Journal of Discrete Mathematical Sciences & Cryptography
ISSN 0972-0529 (Print), ISSN 2169-0065 (Online)
Vol. 26 (2023), No. 5, pp. 1265–1275
DOI : 10.47974/JDMSC-1738

Image retrieval evaluation on smart phone using variant of histogram of gradient

Lalit B. Damahe *
Department of Computer Science & Engineering
Yeshwantrao Chavan College of Engineering
Nagpur
Maharashtra
India

Nileshsingh V. Thakur †
Department of Computer Technology
Yeshwantrao Chavan College of Engineering
Nagpur
Maharashtra
India

Sachin R. Jain §
Department of Computer Science
Oklahoma State University
Stillwater, OK
U.S.A.

Shailesh D. Kamble ‡
Department of Artificial Intelligence and Data Science
Indira Gandhi Delhi Technical University for Women
Delhi
India

* *E-mail:* damahe_l@rediffmail.com (Corresponding Author)
† *E-mail:* thakurnisvis@rediffmail.com
§ *E-mail:* sachin.jain@okstate.edu
‡ *E-mail:* shaileshdkamble@igdtuw.ac.in

Abstract

The retrieval of similar type of data is performed by requesting the query, generally through personal computer. As the smart mobile devices are available at the general user, retrieval of visually similar data is now performed on these devices such as smart phones, PDA etc. A wireless medium is the key component of mobile devices and visually similar image retrieval with minimum latency is the typical issue.Hence the main objective of our proposed work is to develop the efficient mechanism for image retrieval on mobile devices. The image representation scheme V-HOG captures the useful information from the image with the help of gradient vector and the gradients are calculated by using various block size. The size of block, cell and bins are the main components which are varied and developed the V-HOG with feature values 1296, 1176, 672. The experimentation are conceded on the standard Holidays Dataset. The proposed V-HOG approach having a feature value 1296, 1176 and 672 perform better with existing HOG. In comparison with HOG, the precision and recall rate for V-HOG is improved by 27% to 90% and 7% to 32% respectively. The retrieval time is also reduced to 3% to 9%. The proposed V-HOG with 1176 feature perform well and having a good precision and recall rate.

Subject Classification: *Primary 94A08, Secondary 49K15.*

Keywords: *Image retrieval, Variant of histogram of gradient, Mobile device, Feature extraction.*

1. Introduction

From many decades content based image retrieval is the main concern area for researchers and many of them contributing a lot in that direction. In the presented literature of R. Datta et. al. [1] users are classified into browser, surfer and searcher and they can be discriminate based on the clarity of searching goal. Generally the goal of the searchers is to find an information in short of time irrespective of searching perform on desktop or mobile device. As the present era is of smart phones, end user explores the data through this gadget from any location and it saves the time too. From the perspective of searcher, an objective is to find similar and valid information is less amount of time. Smart phones and personal digital assistant (PDA) are equipped with the camera and modern technology

Figure 1

Image Retrieval on Mobile Device through Server

and able to shares the new forms of multimedia information. The end user index/annotate their multimedia contents and that can be further use for searching through server as shown in figure 1. For the annotation, end user applies the concept of metadata like date, time, location, username [2] etc. which can be automatically obtained from the image. Due to change in technology of Mobile phone equipped with camera treated as smart phone and offers a high bandwidth service like 3G.

This facility offer the storing and retrieving of digital data from the smart phones or the server which is located at wireless location. For accessing and storing of such digital data in mobile phones requires the sufficient processing capacity. Therefore, to minimize the power and time required for such operation demands the efficient technique for image retrieval. There are different types of models are used by the researchers for image retrieval on mobile devices that is Query as feature on client, Query as image on server, Query as feature on server and d) Query as compressed feature on server.

The remaining part of the paper is prepared as follows: Section 2 presented the previous work of researchers on image retrieval on mobile devices followed by key observations; Section 3 presented the proposed approach. Experimental results and its evaluation are discussed in section 4. Finally it concludes with some future directions.

