surface structure features for classifying cashmere and superfine merino wool fibers. Here, the features are extracted from brightness variations caused by the cuticular scale height, shape and interval provides an effective way for characterizing different animal fibers and subsequently classifying them.

[Marini, Andreia, *et al.*, 2013] presented a paper on bird species classification based on color features. In this approach the bird species classification is based on color features extracted from unconstrained images. The proposed approach applies a color segmentation algorithm in an attempt to eliminate background elements and to delimit candidate regions, where the bird may be present within an image. Normalized color histograms are computed from these candidate regions.

[Farsi, Hassan, *et al.*, 2013] has presented a paper on Color and texture feature-based image retrieval by using hadamard matrix in discrete wavelet transform. In this study, the authors propose a new method based on combination of Hadamard matrix and discrete wavelet transform (HDWT) in hue-min-max-difference color space. An average normalized rank and combination of precision and recall are considered as metrics to evaluate and compare the proposed method against different methods.

[Piotr Szczypinski, *et al.*, 2014] have presented a paper on texture and color based image segmentation and pathology detection in capsule endoscopy videos. This paper presents an in-depth study of several approaches to exploratory analysis of wireless capsule endoscopy images (WCE). It is demonstrated that versatile texture and color based descriptors of image regions.

From the literature survey, it is found that, most of the work is carried out on characterization and defect detection in fabric materials. A work on inspection of cotton quality is cited. The features like color and intensities are considered. In color recognition, the shades of colors become important. Thus, the motivation for the work related to identification of different shades of basic colors in fabric materials.

3. Proposed Methodology

A rule based approach for classification of the different shades of basic colors of fabric images consists of three phases, namely, image acquisition, feature extraction and classification. The block diagram giving phases is shown in Figure 2.

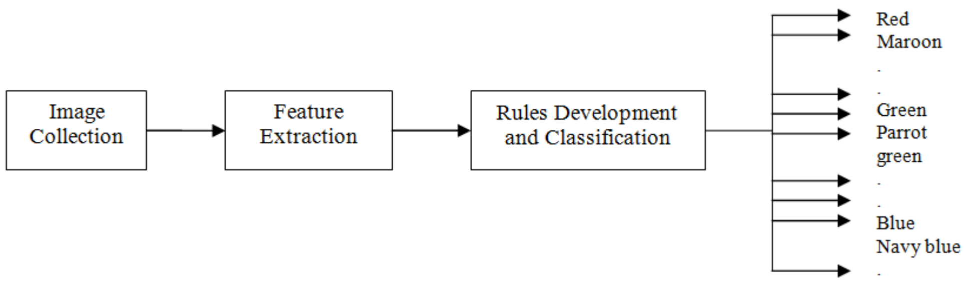

Figure 2. Phases in the Proposed Methodology

3.1 Image Collection

Various shades of basic colors, namely, Red, Green and Blue are acquired using a digital camera having resolution of 12 Mega pixels. We have collected 800 images of different shades of basic colors. The images are collected from the garments shops and also from textile industries. The number of images of each of the basic color considered in the work is given in Table 1.

Table 1. Basic Color Fabric Images

Sl. No.	Color	Number
1	Red	300
2	Green	250
3	Blue	300

3.2 Feature Extraction

The RGB features of images are extracted. It is observed that in the red fabric images, the red component is predominant compared to green and blue components. Similarly, the green and blue components are predominant in green and blue fabric materials respectively. The same observation is made for different shades of basic colors. In order to identify the specific shades, the mean and the deviation parameters are obtained. Feature values of different shades of red, green and blue colors are shown in Table 2, Table 3 and Table 4 respectively. Let Ri represent red mean value for the shade under ith serial number given in Table 2 and σ i represents the corresponding standard deviation. Similarly, Gi and Bi represent the mean values of shades of green and blue colors respectively.

