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A Culture-Oriented Image Search System for Indonesian Cultural Paintings with Semantic Multi-Query Analytical Function

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Abstract

The exchange of digital image on internet increases the number of digital image creation in various categories. This condition extends the need of image search system especially for culture-oriented image that treasures set of impressions that makes image searching become more complex. This paper presents a culture-oriented semantic multi-image query system with an analytical function to generate the representative query impressions. This multi query method permits user to attach more than one image queries as their intentions. The set of steps in the analytical function contain several computation methods to extract and generate the dominant query impressions by generating the representative query colors. The representative impressions will consider user intentions to measure the similarity with image database to find the highest degree of similarity of the retrieved images. For experimental study, we implement our system to 248 Indonesian cultural images consisting of five categories of painting styles which are abstractionism, naturalism, expressionism, realism and romance.

Keywords: culture-oriented image search, semantic multi-image query, representative query color features, Indonesian cultural images, painting styles, impression similarity.

1. Introduction

Multimedia image exchange in digital technology becomes an exponential trend in this digital era. Internet where all the people around the world are connected becomes the appropriate media for spreading the multimedia digital image data. This condition are attracting in both art field and society in developing and distributing various categories of image data. It makes a large number categories of image spreading widely on multimedia image database including cultural related image category. The wide development of digital image data makes the need of efficient image search system increase significantly. From the point of view of cultural related image that treasures set of impressions behind its features the culture oriented image search system become more complex.

Several effective image search system are widely developed in order to give better result of image retrieval. Content based image retrieval (CBIR) system which analyzes the content of an image by extracting primitive features such as color, shape, texture, have been proposed to give better result in such kind of activity. There are several approaches adopted this method such as, image search system utilizing color information inside an image presented by QBIC[9]. VisualSeek[10] introduced a system by diagramming spatial arrangements from representation of color regions. NETRA [11] developed a CBIR system with combination of color and texture features. Image retrieval engine with the extraction method of color, texture, and shape feature introduced by Virage [12]. An image search system with combination of color, shape and structure features using a cluster oriented image retrieval system proposed by CoIRS [13]. Veltkamp and Tanase [14] and Liu et al [15] presented a survey to many image retrieval systems using diverse features.

Image search system commonly uses a content based image retrieval system by using single query. In case of cultural related image that treasures set of impressions behind its feature contents, image search system needs to provide a more flexible query model to apprehend what the user wants to retrieve. Several approaches adopted this multi query method have been proposed to solve the problem. An image search system with a combined-image query by providing operators in the query creation process proposed by Hayashi et al. [6]. Barakbah et al. [7] presented a multi-image query for retrieval with providing a series of emotional contexts. Sasaki et al. [16] presented a dynamic image-query creation and metadata extraction method with semantic correlation computation between color-combinations and impressions of multiple image data. The queries are created by the combination of multiple image sets and operations, which are intersection, accumulation, average, difference of color elements of sample images. A dynamic image-query creation method for imagination-based image search system and its

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application for travel information associated with scenery images presented by Ngunyen et al. [17]. We also proposed a semantic multi query image search system with several analytical functions to generate the representative query color features [19].

2. Objective of our System

In this paper, we propose a culture-oriented image search system with a new idea to construct a new model for representing the user impressions by providing a semantic multi-image query system. The proposed multi-query model consists of an analytical function to semantically generate the representative query color features. The objective of our system proposed in this paper is to apprehend the user intentions for retrieving cultural images those involve a lot of impressions behind their features. We implement our system to 248 Indonesian cultural images consisting of five categories of painting styles which are abstractionism, naturalism, expressionism, realism and romance. The architecture of our proposed system is shown in Figure 1.

