

# Transferring to Grayscale Images Using Luminance Mapping and Pseudo-Colorizing Techniques

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## Abstract

In this paper, we developed an effective algorithm of colorizing a grayscale video sequence. There are two phrase to achieve the goal; one is we use transferring colorizing technique to give the background scenes colorizing. Another is the paseudo-colorizing technique be used for object colorizing. In our approach, a reference scene, a block-based Vector Quantization of Luminance Mapping (VQLM) technique, and transferring colorizing (TC) technique are used to colorizing the background scenes automatically. Where, the reference scenes offer the color samples and the VQLM used for color comparison and titling. Furthermore, the transferring techniques decompose the color image from RGB planes to  $\ell\alpha\beta$  because the  $\ell\alpha\beta$  planes with less correlations of colors. For the object colorizing, we pre-select several colors associate with the pseudo-colorizing (PC) easily to colorize the human hair, skin, cloth, and pants, respectively. Compared to other colorizing schemes, our proposed method has two advantages: 1) The VQLM and TC techniques perfectly colorize the background scenes automatically; 2) The PC and image processing techniques effective colorize the object image.

To explore the utility, simulations under various input images were conducted. The experiment results showed that our proposed algorithm can colorize the desired scenes.

**Keywords:** transferring colorizing, pseudo-colorizing, vector quantization of luminance mapping, color decomposition.

## 1. Introduction

In order to improve the visual appeal of grayscale images such as old black and white photos, classic movies or scientific illustrations, the colorizing techniques are be used to achieve the goal. Beside, the information of some images can be perceptually enhanced with color by exploiting variations in chromaticity as well as luminance. The task of “colorizing” a grayscale image is assigning

three-plane (RGB) pixel values to an image which varies according to only one dimension; grayscale. Since different colors may have the same luminance value but vary in hue or saturation, thus, colorizing grayscale images has no inherently “correct” solution. Due to these problems, human algorithm usually plays a large role in the colorization process. In the case of pseudo-coloring, Gonzalez and Wintz [1] the mapping of luminance values to color values is automatic. Owing to most colorization software used in the movie industry is proprietary, details of describing the process are generally not publicly available. However, one software package is described in which the image is first polygonalized so the user can color individual components like a coloring book. Then the system tracks polygons between frames and transfers colors to reduce the number of frames that the user must color manually [2]. There are exist a number of applications for the use of color in information visualization. For example, Gonzalez and Wintz [1] describe an approach for pseudo-coloring grayscale images of luggage acquired by X-ray equipment at an airport. In medicine, image modalities which acquire grayscale images such Magnetic Resonance Imaging (MRI), X-ray and Computerized Tomography (CT) images can be improved with color for presentations and demonstrations. Pseudo-coloring is a general technique for adding color to grayscale images such as X-ray, MRI, scanning electron microscopy (SEM) and other imaging modalities where its color does not exist. Pratt [3] classifies this method as an “image enhancement” technique owing to it can be used to “enhance the detectability of detail within the image.” In its basic form, pseudo-coloring is a transformation [Pitas 1993], such that, where is the original grayscale image and is the resulting colored for the three RGB color components. For example, the application of an arbitrary color map to the data where a single, global color vector is assigned to each grayscale value. The strength of this approach is that it does not alter the information content of the original data because no extra information is introduced. However, by color-mapping which does not increase monotonically in luminance,

pseudo-colored images may introduce perceptual distortions. Studies have found a strong correlation of the perceived “naturalness” of face images and the degree that the luminance increases monotonically in the color-mapping [4]. Others paper about of the colorizing can in find in [5-8].

In this paper, we concept of transferring color from one image to another is inspired by work by Reinhard et al. [9] in which color is transferred between two color images. We divided image into two part; background image and object image. In background image part, a reference colors image used as a source image is transferred to a background image using a simple procedure. The basic method matches the luminance distribution of grayscale values between the images and then transforms the color distribution of the target image to match the distribution of the source image. On the object image part, a pseudo-colorizing and image processing techniques used to colorize the object. The remainder of this paper is organized as follows: Section 2 presents the Colorizing algorithm (CA). Empirical results is describing in the Section 3. Finally, Section 4 conclusions this paper.

This paper proposed a way to construct the grayscale sequence colorized. Fig.1 shows the flow chart of our algorithm. At the beginning of the process, the R, G, and B planes of a reference color image were transferred by  $RGB$  to  $l\alpha\beta$  mapping from RGB planes into  $l\alpha\beta$  planes denote  $l_c$   $\alpha_c$   $\beta_c$ , respectively. The  $l_c$  is used for luminance comparison while grayscale image colorizing. The  $\alpha_c$  and  $\beta_c$  are used for chrominance padding. On the other hand, a grayscale image is separated two parts; background and object for colorizing. In colorizing background image, a vector quantization of luminance mapping technique (VQLM) is used to search a good match color for padding the  $\alpha_G$  and  $\beta_G$  from  $\alpha_c$   $\beta_c$ . After VQLM, a reverse color mapping  $l\alpha\beta$  to  $RGB$  completed the background image colorizing. Simultaneously, a pseudo-colorizing technique used to colorize the object image. Finally, combining the background image and object image parts, a grayscale sequence colorizing is achieved. The details of the algorithm were described in the following.