Table 2. Feature Values Ri Mean for Red Color Shades (Ri)

Sl No. (i)	Shades	R_i mean	G_i mean	B_i mean	Std. deviation (σ_i)
1	Pink	229.85	70.73	78.79	16.86
2	Reddish Brown	208.41	90.85	79.64	5.29
3	Sunset Orange	235.18	69.66	13.8	7.93
4	Lavender Dark	211.80	69.69	145.73	10.09
5	Lavender	210.95	93.04	123.36	19.14
6	Chocolate	159.61	121.60	102.91	13.65
7	Light magenta	202.39	70.25	97.07	38.32
8	Rani pink	205.92	73.71	146.32	5.64
9	Red	216.61	55.88	43.79	3.90
10	Light Pink	210.44	50.36	129.94	6.83

Table 3. Feature Values Gi Mean for Green Color Shades (Gi)

Sl No. (i)	Shades	R_i mean	G_i mean	B_i mean	Std. deviation (σ_i)
1	Leaf Green	106.52	151.52	120.90	7.11
2	Yellowish Green	153.15	151.79	29.31	6.5
3	Light bottle Green	133.45	150.75	142.90	3.72
4	Pista Green	79.52	153.00	165.76	6.20
5	Sea Green	99.80	150.02	144.18	6.14
6	Medium-Aqua Green	89.43	155.98	131.84	6.79
7	Turquoise Green	6.15	171.38	182.98	5.27
8	Bottle Green	103.61	163.27	75.68	4.13
9	Cement Green	136.94	140.83	131.65	14.22
10	Light Sea Green	104.64	148.13	143.64	7.67

Table 4. Feature Values Bi Mean for Blue Color Shades (Bi)

Sl No. (i)	Shades	R_i mean	G_i mean	B_i mean	Std. deviation (σ_i)
1	Sky Blue	50.85	142.76	234.36	17.16
2	Light Renold Blue	37.23	155.77	210.86	12.05
3	Lavander Blue	108.98	132.91	198.28	17.31
4	Renold Blue	120.28	146.98	164.78	21.82
5	Ash Blue	133.23	140.35	142.64	33.03
6	Blue	107.85	132.49	197.86	11.77
7	Ash gray Blue	144.73	145.87	146.819	26.12
8	Navy Blue	133.29	136.90	151.48	27.37
9	Bright Blue	125.71	124.74	221.91	14.36
10	Dark Blue	98.97	126.27	195.28	15.63

$$\text{Mean}= \frac{\sum_{1}^{n} RGBavg}{N} \quad \text{---} \ (1)$$

The mean value for sky blue is calculated as:
Mean=

[84.14 141.96 253.16] + [47.95 106.99 239.85] + [68.80 136.78 244.64] + [71.88 139.04 242.60] + [66.41 135.43 245.05] + [64.01 124.34 233.01] + [73.25 139.66 249.45] + [76.04 136.78 251.81] + [74.17 130.17 244.01] + [66.87 125.54 249.58] + [59.46 140.55 205.22] + [63.92 146.08 211.59] + [62.19 142.27 206.46] + [69.63 172.07 238.17] + [57.25 150.66 211.29] + [61.59 154.11 212.86]

= [50.85 142.76 234.36]

Where n is the number of pixels in an image and N is the number of images of each shade. The standard deviation for sky blue color is computed using the expression (2).

$$\text{Standard deviation}= \sqrt{\frac{\sum (RGBavg - Mean)^2}{N-1}} \quad \text{----------------------} \ (2)$$

$$= \sqrt{\frac{\sum \left(([84.14 \quad 141.96 \quad 253.16] - [50.85 \quad 142.76 \quad 234.36])^2 + ([47.95 \quad 106.99 \quad 239.85] - [50.85 \quad 142.76 \quad 234.36])^2 \ldots.. \right)}{16-1}}$$

= 17.16

The RGB mean and the standard deviation values for different shades of red color fabric images are plotted as shown in Figure 3. The line representing the red component is dominant, when compared with the other green and blue components values. The RGB mean values and the standard deviation for different shades of green and blue colored fabric images are plotted as shown in Figure 4 and Figure 5 respectively. In these plots the corresponding components are observed dominant.