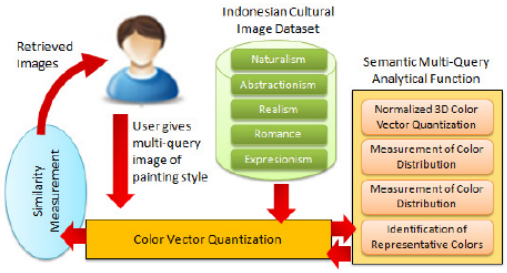


Figure 1. System architecture of our culture oriented semantic image search system

Our proposed system presents a supporting tool to express user's intention in the retrieval by providing semantic multi-image query system. This system will bring a significant contribution to users, especially to the painters, to search and retrieve a series of visual information images related to Indonesian cultural paintings with involving panting styles.

3. Semantic Multi-Image Query Analytical Function

Our previous proposed system is the semantic multi query function consists of several functions to semantically generate the representative query color features. Our semantic multi query function consists of four steps to proceed the multiple image queries given by users and then generate the representative query color features, as shown in Figure 2.

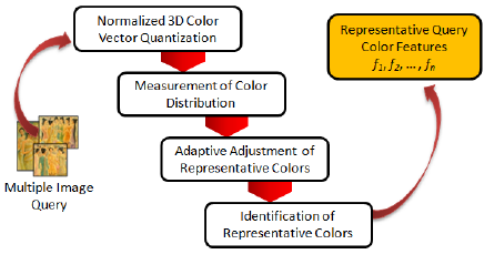


Figure 2. A semantic multi-image query analytical function to generate the representative query color features

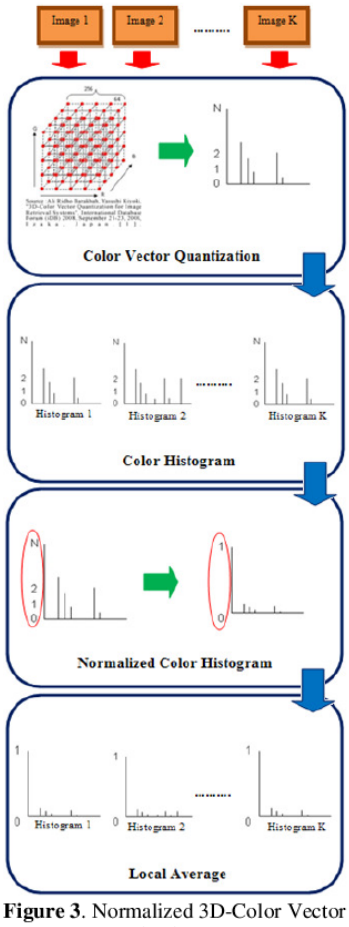


Figure 3. Normalized 3D-Color Vector Quantization

3.1. Normalized 3D Color Vector Quantization

This step is used for extraction the color features of image dataset and multiple image query given by users. In this step, the color information of the image dataset and the image query is extracted using the histogram from 3D-Color Vector Quantization of RGB color space, and then quantized in 4x4x4 size of the RGB color space to 125 positions in the RGB color space. After obtaining the histogram of vector quantization, calculation of the local average is needed to normalize the features considering that the sizes of image queries could be various, as shown in Figure 3.

3.2. Measurement of Color Distribution

This step measures the information of color distribution by statistically calculating the average of all extracted color features (Eq. 1). and then calculating the distribution of their standard deviations (Eq. 2). This step is important to find the dominant colors among image queries and the variance to those dominant colors.

$$Avg=\frac{\sum_{i=1}^{imgquery} locAvg_i}{imgquery} \quad (1)$$

$$SD=\frac{1}{imgquery}\sqrt{\sum_{i=1}^{imgquery}(locAvg_i - \overline{locAvg})} \quad (2)$$

Where *Avg* is color average, *SD* is standard deviation, *imgquery* is the number of image query, *locAvg* is a local average color.

3.3. Adaptive Adjustment of Representative Colors

After calculating the average and standard deviation of extracted color features, we need to measure the density of the color distribution to find the representative colors. The ideal representative colors should fulfill two conditions:

(1) The color feature has a high average value that means that the color appears in many pixels.
(2) The color feature has a low standard deviation value that means that the color is almost dominant in every image queries.