2. Literature Review

From the last decade there are many contributions are available for image retrieval on mobile device. The metadata (time, location, etc) , texture and color are the low level features for the image retrieval. Significant work of retrieval using the metadata, color, and texture is presented in the literature[3],[6],[12],[13],[16].The scale invariant feature transform (SIFT)[14],[18], Speeded up robust features(SURF)[4],[11], Histogram of gradient(HOG)[9],[20],[12] and Bag of features(BoF)[19],[12] is the good alternative for researches and significantly reduces the size of the feature when applies the several types of compression scheme such as Huffman encoding, run length encoding, arithmetic coding, residual coding, etc. The combination of several features with and without compression[5],[7],[8],[10],[15],[17],[18] also contributing towards the promising results. A Elliptical pattern of binary co-occurrence is presented by Hatibaruah et al.[24]. A unique technique for retrieving math formulae is presented by Pathak et al.[23].Based on the critical analysis of literatures following findings are identified.

The operation of a some scheme is fully depends on the mobile internet service. Hence Server computing facility is network dependant. The system has to maintain three different index. Similarly the average time consumption in hybrid image matching is 1908 msec. Total time may be minimized by using efficient indexing structure. As the size of the vocabulary increased , then the classification accuracy reduced. Also vocabulary at both the end must match otherwise it fails. In case of SIFT and SURF descriptor as the database size increase from 100 to 500, the matching accuracy decreases but efficient indexing may improve the result. This work is well suited for pairwise image matching and required 15,890 bits to 26,620 bits per image. This scheme required approximately 71 bits/feature and matching accuracy between 0.96 to 0.98. It is possible to reduce no of bits/image and improved matching accuracy by using efficient coding scheme. There is a Significant reduced in bitrate in comparison with CHoG by using lossy sorting of descriptor but it loses the overall retrieval performance.

3. Proposed Approach

The proposed method of mobile image retrieval is presented and shown in figure 2. The criticality of sample query image is boost by manual modification using image editors such mspaint, adobe photoshop etc. Query image is first transform into gray image. So it can reduced the complexity and redundancy of color image. Before extracting the feature vector for the query image, the preprocessing is done to remove the Gaussian noise. The feature extraction process of proposed work mainly includes the image resizing hence the different block size are formed.

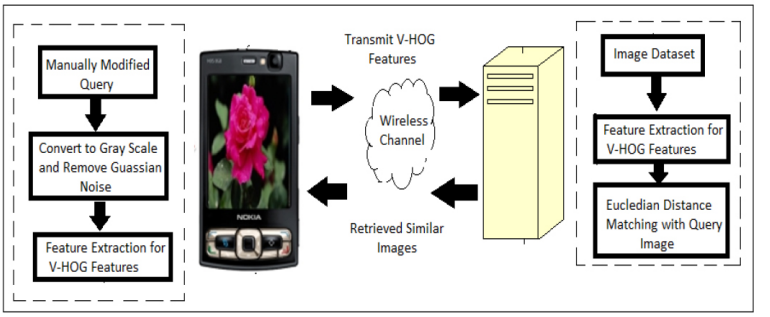


Figure 2

Proposed approach for Image Retrieval on Mobile Device

The Final feature vector is calculated with the help of block size, cell size and no. of bins. The variant of HOG (V-HOG) is created with the help of concept presented in [22]. Once the feature vector is calculated using V-HOG it can be transmitted through the wireless channel to the server. At the server side received feature vector is compare with the existing dataset features and images are retrieved on mobile device. The Euclidean distance function; evaluate the features by comparing with database features. The min distance feature images are retrieved first and so on.