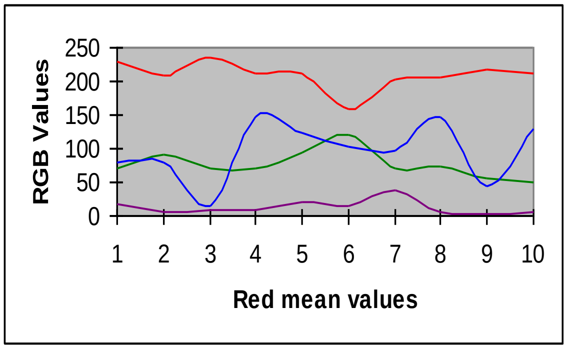

Figure 3. Plot for Red Color Shades

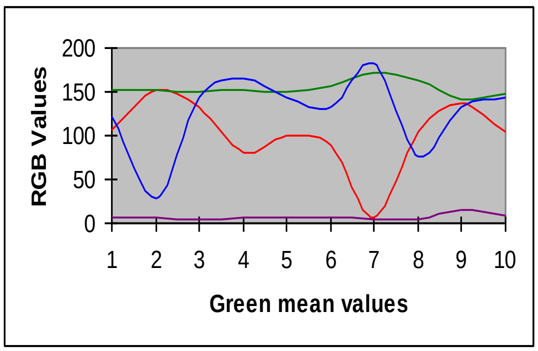

Figure 4. Plot for Green Color Shades

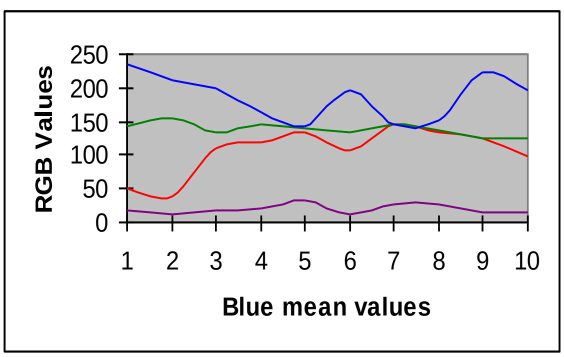

Figure 5. Plot for Blue Color Shades

A set of rules is devised for classifying the basic colors and their different shades. Consider the red colored fabric image. It is observed that the dominant component in RGB mean values is red. Further, the range of RGB values for the different shades of basic colors are observed. The mean and the standard deviation are used as features. The rule for classification of red colored fabric image is given in Box 1. The rules, namely, R1 through R9 are devised taking into consideration the standard deviation and are given in Box 3.


```
if ((R > G)  and (R > B))                                        //Rule
1
          Classify the color as "Red color"
else if ((G > R)  and (G > B))
          Classify the color as " Green  color"                  //Rule
2
```

Box 1. Rules for Classification of Basic Colors

```
if ((G>R)  and (G>B))
    if ( G1 ≤  (G1mean + σ  1))                                  //Rule
1
                    Classify the color as " Leaf Green"
    else  if  ( G2 ≤ (G2mean + σ  2))                            //Rule
2
                    Classify the color as "Sea Green"
```

Box 2. Rules for Classification of Sades of Green Colors

σ

```
if ((R>G)  and (R>B))
     if ( R1 ≤  (R1mean + σ  1))
//Rule 1
                    Classify the color as " Pink"
     else  if  ( R2 ≤  (R2mean + σ  2))
//Rule 2
                    Classify the color as " Reddish Brown"
      else  if ( R3 ≤  (R3mean + σ  3))
                                                                   /R
ule 3
                    Classify the color as " Sunset Orange"
      else  if  ( R4 ≤ (R4mean + σ  4))
                                                                  //R
ule 4
                    Classify the color as " Lavender Dark"
      else  if  ( R5 ≤  (R5mean + σ  5))
//Rule 5
                    Classify the color as " Lavender"
      else  if  ( R6 ≤  (R6mean + σ  6))
//Rule 6
```

Box 3. Rules for Classification of Shades of Red Colors

σ

σ

σ

```
if ((B>G)  and (B>R))
    if ( B1 ≤  (B1mean + σ  1))                                        //Rule 1
              Classify the color as " Sky Blue"
    else  if  ( B2 ≤  (B2mean + σ  2))
              Classify the color as " Light Renold Blue"               //Rule 2
      .
      .
    else if ( B9  ≤  (B9mean + σ  9))                                  // Rule 9
              Classify the color as " Bright Blue"
```

Box 4. Rules for Classification of Shades of Blue Colors

4. Author Name(s) and Affiliation(s)

Author names and affiliations are to be centered beneath the title and printed in Times New.