Considering those two conditions, we can calculate the density of the color distribution by Eq. 3.

$$Density = \frac{avg(f_i)+\alpha}{sd(f_i)+\alpha} \quad (3)$$

where $avg(f_i)$ is average value of color feature f_i, $sd(f_i)$ is standard deviation of color feature f_i and α is a small determination to avoid zero-division.

3.4. Identification of Representative Colors

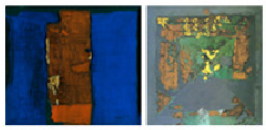
After calculation of the density of the color feature, this step is used to identify the representative colors. We apply a cluster based similarity measurement of the color density. Because we cannot exactly determine how many clusters are appropriate for the color density, the automatic clustering is needed to identify how many cluster should be used. In this case, we use our automatic clustering Valley Tracing algorithm [8]. After clustering the color density, the automatic filtering is applied to filter the non-representative clusters out those are locates near zero vector. The rest of the cluster is selected and the members of those clusters are the representative color features.

4. Experimental Study

We implement our proposed system to 248 paintings consisting of five categories of painting style which are abstractionism, naturalism, expressionism, realism and romance. Here are the description of each painting style.

(1) Abstractionism

This painting style does not have any shapes or objects. Abstractionism painters tend to express their imagination freely without thinking about shapes and objects. The Indonesian famous abstractionism painters are Dadan SA, Achmad Sadali, Amri Yahya and other Indonesian painters. Figure 4 shows an example of abstractionism painting.



Painter : Achmad Sadali

Figure 4. Examples of abstractionism painting style

(2) Naturalism

The naturalism is a painting style expressing natural panoramic view. Muslim Saleh, Raden Saleh, Basuki Abdullah are the famous Indonesian naturalism painters. Figure 5 shows an example of the naturalism painting style.

Painter : Raden Saleh

Figure 5. An example of naturalism painting style

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(3) Expressionism

The painters of expressionism express their feeling about something and embed it into their painting. They involve their deep impression into the paintings. Every part of the painting expresses their deep feeling. The most famous Indonesian painters with this painting style is Affandi. Figure 6 shows an example of the expressionism.

Painter : Affandi

Figure 6. An example of expressionism painting style

(4) Realism

It is a painting style that expresses and reality of human life or society. Some Indonesian painters with this painting style are Herri Soedjarwanto, Raden Saleh, Umar Sidik and Basuki Abdullah. Figure 7 shows an example of the realism painting style.

Painter : Basuki Abdullah

Figure 7. An example of realism painting style

(5) Romance

The painters of this style expresses something dramatic, emotional, mysterious, imaginary, and actual facts or objects in their painting. Some Indonesian painters of this style are Raden Saleh and Basuki Abdullah. Figure 8 shows an example of the romance painting style.

Painter : Raden Saleh

Figure 8. An example of romance painting style

To perform our proposed semantic multi-query image search system, we examine our system with Indonesian cultural painting dataset consisting of 34 paintings of abstractionism, 28 paintings of naturalism, 57 paintings of expressionism, 20 of paintings romance and 109 paintings of realism. Several experiments are applied for each category of the painting styles. To analyze the precision, because the cultural painting image has set of impressions, we compare the similarity of impressions behind the image query and the retrieved images. We use Color Image Scale [21] to extract set of impressions from the images. The similarity rate of retrieved images is calculated with number of retrieved image impressions which are same with the representative query impression.

Experiment 1. Image search from Abstractionism image query

Here we conduct an experimental study to retrieve images from several image queries classified as Abstractionism painting style. Figure 8 shows the retrieved images from the multi-image query in Abstractionism.

