Abstract: Content based image retrieval uses different feature descriptors for image search and retrieval. For image retrieval from huge image repositories, the query image features are extracted and compared with these features with the contents of feature repository. The most matching image is found and retrieved from the database. This mapping is done based on the distance calculated between feature vector of query image and the extracted feature vectors of images in the database. There are various distance measures used for comparing image feature vectors. This paper compares a set of distance measures using a set of features used for CBIR. The city-block distance measure gives the best results for CBIR.

I. INTRODUCTION

The image retrieval using CBIR is based on the distance vectors obtained from the set of feature vectors obtained from the query image and the set of images in the repository. Even though the feature descriptor’s efficiency plays an important role, the technique for distance measure also is very important for getting the most accurate result. The generally used distance measures are Euclidean, City-blok, Canberra, Cosine, Hamming etc.

II. PROPOSED METHOD

This paper does a performance evaluation of various distance metrics which are commonly used for CBIR. The performance of distance measures used for comparison are, Euclidean distance, cityblock distance, cosine distance and hamming distances. These distance measures are used with four different conventional features, maLBP, mdlLBP, LBP [7] and RGB[8]. maLBP stands for multi channel adder Local binary pattern, mdlLBP-multi channel decoder local binary pattern, LBP-local binary pattern. The performance is compared using the average precision metric. A comparison of retrieval results obtained for the above mentioned features using all the distance measures discussed earlier are done. The most appropriate distance is chosen as the best distance measure for CBIR. The experiments are conducted over the Wang’s dataset.

\[ D((p_1, q_1), (p_2, q_2)) = |p_1 - p_2| + |q_1 - q_2| \]  

Equation 1 helps to find the cityblock distance between two points, \((p_1, q_1)\) and \((p_2, q_2)\). The distance between the x coordinates and y coordinates are found separately and the modulus value is added to get the distance [4].

\[ D((p_1, q_1), (p_2, q_2)) = \sqrt{(p_1 - p_2)^2 + (q_1 - q_2)^2} \]  

Equation 2 helps to find the Euclidean distance between two points, \((p_1, q_1)\) and \((p_2, q_2)\). The distance between the x coordinates and y coordinates are found separately, the square value is added and the square root gives the exact to get the distance.

Let \( P \) is defined as, \( P = (p_1, p_2, ... p_m) \) and let \( Q = (q_1, q_2, ... q_m) \) then the minkowski distance between \( P \) and \( Q \) is given in Equation 3 [2].

\[ D(P, Q) = \left( \sum_{i=1}^{n} |p_i - q_i|^m \right)^{1/m} \]  

The cosine distance is calculated by finding the angular distance between the two points. The distance between two points, \( m \) and \( n \) can be calculated using Equation 4 [3].

\[ d_{mn} = 1 - \frac{\sum p_i q_i}{\sqrt{(\sum p_i)(\sum q_i)}} \]  

Hamming distance gives the percentage of coordinates that differ from each other. Equation 5 gives the equation for hamming distance [3].

\[ d_{st} = \frac{\|x \oplus y\|}{n} \]  

The precision is calculated using Equation 6 [7].

\[ P = \frac{\text{No. relevant images retrieved}}{\text{Total number of relevant images}} \]  

The precision value \( P \) is calculated using two important parameters, ‘No. relevant images retrieved’ and ‘Total number of relevant images’.

III. EXPERIMENTS AND DISCUSSIONS

The three distance measures are applied on wang’s database for image search and retrieval when four different features are used. The wang’s database consists of 1000 images. The images in wang’s are classified in 10 classes where each single class has got hundred different images. The images from the database are retrieved using maLBP, using the three distance measures. For each of these experiments the average class wise precision is calculated and then the best distance measure is found based on the performance. The experiment is repeated for the remaining three features. Table 1 shows the average precision obtained for retrieval of 20 images using maLBP feature.
Performance Analysis Of Distance Metric For Content Based Image Retrieval

with different distance measuring techniques. Table.2 shows the average precision obtained for retrieval of 20 images using mdLBP feature with different distance measuring techniques. Table.3 shows the average precision obtained for retrieval of 20 images using LBP feature with different distance measuring techniques. Table.4 shows the average precision obtained for retrieval of 20 images using RGB feature with different distance measuring techniques.

