A Visual Information Retrieval System

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ABSTRACT

This paper describes a tool that will use image templates as search queries instead of conventional searching using keywords. The project tries to automate searching with use of a visually oriented interface. Lastly, part of the goals of the paper is to study, select, and use relevant visual information retrieval tools for the system.

Keywords

Visual information retrieval, picture search, image retrieval, image matching.

1. INTRODUCTION

Ever since people have learned to draw pictures in their caves, the desire to produce or view images has grown with the skills in creating them. There is a clear need to make and to view them.

The fact that most computer screens are now filled with pictures from icons to wallpapers definitely state the necessity of images. This is not confined to the realms of the computer industry. Pictures can be found everywhere including malls, museums, homes, wallets, and lockets. Their economic and sentimental value cannot be set aside.

Along with the growth of the computer industry is the increase of digital pictures. Due to the relative affordability of various image capture devices, digitizing pictures is becoming a common task. Users have a wide variety of scanners to choose from. There is an increase of stores that sell digital cameras and other similar devices. Moreover, various image manipulation applications are now available. For the artistically inclined, there are numerous vendors who sell software that assist in creating graphical image files.

However, the problem lies with the management of the picture databases. Some address this problem by attaching descriptions for each file in the database. Such techniques fall short due to the degree of subjectivity of the domain.

A picture can paint a thousand words, as the cliché goes. There is no clear way of describing a picture, and if the proper image tag can be authored, formulating a suitable query is still complicated. With an *"I know it when I see it"* mindset, users feel that there is clear need for a better visual information retrieval system [4].

2. RELATED WORKS

With the proliferation of graphic files, the need for image databases and VIR systems have increased. Managing and retrieving these images have become a tedious process.

In this regard, various image information systems (IIS) have been experimented, and tested in several universities across the US. The special interest groups such as ACM and IEEE extend these research works. Traditional IIS usually perform image analysis and pattern recognition, image structuring and understanding, and spatial reasoning and image retrieval [2]. These may change the way the images are stored or retained in its original format. They are usually integrated with other systems such as medical databases, military surveillance systems, and other information systems.

In 1951, Calvin Moore coined the term *information retrieval*. Information retrieval embraces the intellectual aspects of the description of information and its specification for search, and whatever systems, techniques, or machines that are employed to carry out the operation. This definition is now extended to non-textual information.

Several universities have taken the task of offering a visually oriented VIR system. They are able to identify certain aspects of what visual information really is. Examples of such systems are Chabot, MetaSEEK, Virage Canvas, QBIC, and PICQUERY+ and VisualSEEK. These systems employ various color composition analysis, texture and pattern analysis, as well as structure recognition in organizing pictures. They are perfectly well capable of returning a set of pictures that are similar to the ones given by the user. Such techniques are called query-by-example.

Table 1. VIR applications with their corresponding inputs and limitations.

Application	Input	Limitation
Chabot	textual info	images need to be labeled and indexed
MetaSEEk	predefined images	limited to color histogram and Tamura texture algorithms
Virage	image color, structure, texture & composition	learning curve
QBIC	image composition based on histogram, color layout & texture	feature vector computation is costly
Picquery+	textual query language	does not allow visual sketches as query input
VisualSEEk	spatial information & relationships	technical knowledge is required from the user

3.

To be able to search for pictures in a database without using keywords, a system of measuring images must first be used. Based on this system, the similarities between pictures can then be measured. If the similarity of images can be measured, an input picture can be used to search for similar images inside a database. Therefore, no keywords will be used in the search.

uses four (4) types of similarity metrics that can be used on pictures, namely: pixel value, histogram, color region, and texture region matching algorithms.

3.1 Color Matching Algorithm

This algorithm determines whether any two given colors are similar or not. The colors were first segregated according to the Color Naming System provided by the Inter-Society Color Council – Bureau of Standards Lexicon of Color (ISCC). This produced different regions on the color wheel, and any two colors found in the same region are considered to be similar.

To provide a degree of fuzziness in the system, the concept of transition color regions is used. A transition color region is the area in between the original ISCC colors on the color wheel (Figure 1).

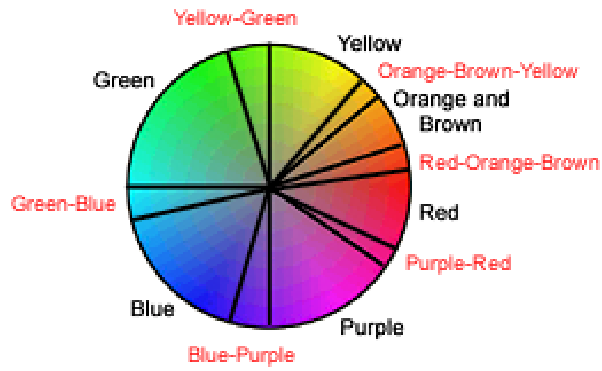

Figure 1. Color wheel with transition regions.