Table 1. Similarity rate between the image queries of abstractionism and impressions of the retrieved images (similar impressions are showed by italic font)

Rank	10-Highly Impressions	Sim. Rate
1	*Chic, sober, subtle and mysterious, exact,* aqueous, *earnest, solemn, stout, majestic,* dignified	80%
2	*Solemn, provincial,* simple quiet elegant, simple and appealing, modest, *subtle and mysterious, formal, chic, earnest, sober*	70%
3	*Chic, majestic,* aqueous, polished, *subtle and mysterious, solemn, sober,* refined, *exact,* urbane	60%
4	*Subtle and mysterious, exact, chic, solemn, sober,* aqueous, *formal, earnest, stout,* assiduous	80%
5	*subtle and mysterious, solemn, chic, exact, stout, earnest, sober, formal, majestic, provincial*	100 %
6	*Subtle and mysterious, exact, solemn, chic, sober, formal, stout,* assiduous, serious, sedate	70%
7	*Chic, subtle and mysterious, sober, solemn,* aqueous, *exact,* subtle, elegant, sedate, sleek	50%
8	*Subtle and mysterious, solemn, exact, chic, sober,* lofty, aqueous, *formal,* authoritative, *earnest*	70%
9	*Subtle and mysterious, solemn, chic, exact,* authoritative, *formal,* lofty, *sober,* aqueous, sleek	60%
10	*Subtle and mysterious, exact, provincial, solemn,* assiduous, *chic, formal, stout,* serious, simple quiet elegant	70%
11	*Subtle and mysterious, exact, solemn, chic, sober, formal, stout,* assiduous, serious, sedate	70%
12	*Subtle and mysterious, exact, solemn, chic, stout, formal,* assiduous, *sober,* serious, bitter	70%
3	*Subtle and mysterious, chic, exact, solemn, formal,* assiduous, *stout, sober,* serious, bitter	0%
4	*Subtle and mysterious, exact, solemn, chic, provincial,* assiduous, quiet and sophisticated, bitter, *formal, stout*	0%
5	*Subtle and mysterious, chic, solemn, sober, exact,* sleek, subtle, elegant, sedate, *earnest*	0%

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Using Color Image Scale, the multi-image query consist of representative impressions which are subtle and mysterious, solemn, exact, stout, chic, earnest, sober, formal, majestic, and provincial. We calculate the similarity rate of the representative impressions of the image query and 10-highly impressions of each retrieved image, as shown in Table 1. Our image search performed 70% average similarity rate from top-15 ranked retrieved images.

Figure 9. Image query and retrieved images of Abstractionism

Experiment 2. Image search from Naturalism image query

An experimental study to retrieve images from several image queries classified as Naturalism painting style is conducted. The retrieved images from the multi-image query in Naturalism is shown in Figure 10. Using Color Image Scale, the multi-image query consist of representative impressions which are subtle and mysterious, chic, exact, solemn, sober, formal, stout, assiduous, aqueous, serious, and sedate. Same way with Abstractionism we calculate the similarity rate of the representative impressions of the image query for Naturalism and 10-highly impressions of each retrieved image, as shown in Table 2. Our image search performed 73.33% average similarity rate from top-15 ranked retrieved images.

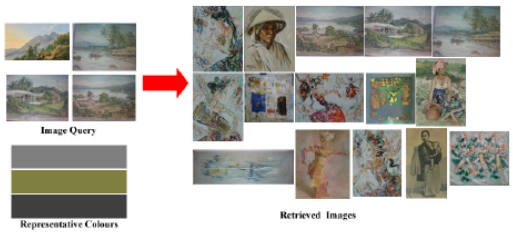

Figure 10. Image query and retrieved images of Naturalism

Table 2. Similarity rate between impressions of the retrieved images and the image queries of naturalism (similar impressions are showed by italic font)