Table.1 Average precision obtained using maLBP feature using the selected distance measures

| Categories | Hamming | Euclidean | Cosine | Cityblock |
|------------|---------|-----------|--------|-----------|
| Africans   | 35.95   | 47.45     | 53.35  | 57.9      |
| Beaches    | 23      | 36.2      | 39.55  | 45.15     |
| Buildings  | 35.9    | 45.85     | 45.65  | 58.9      |
| Bases      | 56.65   | 67.7      | 78.85  | 88.75     |
| Dinosaurs  | 78.4    | 96.25     | 95.9   | 97.85     |
| Elephants  | 30.95   | 35.95     | 40.05  | 44.45     |
| Dinosaurs  | 75.6    | 71.6      | 74.05  | 86.45     |
| Horses     | 45.3    | 59.05     | 69.7   | 70.8      |
| Mountains  | 25.55   | 27.95     | 31.55  | 33.9      |
| Food       | 37.7    | 47.75     | 52.25  | 62.15     |
| Average    | 44.5    | 53.575    | 58.09  | 64.63     |

Table.2 Average precision obtained using mdLBP feature using different distance measures

| Categories | Hamming | Euclidean | Cosine | Cityblock |
|------------|---------|-----------|--------|-----------|
| Africans   | 42.8    | 56.2      | 58.45  | 64.25     |
| Beaches    | 12.95   | 37.15     | 40.45  | 47.9      |
| Buildings  | 34.45   | 46.55     | 43.95  | 60.4      |
| Bases      | 6.65    | 71.95     | 74.6   | 88.75     |
| Dinosaurs  | 22.3    | 96.05     | 95.55  | 97.8      |
| Elephants  | 20.55   | 40.4      | 42.45  | 47.4      |
| Flowers    | 19.8    | 65.25     | 61.5   | 83        |
| Horses     | 42.75   | 68.9      | 70.1   | 77.4      |
| Mountains  | 20.35   | 30.2      | 32.3   | 34.7      |
| Food       | 7.3     | 47.25     | 44.25  | 61.55     |
| Average    | 22.99   | 55.99     | 56.36  | 66.315    |

Table.3 Average precision obtained using LBP feature using different distance measures

| Categories | Hamming | Euclidean | Cosine | Cityblock |
|------------|---------|-----------|--------|-----------|
| Africans   | 25.9    | 49.8      | 50.9   | 54.85     |
| Buildings  | 28.6    | 36.5      | 39.4   | 47.7      |
| Buses      | 24.9    | 33.8      | 38.3   | 46.45     |
| Dinosaurs  | 30.2    | 72.9      | 76.05  | 87.75     |
| Elephants  | 65.2    | 94.7      | 98.3   | 97.4      |
| Flowers    | 25.4    | 28.85     | 29.55  | 34.6      |
| Horses     | 63.4    | 68.8      | 77.65  | 82.75     |
| Mountains  | 27      | 62.9      | 61.75  | 66.75     |
| Food       | 18.5    | 28.1      | 29     | 33.35     |
| Average    | 21.1    | 43.1      | 44.85  | 51.05     |

Table.4 Compares average precision obtained using RGB feature using different distance measures

| Categories | Hamming | Euclidean | Cosine | Cityblock |
|------------|---------|-----------|--------|-----------|
| Africans   | 12.65   | 59.05     | 59.9   | 63.95     |
| Beaches    | 37.8    | 40.05     | 40.95  | 43.1      |
| Buildings  | 38.95   | 35.15     | 37.45  | 45.45     |
| Buses      | 9.25    | 50        | 44.9   | 53.35     |
| Dinosaurs  | 63.8    | 99.9      | 99.85  | 99.95     |
| Elephants  | 10.75   | 49.05     | 48.1   | 53.35     |
| Flowers    | 37.85   | 55.35     | 64.6   | 66.5      |
| Horses     | 16.1    | 85.55     | 88.25  | 91.2      |
| Mountains  | 25.6    | 33.5      | 34.4   | 39.25     |
| Food       | 10.8    | 64.05     | 61.05  | 67.8      |
| Average    | 26.355  | 57.155    | 57.945 | 62.39     |