Any color found in these transition color regions are considered to belong to the original ISCC colors found in the adjacent regions. A sensitivity variable controls the size of these transition color regions. So, any two colors found in the same color region or in adjacent color regions are considered similar.

3.2 Pixel Value Matching Algorithm

This algorithm produces a percentage value of two pictures' similarity based on the values of their corresponding pixels (Figure 2). The pictures are first resized to matching dimensions. Both images are scanned left to right, top to bottom, and using the Color Matching Algorithm described earlier, the number of matched pixels are counted.

The percentage of similarity between the two pictures are computed as:

%Similarity = Number of matched pixels / Total number of pixels * 100

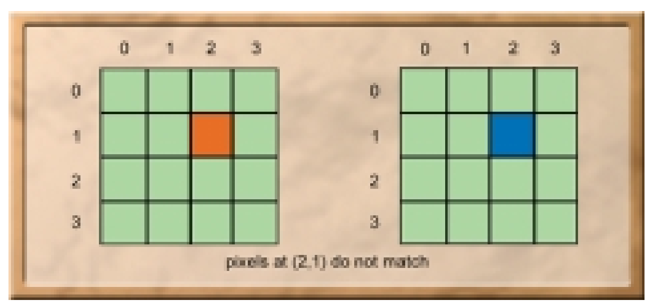

Figure 2. Pixel value matching.

3.3 Histogram Matching Algorithm

This algorithm produces a percentage value of two pictures' similarity based on their color histograms. Figure 3 shows some pictures and their computed histograms. The columns of the color histograms used in the system are based on the ISCC Color Naming System, with additional columns for the transition colors. To derive the histogram of the images, the Color Matching Algorithm is used to determine which column of the histogram is incremented. Next, the individual similarities of the columns of the ISCC colors are computed. All the columns associated with a particular ISCC color are considered, and the most similar combination is taken as that color's percentage similarity.

For example, to compute for the similarity of the blue columns of two images, the blue, blue-purple, and green-blue columns are used to determine which combination of columns produce the least difference. This value becomes the percentage similarity for the color blue.

The total percentage is then computed as:

%Similarity = Σ(Percentage similarity of color * Number of pixel of color / Total number of pixels)

3.4 Color Region Matching Algorithm

This algorithm produces a percentage value of two pictures' similarity based on their color regions. A color region is defined by a group of similar colors enclosed by a minimum-bounding rectangle (Figure 4). A color region also has a percentage value that represents how much of that color is in the region.

The input image is first scanned and divided into color regions. The Color Matching Algorithm is used to determine the color and the percentage of that color in the regions. Then the regions are mapped to the second picture and the Color Matching Algorithm is used to scan and compute the percentage of the original region's color in the mapped region. These percentages are used to compute for that region's similarity.

The final percentage similarity is then computed as:

%Similarity = Σ(Percentage of region * Area of region / Total area of regions)

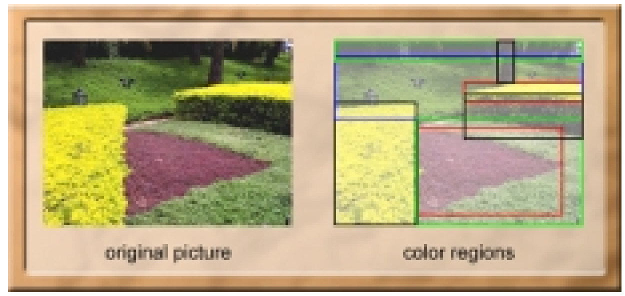

Figure 4. An image divided into color regions.

3.5 Texture Region Matching Algorithm

This algorithm produces a percentage value of two pictures' similarity based on their texture regions. The pictures are first resized to match dimensions, and then they are divided into texture windows of a constant size (Figure 5). A texture window is just a segment of the picture, and each window's texture attributes are derived.

The texture attributes are coarseness, orientation, and repetition. Each texture window is scanned and using the Color Matching Algorithm, the number of color changes between adjacent pixels is used to compute for the texture attributes. The percentage similarity of each attribute in each corresponding texture window is then computed.

The final percentage similarity is then computed as:

%Similarity = Average(%Similarity of texture attributes)

4. RESULTS AND OBSERVATIONS

The following tests were conducted by order to mark specific factors in image matching. The image template that was used is the first picture in the set.