Rank	10-Highly Impressions	Sim. Rate
1	*Subtle and mysterious, solemn, chic, exact,* authoritative, *formal,* lofty, *sober, aqueous,* sleek	70%
2	*Solemn,* provincial, simple quiet elegant, simple and appealing, modest, *subtle and mysterious, formal, chic,* earnest, *sober*	50%
3	*Subtle and mysterious, exact, solemn, chic, sober, formal, stout, assiduous, serious, sedate*	100 %
4	*Subtle and mysterious, exact, solemn, chic, sober, formal, stout, assiduous, serious, sedate*	100 %
5	*Subtle and mysterious, exact, chic, solemn, sober, aqueous, formal,* earnest, *stout, assiduous*	90%
6	*Subtle and mysterious, solemn, exact, chic, sober,* lofty, *aqueous, formal,* authoritative, earnest	70%
7	*Subtle and mysterious, solemn, chic, exact, stout,* earnest, *sober, formal,* majestic, provincial	70%
8	*Chic,* majestic, *aqueous,* polished, *subtle and mysterious, solemn, sober,* refined, *exact,* urbane	60%
9	*Subtle and mysterious, exact, solemn, chic,* provincial, *assiduous,* quiet and sophisticated, bitter, *formal, stout*	70%
10	*Subtle and mysterious, solemn, exact,* provincial, *formal, chic, assiduous,* simple quiet elegant, *serious,* bitter	70%
11	*Chic, sober, subtle and mysterious, exact, aqueous,* earnest, *solemn, stout,* majestic, dignified	70%
12	*Subtle and mysterious, exact,* provincial, *solemn, assiduous, chic, formal, stout, serious,* simple quiet elegant	80%
13	*Subtle and mysterious, chic, solemn, sober, exact,* sleek, subtle, elegant, *sedate,* sedate	60%
14	Provincial, *subtle and mysterious, formal, assiduous, exact,* modest, *solemn,* simple quiet elegant, *serious, chic*	70%
15	*Chic, subtle and mysterious, sober, solemn, aqueous, exact,* subtle, elegant, *sedate,* sleek	70%

Experiment 3. Image search from Expressionism image query

Experiment 3 is conducted to retrieve images from several image queries classified as Expressionism painting style. Figure 11 shows the retrieved images from the multi-image query in Expressionism. Using Color Image Scale, the multi-image query consist of representative impressions which are subtle and mysterious, solemn, chic, exact, sober, earnest, lofty, authoritative, formal, aqueous, and sleek. The similarity rate is measured between the representative impressions of the image query in Expressionism and 10-highly impressions of each retrieved image, as shown in Table 3. The search system performed 68% average similarity rate from top-15 ranked retrieved images.

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Figure 11. Image query and retrieved images of Expressionism

Table 3. Similarity rate between impressions of the retrieved images and the image queries of expressionism (similar impressions are showed by italic font)

Rank	10-Highly Impressions	Sim. Rate
1	*Chic, sober, subtle and mysterious, exact, aqueous, earnest, solemn,* stout, majestic, dignified	70%
2	*Solemn,* provincial, simple quiet elegant, simple and appealing, modest, *subtle and mysterious, formal, chic, earnest, sober*	60%
3	*Chic,* majestic, *aqueous,* polished, *subtle and mysterious, solemn, sober,* refined, *exact,* urbane	60%
4	*Subtle and mysterious, exact, chic, solemn, sober, aqueous, formal, earnest,* stout, assiduous	80%
5	*Subtle and mysterious, solemn, chic, exact,* stout, *earnest, formal,* majestic, provincial	70%
6	*Subtle and mysterious, exact, solemn, chic, sober, formal,* stout, assiduous, serious, sedate	60%
7	*Chic, subtle and mysterious, sober, solemn, aqueous, exact,* subtle, elegant, sedate, *sleek*	70%
8	*Subtle and mysterious, solemn, exact, chic, sober, lofty, aqueous, formal, authoritative, earnest*	100%
9	*Subtle and mysterious, solemn, chic, exact, authoritative, formal, lofty, sober, aqueous, sleek*	100%
10	*Subtle and mysterious, exact,* provincial, *solemn,* assiduous, *chic, formal,* stout, serious, simple quiet elegant	50%
11	*Subtle and mysterious, exact, solemn, chic, sober, formal,* stout, assiduous, serious, sedate	60%
12	*Subtle and mysterious, exact, solemn, chic,* stout, *formal,* assiduous, *sober,* serious, bitter	60%
13	*Subtle and mysterious, chic, exact, solemn, formal,* assiduous, stout, *sober,* serious, bitter	60%
14	*Subtle and mysterious, exact, solemn, chic,* provincial, assiduous, quiet and sophisticated, bitter, *formal,* stout	50%
15	*Subtle and mysterious, chic, solemn, sober, exact, sleek,* subtle, elegant, sedate, *earnest*	70%