4. Experimental Setup and Results

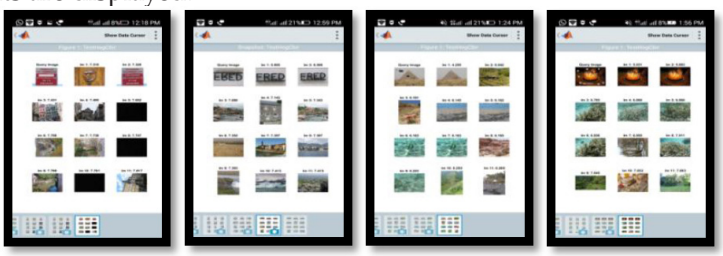
Mobile MATLAB is used to evaluate the performance of proposed approach. It is specially designed for performing operation on tiny devices and it provides the facility to perform the different image processing operation devices like Smartphone. The mobile MATLAB is Install and configure on the Lenovo A6000 Smartphone and connected to the desktop machine through wifi. The Smartphone is having a configuration of Quad Core 1.2Ghz Processing unit with 1 GB of RAM. The Smartphone is connected by the 4G network to the Desktop having a capacity of i5 , 2.6 Ghz processing unit and 4GB RAM with windows 7 as a platform. To evaluate the performance of the existing and proposed approach Holidays dataset [21] is used and some sample images are selected for experimentation.

4.1 *Experimental Result of HOG and V-HOG on MATLAB Mobile*

The total 16 sample images are considered for the experimentation on mobile device. These samples are intentionally modified to check the effectiveness of the existing and proposed scheme for the retrieval. When query requested by the user from the mobile device, the device was busy to perform other operations of applications such as Whatsapp, security check etc. Hence to evaluate the time required to display the output of requested query, we have to re-execute the single query three to four times and then Retrieval time is calculated.

In Figure 3 the query image denotes the modified image which is artificially modified and given as a input to the HOG approach. The query image is modified using the tools and the cropping of the image has been done and some part of image is partially deleted. The rotation of the query image is also performed to evaluate the performance. Query image is also modified by adding the visual contents. This helps to check

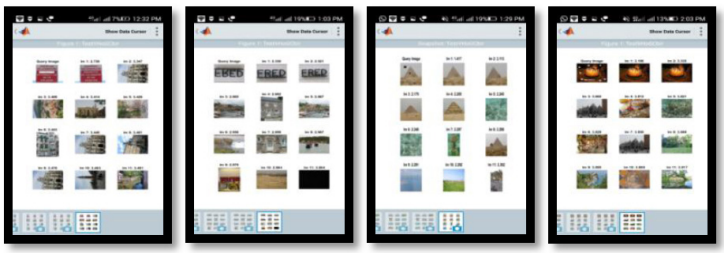
the robustness of the system. Figure 3a) presented the retrieved images for the given sample query and rank one shows the dissimilarity. The samples of different queries are presented to evaluate the accuracy of the existing approach. As per the different modification performed on the query image outputs are displayed.



a) Image Query 1 b) Image Query 4 c) Image Query 10 d) Image Query 15

Figure 3

Retrieval output HOG for sample query Image on mobile device



a) Image Query 1 b) Image Query 4 c) Image Query 10 d) Image Query 15

Figure 4

Retrieval output of V-HOG for sample query Image on mobile device

In Figure 4 the query image denotes the modified image which is artificially modified and given as a input to V-HOG. The query image is modified using the tools and the flipping of the image has been done. The sample output of proposed approach is better in terms of accuracy and similarity of retrieved images and retrieval performance of this approach is evaluated and presented in the next section.