A. Result Analysis

A shown in Table.1 when the maLBP feature is applied for image retrieval the city block distance method shows 6.54%, 11.055 and 20.13% increment than cosine, Euclidean and Hamming distance measures respectively. In Table.2 when the mdLBP feature is applied for image retrieval the city block distance method shows 9.955%, 10.325 and 43.325% increment than cosine, Euclidean and Hamming distance measures respectively. Table.3 has the average precision values obtained when the LBP feature is applied for image retrieval the city block distance method shows 5.69%, 8.32% and 27.245% increment than cosine, Euclidean and Hamming distance measures respectively. Table.4 has the average precision values obtained when the RGB feature is applied for image retrieval the city block distance method shows 4.445%, 5.235% and 36.035% increment than cosine, Euclidean and Hamming distance measures respectively.
Figure 1: Graphical representation of retrieval results using maLBP

Figure 2: Graphical representation of retrieval results using mdLBP

Figure 3: Graphical representation of retrieval results using LBP

Figure 4: Graphical representation of retrieval results using RGB

Performance comparison of distance measures using maLBP feature

Performance comparison of distance measures using mdLBP feature

Performance comparison of distance measures using LBP feature

Performance comparison of distance measures using RGB feature
IV. CONCLUSION

This paper implemented different distance measures over the wang’s dataset and compared the results obtained for content based image retrieval using four features. The features used are, mALBP, mDLBP, LBP and RGB. The results infer that the cityblock distance measure gives the best results for CBIR. City block distance measure got an average improvement of 12.575%, 21.202%, 36.035% and 15.083% improvement when the mALBP, mDLBP, LBP and RGB features respectively are used for retrieval.

REFERENCES

1. Lim, Kian Huat; Ferraris, Luciana; Filloux, Madeleine E.; Raphael, Benjamin J.; Fairbrother, William G. (5 July 2011). "Using positional distribution to identify splicing elements and predict pre-mRNA processing defects in human genes". Proceedings of the National Academy of Sciences of the United States of America. 108 (27): 11093–11098. Bibcode:2011PNAS..10811093H. doi:10.1073/pnas.110135108. PMC 3131113. PMID 21685335. Retrieved 7 June 2016.

2. Minkowski, Hermann (1910). Geometrie der Zahlen, Leipzig and Berlin: R. G. Teubner.

3. Anton, Howard (1994), Elementary Linear Algebra (7th ed.), John Wiley & Sons, pp. 170–171, ISBN 978-0-471-58742-2

4. Sidorov, Grigor; Gelbukh, Alexander; Gómez-Adorno, Helena; Pinto, David (29 September 2014). "Soft Similarity and Soft Cosine Measure: Similarity of Features in Vector Space Model". Computación y Sistemas. 18 (3): 491–504. doi:10.13053/CyS-18-3-2043. Retrieved 7 October 2014.

5. Graham L. Giller (2012). "The Statistical Properties of Random Bitstreams and the Sampling Distribution of Cosine Similarity". Giller Investments Research Notes(20121024/1). doi:10.2139/ssrn.2167044

6. Hamai, Ikuso (1955). "Stratification of community by means of "community coefficient" (continued)". Japanese Journal of

7. Dubey, S. R., Singh, S. K., & Singh, R. K. (2016). Multichannel decoded local binary patterns for content-based image retrieval. IEEE transactions on image processing, 25(9), 4018-4032.

8. Zhou, J. X., Liu, X. D., Xu, T. W., Gan, J. H., & Liu, W. Q. (2018). A new fusion approach for content based image retrieval with color histogram and local directional pattern. International Journal of Machine Learning and Cybernetics, 9(4), 677-689.

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