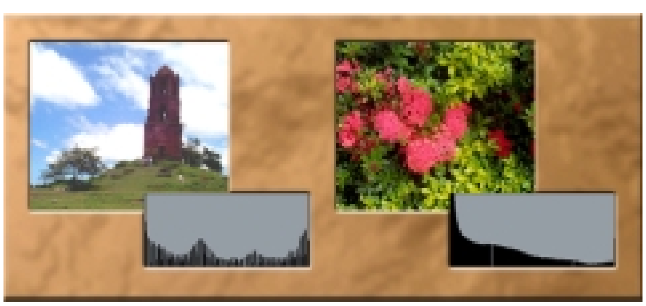

Figure 3. Examples of images with their corresponding histograms.

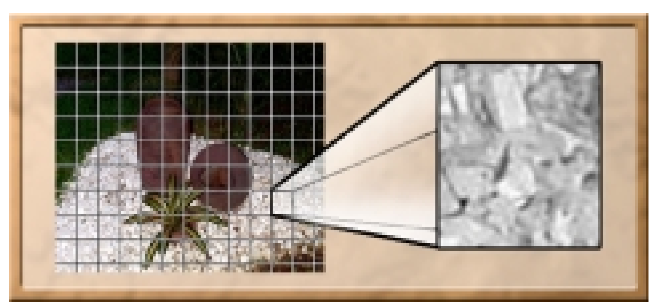

Figure 5. An image divided into texture windows.

4.1 Black and White Test (Figure A-1)

This test was performed by matching a 16-bit color image with its corresponding black and white, and sepia versions.

Ideally, the Pixel Value Matching percentage should be near zero, but since the template image has some gray colors in it, some pixels matched. This does not hold true in Image C. It was expected that the Texture Window Matching percentage is higher than the results. This is due to the lost of fine detail (affecting all attributes) in converting a picture to its grayscale equivalent.

4.2 Rotation Test (Figure A-2)

This test was done by matching an image with its copies that were rotated at 90, 180, and 270 degrees.

The Histogram Matching algorithm percentage alone have a high score, since the other algorithms are sensitive to the location of the pixels. Ideally, the percentage values for the Histogram Matching algorithm should be 100%. The discrepancy resulted because of the transformation method used to rotate the pictures. The software that was used in rotating the pictures does not simply relocate the pixels when rotating pictures but interpolates the pixel values to their new location.

4.3 Color Resolution (Figure A-3)

This test was done by comparing an image with its copies that have different color resolutions, namely: 24-bit color, 256-color, 16-color, and 2-color resolution.

The decrease of percentage matches is relative to the decrease of color detail due to the changes in the color resolution.

4.4 Zooming Test (Figure A-4)

This test was done by comparing an image with its copies that have varying degrees of magnification.

As expected, the Histogram Matching and Color Region Matching percentages remain relatively the same from Images B to D. The Histogram Matching percentage is relatively high because in zooming, only the positions of the pixels change, not the actual colors. In Color Region Matching, the percentage match depends on how large the image is zoomed.

4.5 Shifting Test (Figure A-5)

This test was done by comparing an image with its copies that were shifted to the left repeatedly.

Since the picture was shifted slightly, there is a high percentage match. As for Color Region percentage match, as long as the shift is not too large, in which the fuzziness is as large the shift, it will return a fairly high score.

4.6 Scaling Test (Figure A-6)

This test was done on simple and complex images that were enlarged and reduced. Simple images are images with relatively small number of colors and a plain texture pattern (Figure 3-6a), while complex images are images that uses several colors and a noisy texture pattern (Figure 3-6b).

Among the four algorithms, the one affected by scaling is the Texture Region Matching algorithm. This is true when the picture is scaled down. The loss of detail that results in scaling affects all the three Texture Window attributes. Simple images are less affected by scaling than complex images.

5. CONCLUSION

Certainly, the system will benefit everyone who uses digital images. Since the system will support template-based queries, it will help the user eliminate the need to use words to retrieve images. The user will be able to retrieve pictures that are hard to describe or pictures that are difficult to illustrate through words.

It will be possible to create large and manageable picture database systems. The system will aid in managing picture databases since it will minimize the need to produce descriptive filenames each time the database is updated. Since users will not have to go through the tedious process of manual searching, the need to classify pictures will also be eliminated.

The main significance of the study is that it will place into the hands of the common user the power of the system. Most of the successful VIR systems today are usually confined within the bounds of the academic community. With the technology is made available to most users.

With the proliferation of digital images, there is a need to for a system that can look for a particular image. Traditional use of keywords to index images is not enough. We have shown that a template-based visual information retrieval system addresses this need.

