Analysis of Image Matching Towards the Hard Clustering

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Abstract- With the study of computers and computer applications since the first phase of 20th century, Image Processing has upraised and withstand as a vast application field. The work in this field is incredible and of immense importance with respect to various applications like Medical, Computer Imaging Systems and Computer Aided Design, Digitization, Human Visual System (HVS), etc. The same enlighten interest and curiosity within us to work in the field of Image Processing. Thus, in the proposed system with the help of research and data available, we are framing out a way to detect counterfeit in the Indian Currency notes. This paper comprises of the related studies and work drafted by scholars who have already worked in this field. We have possibly framed out the comparative study of the work we referred so as to put forth the proposed system.

Index Terms- Image Processing, Computer Imaging Systems, counterfeit, Indian Currency.

I. Introduction

The vast enhancement in the field of Computer Science along with the various upcoming fields like Networking, Image Processing, Database Management in recent times have laid down a concrete platform for software development. Drafting software solutions for the various problems is the need of 21st century. This is because software can fulfill the requirements of time and ultimately reduce human efforts. Also a software solution to any problem increases accuracy, working efficiency and reduce the time required.

Today there are many problems which demand for accuracy and reliability. A similar critical problem is in the context of Indian currency. All the rights related to the Indian Currency are with the Reserve Bank of India (RBI). But still many a times we notice that there are people making contempt of the laws. Since recent times we have came across various cases of currency counterfeit which in no means are legal. Also it is highly unsafe to just rely on human beings to check and detect the counterfeit. After all we humans have natural limitations and are somewhat restricted at some stage. Also it is not the case that each individual is reliable in such critical case.

Thus a generalized solution for the same is expected to be drafted out with the help studies so far and which should be software driven. As the Indian Currency is produced with the help of watermarking technique, we opt to precede our work with Image Processing techniques. This can be done with the help of studies and work in the field of Image Processing.

Ultimately, any subject has to be technically overlooked to proceed with the actual work. Actually exploring any subject to the best extent so as to meet the necessary functionality is of immense importance. The available thesis, experiments and data helps to explore the subject and clear the fundamentals. Thus, we focused on the related work to enhance our knowledge and attempt to draft the same.

To summarize, the further paper is organized as follows:

1. Section 2 put emphasis on the basics of Image Matching. The main focus of this section comprises the concepts and work related to Image matching.
2. Section 3 describes the work in the context of RGB to Grayscale conversion.
3. Section 4 describes the study of related to the cluster analysis.
4. Section 5 briefly summarizes the comparative description of the focused topics.
5. Section 6 states the derived conclusion of the work.

II. Image Matching

Over the recent few years many scholars have contributed in the field of color image processing. It is quite obvious that color representation of any object speaks more than the mere binary or gray image representation. Also one can have more number of features to work with so as to gain accuracy in feature analysis. We find pattern recognition, image analysis, feature tracking, etc. is the basic which eventually leads to the core problem of image matching [].

Amongst the various approaches for the image matching problem, there are two main approaches usually referred. These two main matching approaches to get rid of the image matching problem are:

1.1 Intensity based matching
1.2 Feature based matching

2.1 Intensity Based Matching:

Image comprises of pixels and thus it is the pixels which are formed of different color combinations and color intensities. Thus one can use the intensity information to proceed with the work for image matching. Often functions like the sum of squared differences (SSD) or sum of absolute differences (SAD) is used. These functions are used to set up a similarity function between the template and the target image. Then using the various principles like choosing the maximum value, mean value, etc. matching is done.

2.2 Feature Based Matching:

This approaches generally deals with the geometric features, such as points, edges and corners, etc. For feature extraction the normal feature extraction algorithms are usually referred. Then the similarity function such as Hausdorff distance function is used to get the match position and finally matching is performed [].

In the entire process of image matching, one of the most important tasks is feature detection. The ultimate accuracy is dependent on these basic steps as features contain vital image information. This vital information in images is expressed using various color spaces like RGB, HSV, XYZ, LAB, CMY, YCbCr, etc. Thus we have another problem arising that is to decide the most appropriate color space for the particular application.