4. Results and Discussion

A graph of recognition rates for different shades of basic colors is shown in Figure 6. The average recognition rate of basic colors is found to be 97.64%. A plot of recognition rates for different shades of red color is shown in the graph given in Figure 7. The average recognition rate is found to be 98%. The recognition rates for light magenta and red shades are 90%. A plot of recognition rate for different shades of green color is as shown in Figure 8. The average recognition rate is found to be 97.91%. The recognition rate for medium aqua green is 90%. A plot of recognition rates of different shades of blue color is shown in Figure 9. The average recognition rate is found to be 97.07%. The recognition rate for ash blue color is observed to be 80%.

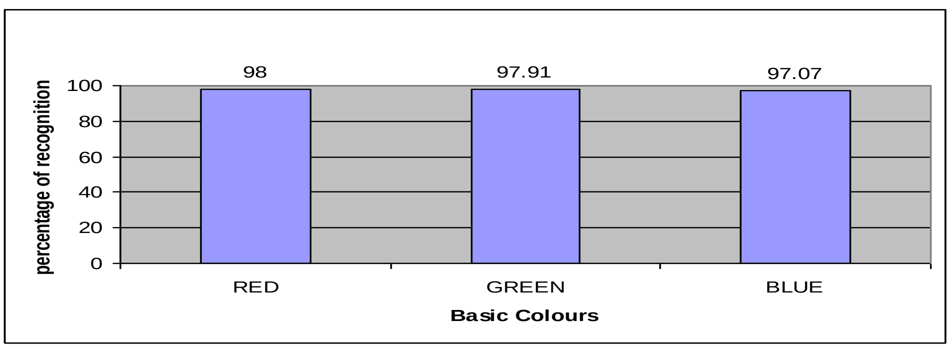

Figure 6. Recognition Rate for Basic Colors

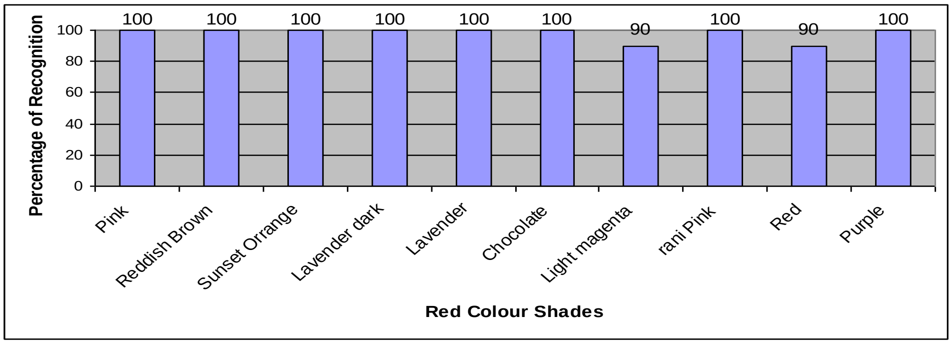

Figure 7. Recognition Rate for Shades of Red Color

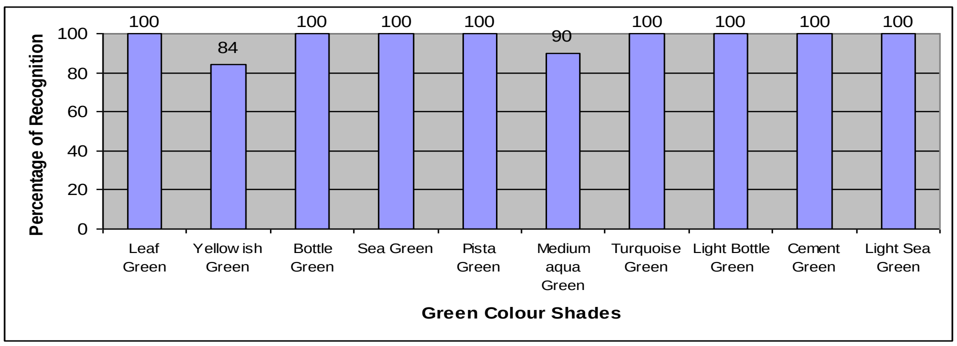

Figure 8. Recognition Rate for Shades of Green Color

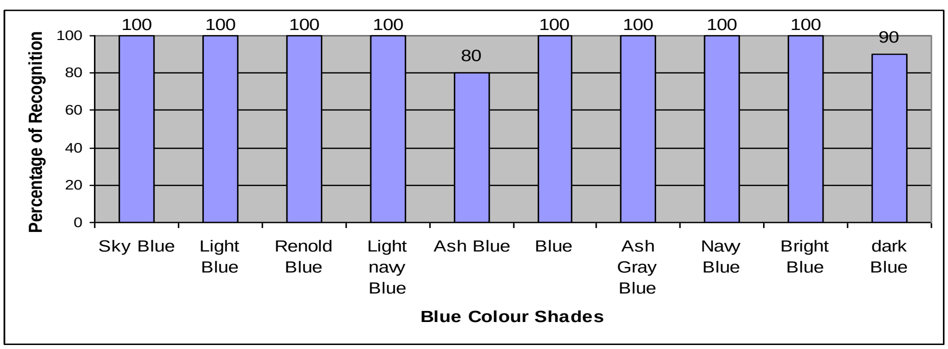

Figure 9. Recognition Rate for Shades of Blue Color

We have carried out an experiment to study the behavior of classification process with training samples expressed as percentage of total samples. A plot of percentage of training versus computation cost is shown in Figure 10. A plot of training versus percentage of recognition is shown in Figure 11.