6. ACKNOWLEDGMENTS

A very special thanks is given to our advisers, Dr. Arnulfo Azcarraga and Dr. Florante Salvador, for their ideas and guidance during the development of this study. We would also like to thank all our teachers for imparting their knowledge to us.

7. REFERENCES

[1] M. Beigi, A.Benitez, and S.F. Chang, “A Content-based Image Meta-Search Engine Using Relevance Feedback” *http://www.ctr.columbia.edu/ metaseek* (1997).

[2] S.Chang, Fellow, and A.Hsu "Image Information System: Where Do We Go From Here?" *IEEE Transactions on Knowledge and .Data Engineering*, v.4 n.5 IEEE Computer Society Publication, New York, USA, (1992).

[3] S.F. Chang and J.R. Smith, “VisualSEEk: A Fully Automated Content-Based Image Query System.” *http://www.ctr.columbia.edu/visualseek/* (1996).

[4] A.Gupta, S.Santini, and R. Jain, "In search of Information in Visual Media", *Communications of the ACM*, v.40 n.12 ACM Publications, New York, USA, (1997).

[5] IBM Corporation Almaden Research Center, “Query By Image Content.” *http://wqbic/almaden/ibm/com/~qbic* (1998).

[6] R. Jain and A.Gupta, "Visual Information Retrieval", *Communications of the ACM*, v.40 n.5 ACM Publications, New York, USA, (1997).

[7] V. Ogle and M. Stonebraker, “Chabot: Retrieval From A Relational Database of Images.” *http://elib.cs.berkeley.edu/~ginger/chabot/html* (1995).

[8] "Visual Information Retrieval Image Engine" *htttp://www.virage.com/static/products.image-vir.html* (1999).