Experiment 4. Image search from Realism image query

In Experiment 4 we make an experimental study to retrieve images from several image queries classified as Realism painting style. The retrieved images from the multi-image query in Realism is shown in Figure 12. Using Color Image Scale, the multi-image query consist of representative impressions which are dry, familiar, calm, simple and appealing, restful, Japanese, tranquil, natural, conservative, and simple quiet elegant. The similarity rate is measured between the representative impressions of the image query in Realism and 10-highly impressions of each retrieved image, as shown in Table 4. The search system performed 67.33% average similarity rate from top-15 ranked retrieved images.

Table 4. Similarity rate between impressions of the retrieved images and the image queries of realism (similar impressions are showed by italic font)

Rank	10-Highly Impressions	Sim. Rate
1	*Dry, familiar, calm, simple and appealing, restful, Japanese, conservative,* sound6, nostalgic, *tranquil*	80%
2	*Dry, familiar, simple and appealing, restful, calm, tranquil, Japanese, natural, simple quiet elegant,* pleasant	90%
3	*Dry, familiar, restful, calm, simple and appealing, tranquil, natural, Japanese, conservative,* sound6	90%
4	*Dry, calm, familiar, simple and appealing, restful, Japanese, simple quiet elegant,* provincial, *conservative, natural*	90%
5	*Dry, familiar, simple and appealing, tranquil, restful, calm, simple quiet elegant, natural, Japanese,* sober	90%
6	*Dry, familiar, restful, simple and appealing, tranquil, natural, calm,* plain, large hearted, pleasant	70%
7	*Dry, calm, familiar, simple and appealing,* provincial, *restful, simple quiet elegant, Japanese,* nostalgic	80%
8	*Dry,* provincial, *calm, simple quiet elegant, simple and appealing, Japanese,* sober, nostalgic, *conservative,* sound6	60%
9	*Dry,* plain, *simple and appealing, Japanese,* provincial, *tranquil, simple quiet elegant,* sober, *natural, restful*	70%
10	Earnest, metallic, chic, *simple and appealing, simple quiet elegant,* sober, aqueous, *tranquil, dry,* elegant	40%
11	Provincial, *simple quiet elegant, dry,* subtle and mysterious, *calm,* nostalgic, *Japanese,* sober, *simple and appealing,* assiduous	50%
12	*Familiar, natural, calm,* pristine, *restful,* provincial, *simple and appealing,* large hearted, *dry,* aromatic	60%
13	Provincial, *calm, familiar,* aromatic, *dry, natural, simple and appealing, simple quiet elegant,* nostalgic, *restful*	70%
14	*Simple quiet elegant,* provincial, *simple and appealing,* sober, chic, *dry,* aqueous, assiduous, earnest, metallic	30%
15	Subtle and mysterious, *dry,* provincial, *simple quiet elegant, Japanese, simple and appealing,* sober, exact, assiduous, solemn	40%

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Figure 12. Image query and retrieved images of Realism

Table 5. Similarity rate between impressions of the retrieved images and the image queries of romance (similar impressions are showed by italic font)