III. RGB Image to Grayscale Image Conversion

Any color image comprises of three basic colors: Red (R), Green (G) and Blue (B). Various large numbers of colors are formed due to the combination of these basic colors. Human eye notice these colors due to the variations in intensity of the RGB colors. Thus it is very crucial task to convert any RGB color image to other color space maintaining the intensity information.

The conversion of RGB color image to any other color space depends on the application and the necessity of various features to be focused while conversion. But to have more precise knowledge about the color image is of immense importance. The RGB image consist of two main attributes i.e. luminance and chrominance. Thus, conversion of a RGB image into a Grayscale image is converting the 24 bit RGB values into 8 bit Grayscale values. Hence, there are 256 gray levels in an 8 bit grayscale image and the intensity ranges from 0 to 255, where 0 being black and 255 being white.

The various available image processing techniques and software applications converts RGB image to grayscale image. However, usually we find these techniques consider only one of the factor either luminance or chrominance. The below mentioned algorithm not only considers both the factors, but, at the same time highly consumes computational time and memory.

ALGORITHM:

1. Y = (0.299 x R) + (0.587 x G) + (0.114 x B);
2. U = (B - Y) x 0.565;
3. V = (R - Y) x 0.713;
4. UV = U + V;
5. R1 = R*0.299;
6. R2 = R*0.587;
7. R3 = R*0.114;
8. G1 = G*0.299;
9. G2 = G*0.587;
10. G3 = G*0.114;
11. B1 = B*0.299;
12. B2 = B*0.587;
13. B3 = B*0.114;
14. R4 = (R1+R2+R3)/3;
15. G4 = (G1+G2+G3)/3;
16. B4 = (B1+B2+B3)/3;
17. I1 = (R4+G4+B4+UV)/4;
18. END

The steps 1 to 3 calculate the luminance and chrominance values of the source color image. In the step 4 sum of chrominance value calculated. Steps 5 to 16 the RGB values are approximated using RGB components. Step 17 calculates the average of the four values R4, G4, B4 and UV. The I1 represents the resulted gray color image [3].

This algorithm yields grayscale image with better luminance and chrominance property for most of the cases and as standard for other few cases. However, there is a minimum amount of loss in the grayscale image due to reduction the algorithm preserved contrasts, sharpness, shadow, and structure of the color image in the reproduced grayscale image.

IV. Clustering Analysis

Clustering in simple terms is grouping or classifying things or objects of study together with respect to their properties. Clustering analysis is a tool of immense importance in statistical data analysis to deal with uncertainty, unclear and poor expression. Basically, clustering analysis is classified into two types as soft clustering and hard clustering.

Fuzzy clustering analysis is one of the most usually used efficient methods for clustering analysis which comes under the head of soft clustering. In soft clustering, clusters are so formed that maximum area of interest is covered under clustering. A single element in this can be a part of one or more clusters and so is subjected to more keen observations. Fuzzy clustering analysis is a point of view used for clustering analysis in which the data sets or clusters are formed in the same way as defined by the fuzzy logic. The clustering is not only based on the relationship between the two elements, but the depth of the relationship between them is also considered. Thus, fuzzy clustering analysis can be adapted to the objects and elements which possess vagueness and uncertainty.

The fuzzy clustering uses fuzzy logic to create fuzzy partition which ultimately deals with the Fuzzy C Means algorithm. The FCM algorithm classifies the image by grouping similar data points in the feature space into clusters. This clustering is achieved by iteratively minimizing a cost function that is dependent on the distance of the pixels to the cluster centers in the feature domain. The Objective function is as given below,

$$J = \sum_{j=1}^{N} \sum_{i=1}^{C} U_{ij}^{m} \; ||X_j - V_i||^2$$

Where,
Uij = membership of pixel ‘Xj’ in the ith cluster,
m = fuzziness of the resulting partition, and m=2,
Xj = ith element of d-dimensional measured data,
Vi = center of the cluster,
J = total number of pixels [6].