Appendix A

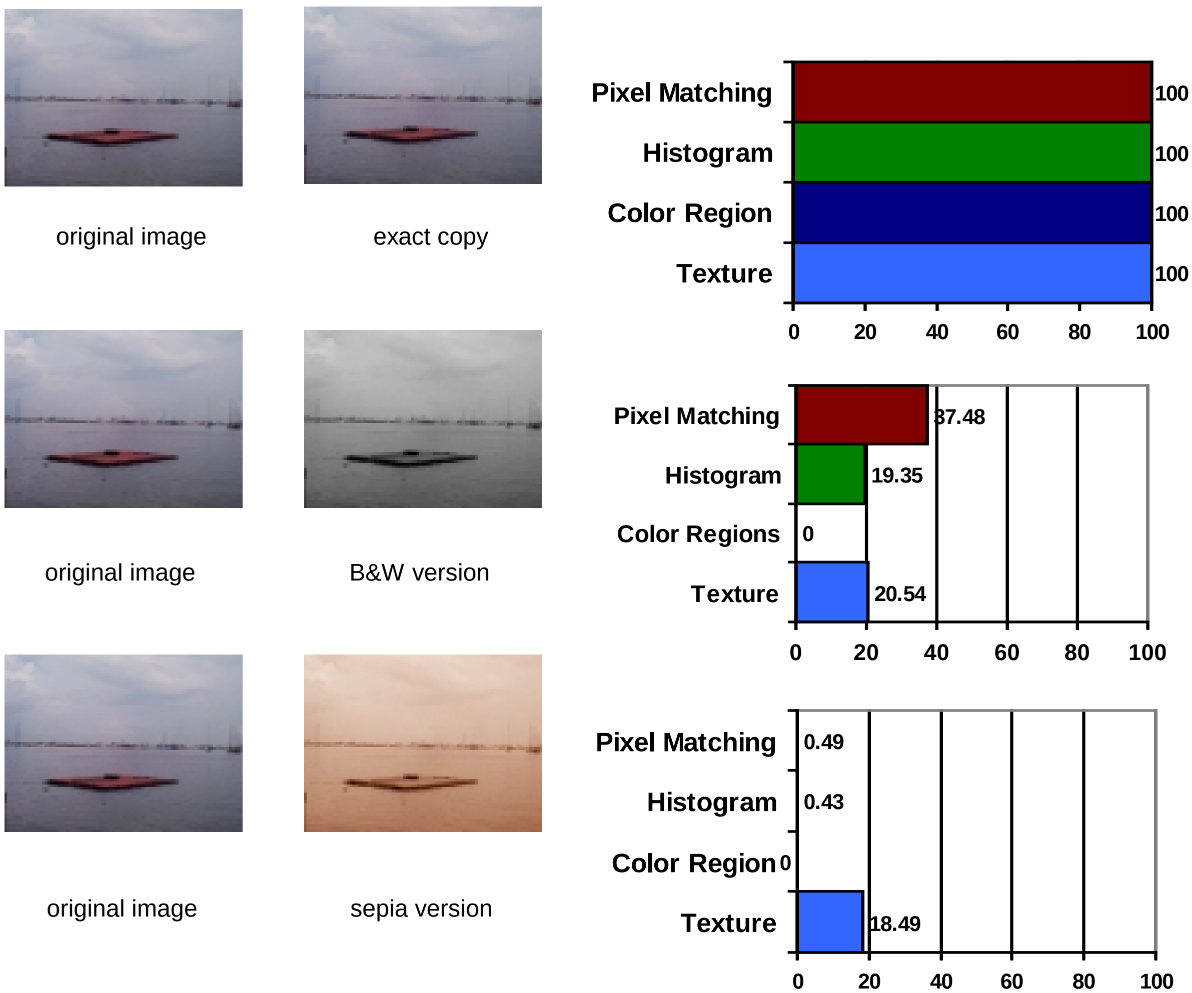

Figure A-1. Black and White Test

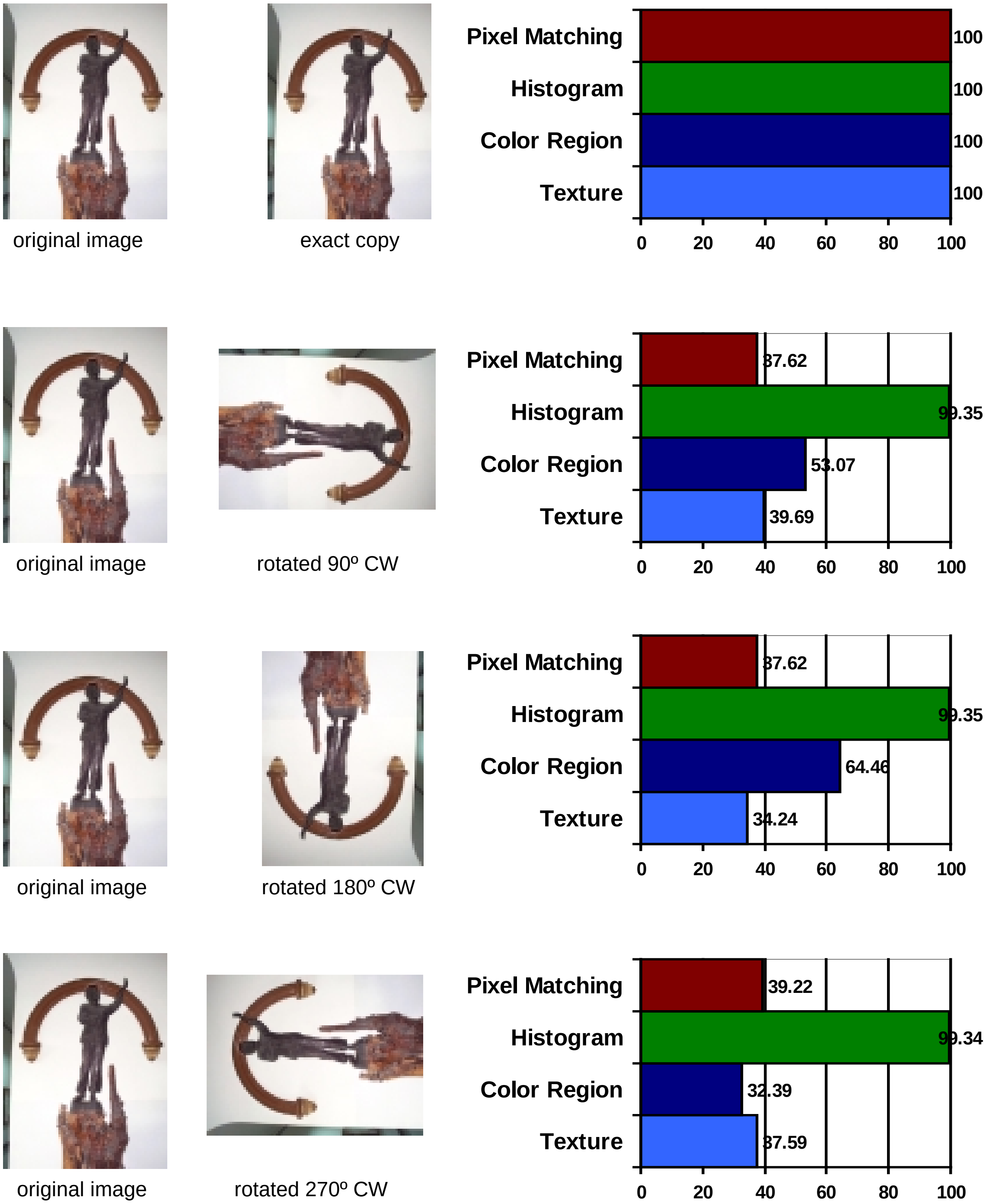