Rank	10-Highly Impressions	Sim. Rate
1	*Subtle and mysterious, solemn, exact, bitter,* quiet and sophisticated, conservative, *authoritative,* salty, lofty, provincial	50%
2	*Subtle and mysterious, authoritative, solemn, formal,* light, *bitter,* intellectual, pure, crystalline, neat	50%
3	*Authoritative, heavy and deep, formal,* intellectual, *bitter, subtle and mysterious, stout,* earnest, modern, majestic	60%
4	*Subtle and mysterious, authoritative, formal, bitter,* intellectual, *solemn, heavy and deep, exact, stout,* earnest	80%
5	*Subtle and mysterious, authoritative, formal, solemn, exact, bitter,* intellectual, *stout, heavy and deep,* lofty	80%
6	*Authoritative, formal,* intellectual, *heavy and deep, subtle and mysterious, bitter, stout,* composed, old fashioned, modern	60%
7	*Authoritative, subtle and mysterious, formal, bitter, heavy and deep,* intellectual, *solemn, stout, exact,* majestic	80%
8	*Subtle and mysterious, formal, authoritative, bitter, solemn, exact, stout, heavy and deep,* intellectual, majestic	80%
9	*Authoritative, formal,* intellectual, *heavy and deep, subtle and mysterious, bitter,* modern, composed, *stout, solemn*	70%
10	*Authoritative,* old fashioned, *formal,* provincial, intellectual, *heavy and deep, subtle and mysterious,* simple quiet elegant, *bitter,* robust	50%
11	*Subtle and mysterious, solemn, exact, authoritative, formal, bitter, stout,* intellectual, *heavy and deep,* majestic	80%
12	*Formal, authoritative, subtle and mysterious, heavy and deep,* intellectual, *bitter,* old fashioned, *stout,* sturdy, provincial	60%
13	*Subtle and mysterious, exact, solemn, formal, bitter, authoritative, stout,* lofty, salty, quiet and sophisticated	70%
14	*Authoritative, formal, heavy and deep,* intellectual, *bitter,* modern, *stout, subtle and mysterious,* majestic, composed	60%
15	Quiet, urbane, crystalline, refined, polished, precise, refreshing, *exact, subtle and mysterious,* subtle	20%

Experiment 5. Image search from Romance image query

Here we conduct an experimental study to retrieve images from several image queries classified as Romance painting style. Figure 13 shows the retrieved images from the multi-image query in Romance. Using Color Image Scale, the multi-image query consist of representative impressions which are subtle and mysterious, formal, authoritative, bitter, assiduous, exact, chic, heavy and deep, stout, and solemn. We calculate the similarity rate of the representative impressions of the image query and 10-highly impressions of each retrieved image, as shown in Table 5. Our image search performed 63.33% average similarity rate from top-15 ranked retrieved images.

Figure 13. Image query and retrieved images of Romance

5. Conclusion

In this paper we have presented a cultural semantic image search system with a new model for representing the user impressions by providing a semantic multi-query image search system. The proposed multi-query model provides an analytical function to semantically generate the representative query color features. The function consists of four steps: (1) The normalized 3D-Color Vector Quantization for local extraction of color features in an image, (2) Measurement of color distribution among image queries by calculating average and standard deviation of extracted color features, (3) Adaptive adjustment of representative colors by measuring the density of the color distribution, and (4) Identification of representative colors by applying cluster based similarity measurement of the color density. Our proposed culture-oriented image search system was examined with five experiments to retrieve images from several image queries classified as each painting style in Indonesian cultural painting dataset which are Abstractionism, Naturalism, Expressionism, Realism and Romance. Several experiments are applied for each category of the painting styles. The precision was analyzed from the similarity of impressions behind the image query and the retrieved images extracted from Color Image Scale. From five experimental study for each painting style, our proposed culture-oriented image search system with semantic multi-query analytical

function performed effectively the search results for Indonesian Cultural Paintings by retrieving more than 60% correct retrieved images to the image queries for all painting styles. Our proposed system provided a supporting tool to express user's intention in the retrieval and will give a significant contribution to users, especially to the painters, to search and retrieve a series of visual information images related to Indonesian cultural paintings with involving panting styles.

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