In FCM technique, a noisy pixel is wrongly classified because of its abnormal feature data. One of the important characteristics of an image is that neighboring pixels are highly correlated, i.e. the pixels in the immediate neighborhood possess nearly the same feature data. Therefore, the spatial relationship of neighboring pixels is an important characteristic that can be

great aid in image segmentation. Spatial Fuzzy C Means method incorporates spatial information, and the membership weighting of each cluster is altered after the cluster distribution in the neighborhood is considered. The first pass is the same as that in standard FCM to calculate the membership function in the spectral domain. In the second pass, the membership information of each pixel is mapped to the spatial domain and the spatial function is computed from that. The FCM iteration proceeds with the new membership that is incorporated with the spatial function. The iteration is stopped when the maximum difference between cluster centers or membership functions at two successive iterations is less than a threshold value 0.02. To develop the spatial information, a spatial function is defined as below,

$$h_{ij} = \sum_{k \epsilon NB(X_j)} U_{ik}$$

Where,
NB(Xj) = square window centered on pixel 'Xj' in spatial domain.
hij = the probability that pixel 'Xj' belongs to ith cluster.

In Spatial fuzzy c means the initial membership matrix for initialized clusters is generated randomly. The initial membership matrix does not depend on samples of data sets. If the quantities (like the cluster number, initial center and membership matrix) are not selected correctly for a noisy data, this algorithm will stop in local minimum [6].

V. Summary

This paper typically comprises the thesis related to Image Processing. The various data referenced throughout the survey correspondently promoted us to study work related to Image Matching. Going through the vast subject, the descriptive study of the survey is briefly discussed. The thesis subjectively covers Image matching, RGB image to Grayscale image conversion and Clustering analysis.

5.1 Image Matching:

Usually image matching is done either intensity based or feature based. The intensity based approach is simple to use, but can introduce localization error and is sensitive to illumination variation. While, the feature based approach eliminates illumination variation but increases calculation complexities.

5.2 RGB Image to Grayscale Image Conversion:

Choosing a color space to focus on the subject is a critical task. When working with image intensity, it is important to preserve the intensity information while converting RGB image to Grayscale image. Thus, we need to consider both luminance and chrominance factor, also decrease the calculation overhead in the above mentioned algorithm. The conversion procedure must take into consideration the NTSC standards.

5.3 Clustering Analysis:

Clustering analysis is dependent on the system requirements. The thesis helps to go through the Fuzzy clustering analysis clarifying the two types of clustering viz. soft clustering and hard clustering. The clustering approach should not only consider the relationship between neighboring pixels, but, should also consider the depth of relationship. Fuzzy clustering analysis is the most widely used clustering algorithm, but, many a times increases the complexity. Also the FCM technique wrongly classifies a noisy pixel. Thus the various errors were minimized in the spatial fuzzy c means. Although, scholars have put forth many changes to overcome drawbacks, still complexities and calculation overhead exits.

VI. Conclusion

All this enhancing subjective study aided the way to introduce the fake note detection system. Using the thesis so far, we club the various related material to enhance our work. With the aim of image matching in mind, we frame a RGB image to Grayscale image conversion algorithm and will use hard clustering techniques to carry over the clustering analysis.

References

[1] B.Sirisha and B.Sandhya, "Evaluation of Color Spaces for Feature Point Detection in Image Matching Application," 2013 Third International Conference on Advances in Computing and Communications.

[2] C. Saravanan, "Color Image to Grayscale Image Conversion," 2010 Second International Conference on Computer Engineering and Applications.

[3] Dr. D. Selvathi, R. Dhivya, "Segmentation of Tissues in MR Images using Modified Spatial Fuzzy C Means Algorithm," 2013 International Conference on Signal Processing, Image Processing and Pattern Recognition [ICSIPRI].

[4] Juwei Lu and K.N. Plataniotis, "On Conversion from Color to Gray-scale Images for Face Detection," 2009 IEEE.

[5] Rui Mou, Minying Huang and Qinyin Chen, "Research on Improvement of Fuzzy Clustering Analysis," 2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE).

[6] Tarun Kumar and Karun Verma, "A Theory Based on Conversion of RGB image to Gray Image," International Journal of Computer Applications (0975 – 8887) Volume 7– No.2, September 2010.

[7] Xiaohang Hu, Shuangxia Pan, Han Bai, "A New Image Matching Algorithm Based on the Relative Position of Intensity," 2007 IEEE.

[8] Yongjun Zhou, Jing Wang, Ming Li, Jing Tian, Guang Ji, Hanping Dong, Li Yu, "Method of a Fuzzy Cluster Analysis to Evaluate Microbial Enhanced Oil Recovery," 2012 International Conference on Communication Systems and Network Technologies.

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