Figure A-2. Rotation Test

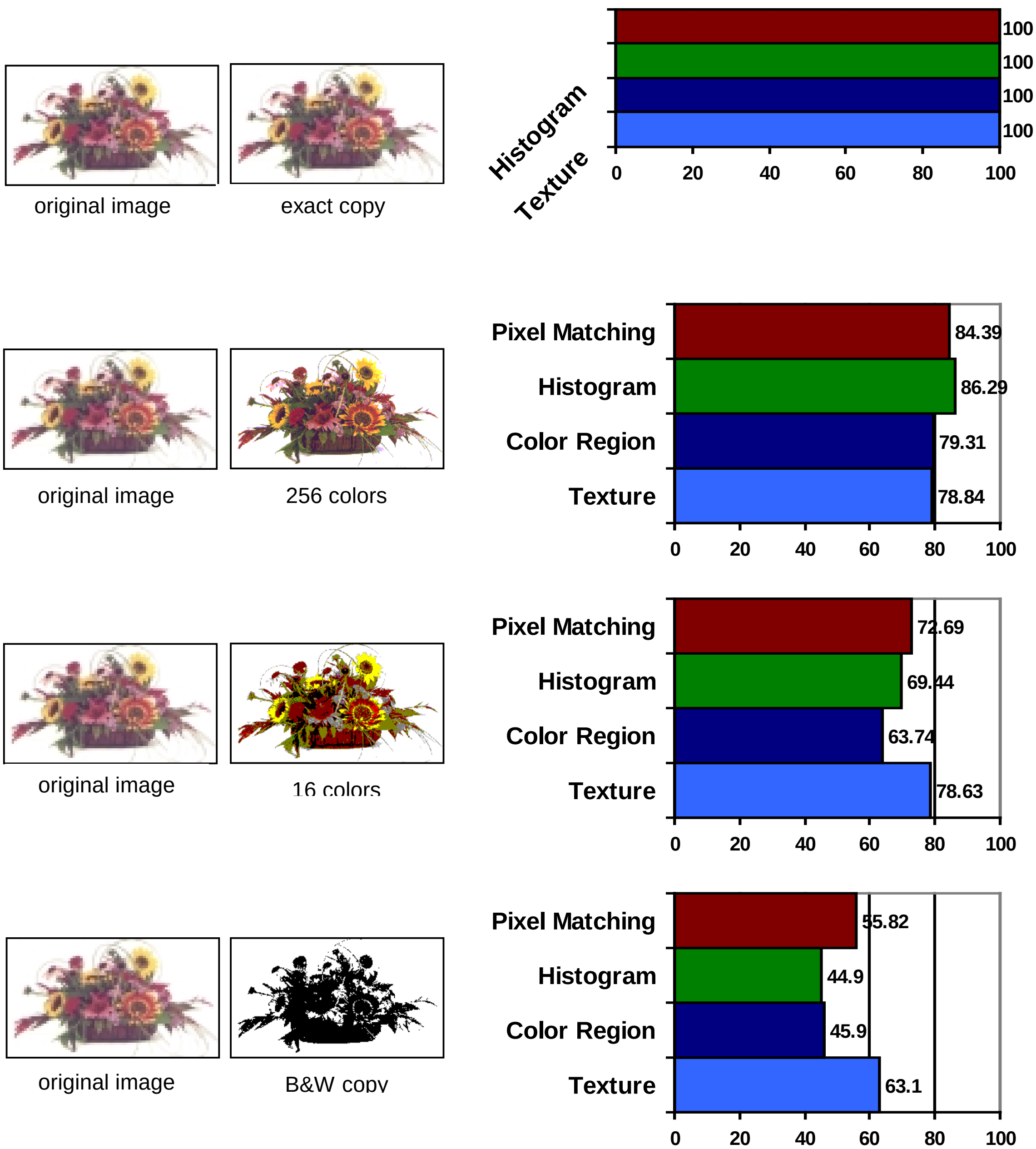

Figure A-3. Color Resolution Test

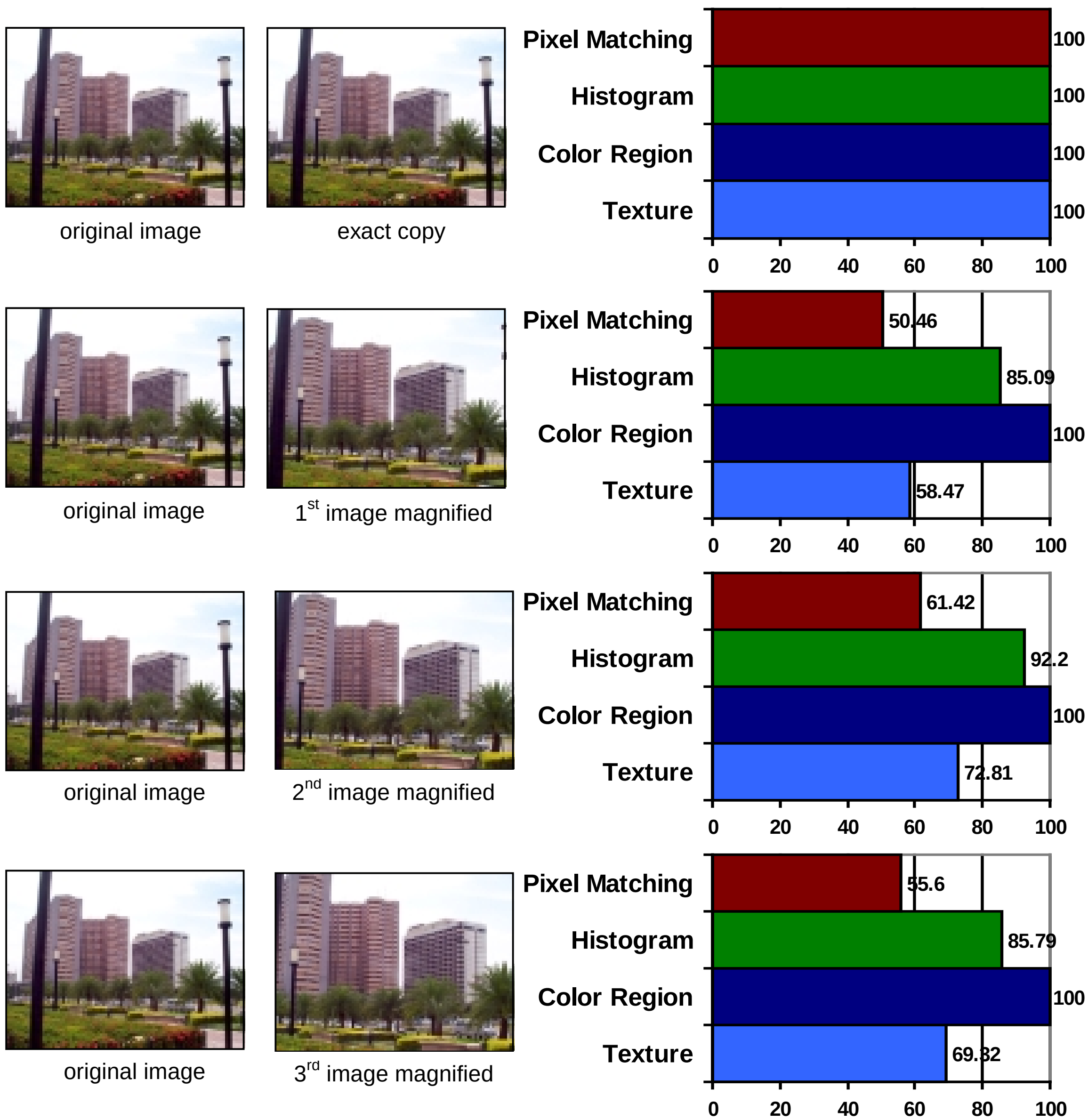