4.2 *Evaluation of HOG and V-HOG on MATLAB Mobile*

The sample output for the two different schemes is presented in the above section that is HOG and V-HOG. The different variants of HOG has been developed by varying the number of block size and number of bins

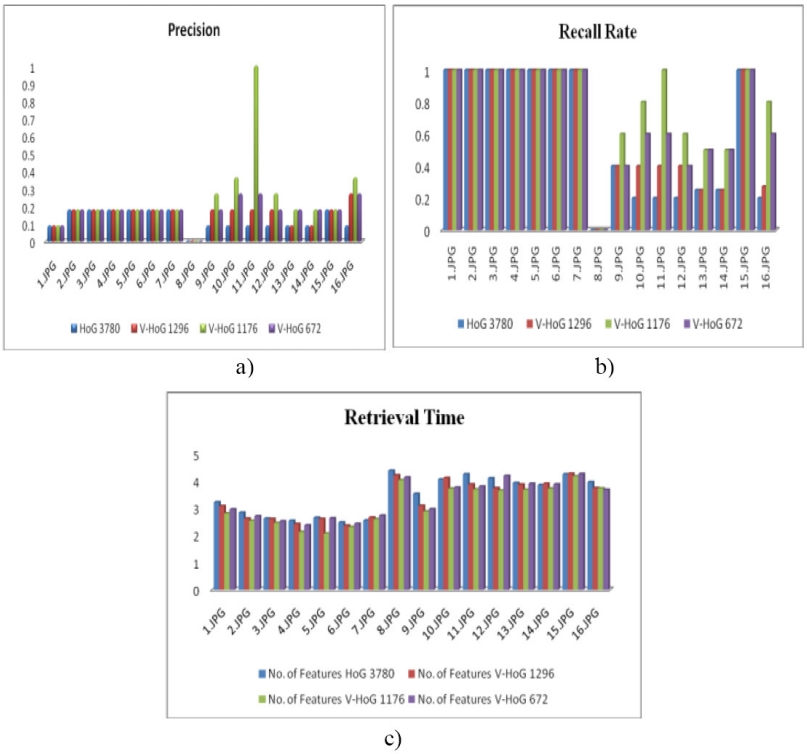


Figure 5

Comparison of Experimental results on Mobile device for Holidays dataset.

and experiment is performed on the Smartphone using mobile MATLAB. The performance of a given approach is evaluated using precision, recall, retrieval time and average precision and recall rate. The no of features of the existing approach is 3870 and it reduced to1296, 1176 and 672 by varying block size, cell size and no. of bins. The V-HOG descriptor of size of 1296, is created images resizes into 320×240 and created a block size of 54.

Figure 5 a) presenting, a precision rate of different samples of query image and it is observed from the graph that, V-HOG descriptor outperformed with 1176 features. Figure 5b) shows the recall rate for given sample query. It is observed that, V-HOG (variant of histogram of gradient) descriptor with 1176 features having a better recall, followed by V-HOG with 672 features.

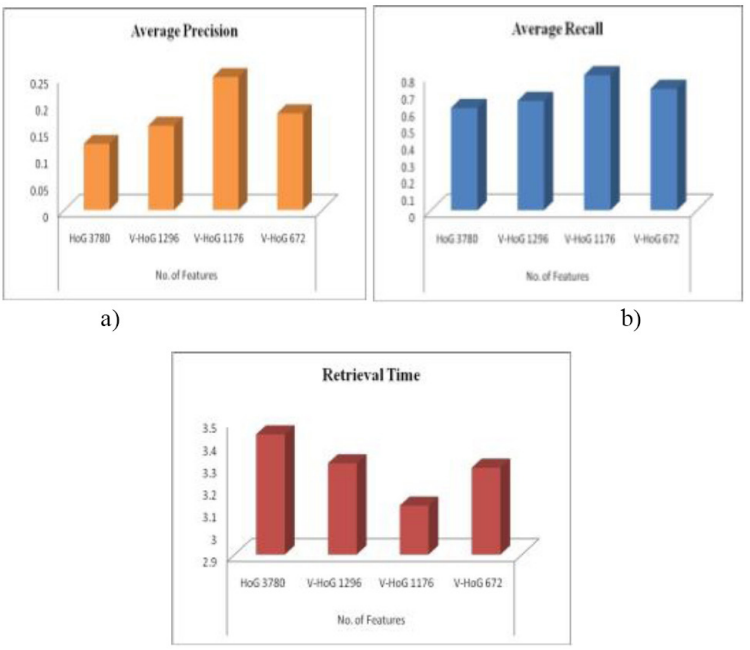


Figure 6

Comparison of Average Precision, Recall and Retrieval Time on Mobile

Figure 5c) shows the comparison of Retrieval time on Mobile device. The max retrieval time is less than 5 sec and it can be observed that V-HOG perform better with HOG descriptor. The variant of Histogram of Gradient having 1176 feature value required less retrieval time.

