and a target (T) image, respectively. Let (h_{qi}, s_{qi}) be the dominant hue-saturation pair for the selected block in the query image. Let (h_{ti}, s_{ti}) represent the same in the target image. The block-level similarity is then defined by the following relationship:

$$S(q_i, t_i) = \frac{1}{(1 + (aD_h(h_{qi}, h_{ti}) + bD_s(s_{qi}, s_{ti})))}$$

Here D_h and D_s represent the functions that measure similarity in hue and saturation, respectively. The quantities a and b in above expression stand for two constants that define the relative importance of hue and saturation components in similarity calculation. Since human perception is more sensitive to hue, Color-WISE uses a higher value for a than b. For function D_h, the following function is used in Color-WISE:

$$D_h(h_{qi}, h_{ti}) = \frac{1 - \cos^k(\|h_{qi} - h_{ti}\| * \frac{2\pi}{256})}{2}$$

This function explicitly takes into account the fact that hue is measured as an angle. Through empirical evaluations, we have determined k equals to two provides a good nonlinearity in the similarity measure to approximate subjective judgement of hue similarity. The saturation similarity is measured by the following function:

$$D_s(s_{qi}, s_{ti}) = \frac{\|s_{qi} - s_{ti}\|}{256}$$

Using the similarities between the corresponding pairs of blocks from the query and target images, the similarity between a query-target image pair is computed by the following expression:

$$S(Q,T) = \frac{\sum_{i=1}^{M*N} b_i S(q_i, t_i)}{\sum_{i=1}^{M*N} b_i}$$

The quantity b_i in the above expression represents the masking bit for block i; when it is zero, block i is not included in similarity calculation. This is done for partial-image queries to search for images with specific color content at some image position regardless of color content in rest of the image, for example image with red color in the middle.

3. PERFORMANCE EVALUATION

Color-WISE is implemented using Microsoft Access and Visual Basic. At present, it has 2100 images in its database. Each image is partitioned into 8*8 blocks. This gives rise to 64 hue and 64 saturation values per image. Figure 6 shows an example of image retrieval using full-image query.

To see how well Color-WISE compares with some other approaches, a performance evaluation study that was carried out. In this study, three schemes were studied. These are: (1) global color histogramming, (2) local color histogramming, (3) Color-WISE. Since the focus of the study was to compare the relative merits of the three representation approaches, similar images were searched using the brute-force search. To minimize the search time, the study was carried out using a subset of 200 images of the 2100 images present in our database. For global histogramming, global hue and saturation histograms for each image