Figure A-4. Zooming Test

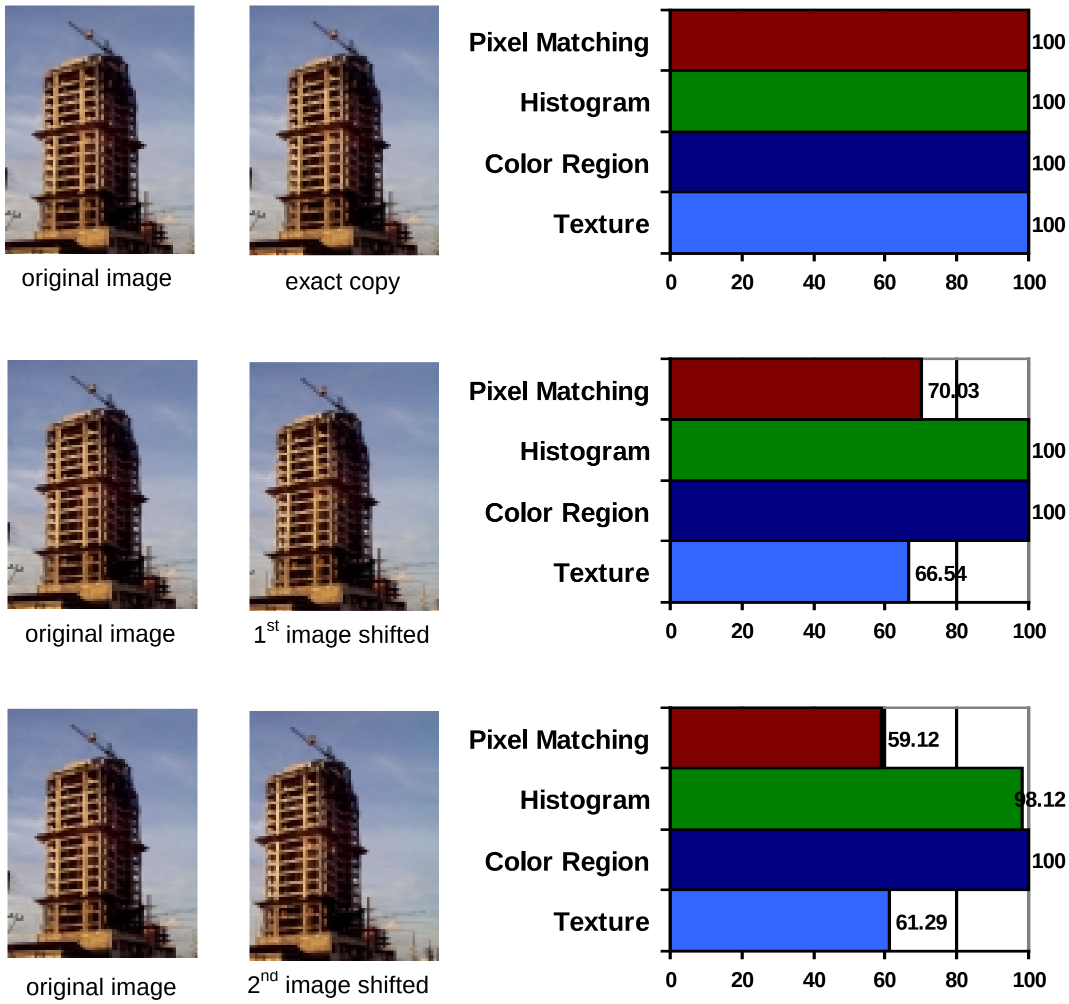

Figure A-5. Shifting Test