The average precision, recall and retrieval time of the proposed approach with existing approach and with different feature values are shown in Figure 6. It is observed that average precision, recall and retrieval time of V-HOG is effective for the features value 1176. The retrieval time for the feature value 1296 and 672 is almost equal.

5. Conclusion and Future Scope

The approach based on V-HOG is presented for image retrieval on mobile device. The HOG feature vector is invariant for the different type of transformation such as rotation, illumination etc. This property of descriptor is helpful for similarity matching. Hence reduction of feature size through V-HOG not only improves the matching accuracy

but also reduces the feature descriptor dimension, and retrieval time. The experimentation is performed on the mobile device using V-HOG and the average precision, average recall and average retrieval time is good in comparison with HOG approach. Future works needs to investigate the different compression mechanism to further reduce the descriptor size for image retrieval.

References

[1] R. Datta, D. Joshi, J. Li, and J. Z. Wang, "Image Retrieval: Ideas, Influences, and Trends of the New Age", *ACM Computing Surveys (CSUR),* vol. 40, no. 2, pp. 1-60, (2008).

[2] Sarvas, R., Herrarte, E., Wilhelm, A., and Davis, M., "Metadata Creation System for Mobile Images", MobiSys June 6-9, Boston, MA, USA. *ACM Press*, (2004).

[3] M. Subramanian , V. Lingamuthu , C. Venkatesan and S. Perumal, "Content- Based Image Retrieval Using Colour, Gray, Advanced Texture, Shape Features, and Random Forest Classifier with Optimized Particle Swarm Optimization", *Int. J. Biomed. Imaging* 2022: 3211793:1-3211793:14 (2022).

[4] D. M. Chen, S. S. Tsai, V. Chandrasekhar, G. Takacs, R. Vedantham, R. Grzeszczuk, and B. Girod, "Inverted index compression for scalable image matching", in Proc. *IEEE Data Compression Conf.* (DCC), Snowbird, UT, (2010).

[5] N. Yu ,O. Hua, K.A. Hua and D. Liu, "Client relevance feedback approach for image retrieval in mobile environment", *IEEE International Conference on Multimedia and Expo*, pp.552-555, (2007).

[6] S. Xia , X. Gong , W. Wang , Y. Tian X. Yang , J. Ma ,"Context-Aware image annotation and retrieval on mobile device", *Second International Conference on Multimedia and Information Technology (MMIT)*, 2010, vol. 1, pp. 111–114, (2010).

[7] Y. Nimmagadda, K. Kumar and Y. Lu, "Energy-efficient image compression in mobile devices for wireless transmission", ICME'09 Proceedings of the *IEEE international conference on Multimedia and Expo*, pp. 1278-1281, (2009).

[8] V. Chandrasekhar , D. M. Chen , A. Lin , G. Takacs , S. S. Tsai , Ngai-Man Cheung , Y. Reznik , R. Grzeszczuk , B. Girod, "Comparison of local feature descriptors for mobile visual search", *17th IEEE*

International Conference on Image Processing (ICIP), pp. 3885-3888, (2010).

[9] V. Chandrasekhar, G. Takacs, D. M. Chen, S. S. Tsai, Y. Reznik, R. Grzeszczuk, and B.Girod, "Compressed histogram of gradients: A low-bitrate feature descriptor", *International Journal of Computer Vision*, Vol. 96, Issue 3, pp. 384-399, (2012).