From the results, it is observed that, the recognition rate increases linearly with the increases with the training data size. It is also observed that the computation cost increases linearly with the increase in training data size. The results also reveal that with 50% or more training data size is sufficient to yield more than 90% of recognition rate.

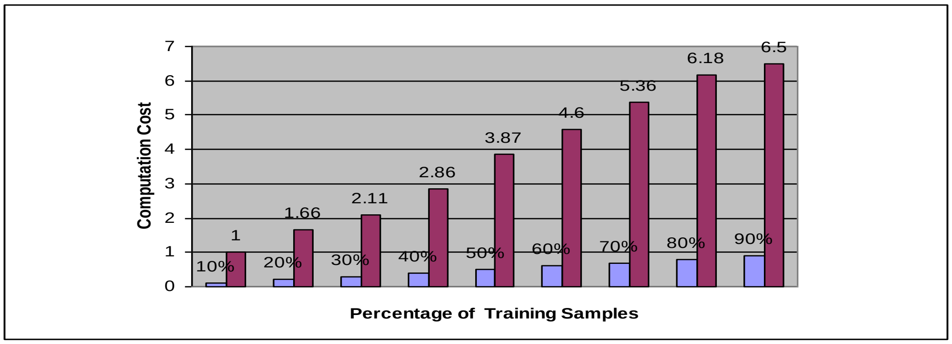

Figure 10. Training Vs Computation Cost

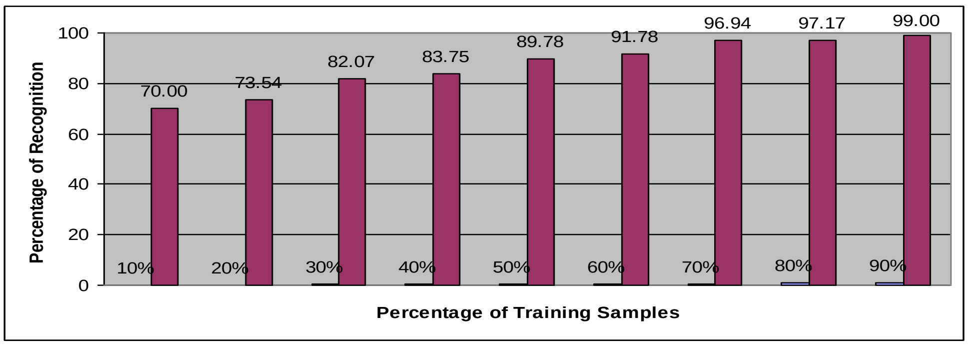

Figure 11. Training Versus Percentage of Recognition

5. Conclusion

The proposed methodology is used to classify the different shades of basic colors of fabric images. The recognition rate of basic colors is found to be 97.64%. The recognition rates for the different shades of red, green and blue colors are 98%, 97.81% and 97.91% respectively. The recognition rate for the different shades of is 97.91%. It is observed that minimum of 50% samples must be used to train the classifier to get good results. The work finds applications in automation in apparel industry, namely, readymade garments, knitwear, formal ware, cotton dress materials, *etc.*

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