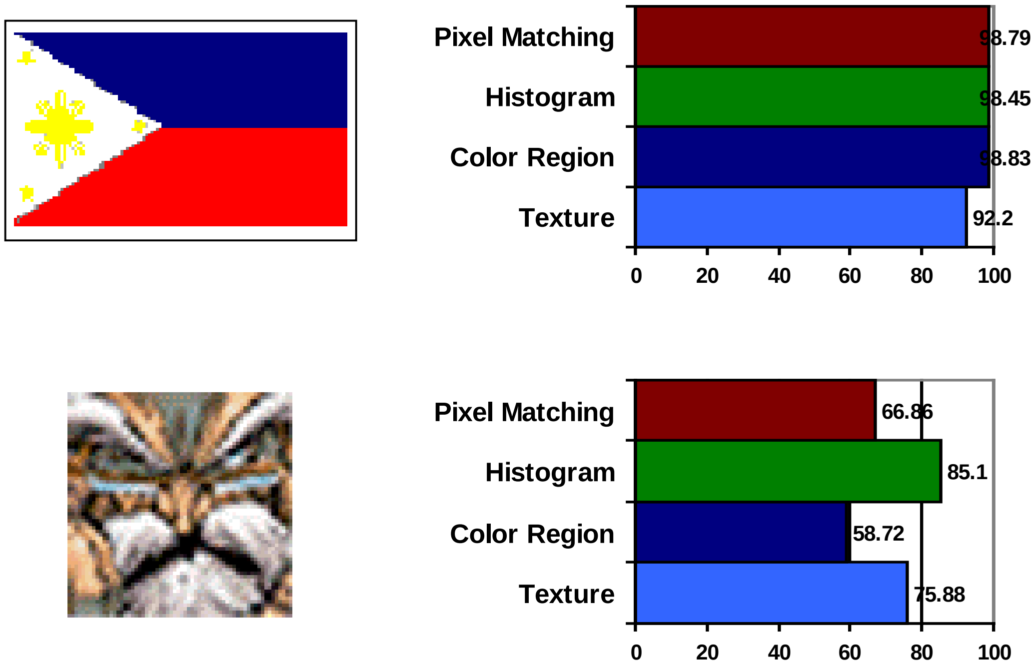

Figure A-6. Scaling Test

Appendix B. Personal Vitae

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