[10] V. Chandrasekhar , G. Takacs , D. Chen , S. S. Tsai , J. Singh and B. Girod "Transform Coding of Image Feature Descriptors", Proc. SPIE 7257, *Visual Communications and Image Processing*, 725710, (2009).

[11] D. M. Chen, S. S. Tsai, V. Chandrasekhar, G. Takacs, J. Singh and B. Girod, "Tree Histogram Coding for Mobile Image Matching", *DCC 09 Proceedings of the Data Compression Conference*, pp.143-152, (2009).

[12] Sheng, Jianqiang, Wang, Fei, Zhao, Baoquan, Jiang, Junkun, Yang Yu and Cai, Tie, "Sketch-Based Image Retrieval Using Novel Edge Detector and Feature Descriptor", *Wireless Communications and Mobile Computing* ,Volume 2022, pp. 1-12, (2022).

[13] S. So, "Efficient Image Indexing And Retrieval Over Mobile Devices", *Journal of Mobile Multimedia* , Vol. 1, Issue 2, pp. 149-160, (2005).

[14] ilab.usc.edu/~kai/projects/cs546-Spring2009-Google.pdf.

[15] Changyun Zhu, Kun Li, Qin Lv, Li Shang, and Robert P. Dick, " iScope: personalized multi-modality image search for mobile devices", Proceedings of the *7th International Conference on Mobile Systems, Applications, and Services, Wroclaw*, Poland ACM, pp. 277-290, June (2009).

[16] D. Kashilani, L. B. Damahe and N. V. Thakur, "An Overview of Image Recognition and Retrieval of Clothing Items," *International Conference on Research in Intelligent and Computing in Engineering (RICE)*, San Salvador, El Salvador, pp. 1-6, (2018). doi: 10.1109/RICE.2018.8509041.

[17] B. Ruf, E. Kokiopoulou and M. Detyniecki, "Mobile museum guide based on fast SIFT recognition", AMR'08 Proceedings of the *6th international conference on Adaptive Multimedia Retrieval: identifying, Summarizing, and Recommending Image and Music*, pp.170-183, (2010).

[18] X. Fan ,X. Xie ,Z. Li, M. Li and W. Ma ,"Photo-to-Search: Using Multimodal Queries to Search the Web from Mobile Devices", MIR '05 Proceedings of the *7th ACM SIGMM international workshop on Multimedia information retrieval* , New York, USA, pp. 143-150, (2005).

[19] Jie Lin, Ling-Yu Duan, Jie Chen, Rongrong Ji, Siwei Luo and Wen Gao, "Learning multiple codebooks for low bit rate mobile visual search", IEEE *International Conference on Acoustics, Speech and Signal Processing (ICASSP),* pp.933-936, (2012).

[20] Jie Chen, Ling-Yu Duan, Rongrong Ji, Hongxun Yao, Wen Gao , "Sorting local descriptors for low bit rate mobile visual search", IEEE *International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pp.1029-1032, (2011).

[21] Holidays Dataset [Online] Available: https://lear.inrialpes.fr/~jegou/data.php

[22] R. Sharma, L. Damahe and N. V. Thakur , "V-HOG: Towards Modified Query Based Image Retrieval" *International Conference on Smart and Innovative Trends in Next Generation Computing Technologies (NGCT)*, pp. 628-639, (2017).

[23] Amarnath Pathak, Partha Pakray & Ranjita Das, "Context guided retrieval of math formulae from scientific documents", *Journal of Information and Optimization Sciences*, 40 : 8, 15591574, (2019). DOI: 10.1080/02522667.2019.1703255

[24] R. Hatibaruah, V. K. Nath, K. J. Saikia & D. Hazarika, "Elliptical local binary co-occurrence pattern for face image retrieval", *Journal of Statistics and Management Systems*, 22 : 2, 223-236, (2019) DOI: 10.1080/09720510.2019.1580902.