## 2 Colorizing algorithm (CA)

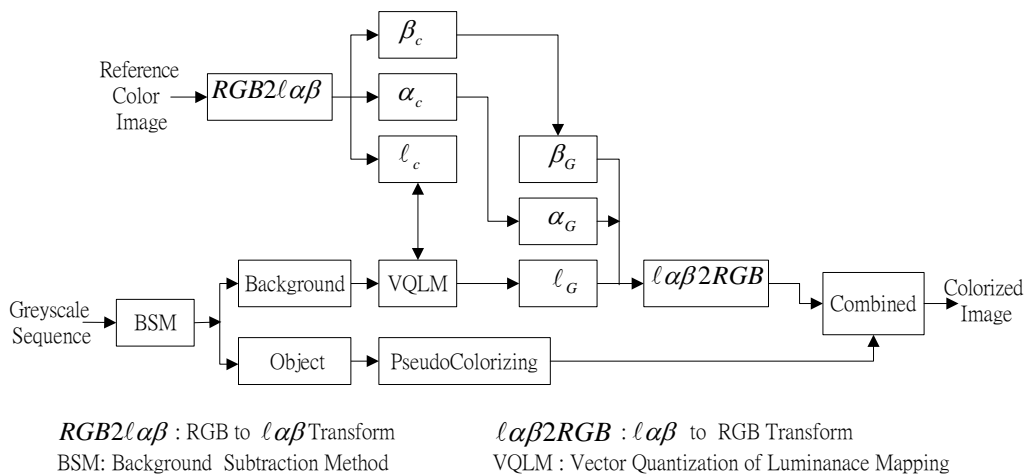


Fig. 1 the flow chart of the Colorizing algorithm

### 2.1 Background Subtraction Method

Fig. 2 shows the flow chart of image processing for obtaining a grayscale image of moving objects with background removed. The background averaging procedure is used to obtain a background image by averaging exceed 50 pictures of moving objects having same background. Background subtraction is a popular and effective method for detecting moving foreground objects in the scene.

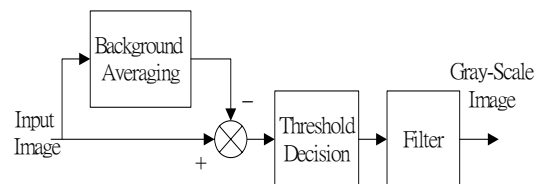


Fig. 2 The flow chart of background removal

## 2.2 Object Detection

To distinguish an object in the image is core work of the algorithm. Fig. 3 shows the flow chart of the object detection in the paper. At the beginning, the mean filter is used to blur the image and pad the edge area. In this paper, we use threshold value 0.7 to re-decide the pixel is high or low after mean filter operation. Fig. 4 shows the mean filter mask. Next, a closing operation use to connect the two parts that separated causing by noise. Finally, a small area discard step use to throw those objects which is not be a face image because its area is so small. In our scheme, we use the value 3600 as a criterion to discard those small object images. Fig. 5 shows the images of the object detection processing, where Fig. 5(a) is the original input binary image, Fig. 5(b) denotes the image after mean filter, Fig. 5(c) is the image after closing operation, and Fig. 5(d) shows the image after small area discard. From the Fig. 5, we see the objects are detected clearly and correctly.

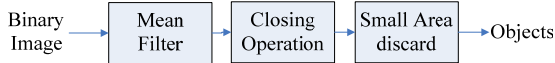


Fig. 3 The flow chart of object detection

$$\frac{1}{16} \times \begin{array}{|c|c|c|} \hline 1 & 2 & 1 \\ \hline 2 & 4 & 2 \\ \hline 1 & 2 & 1 \\ \hline \end{array}$$

Fig. 4 The mean filter mask

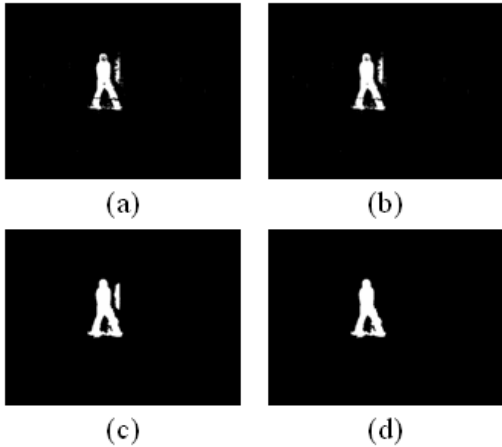


Fig. 5 The images under object detection processing, (a) the original input binary image, (b) the image after mean filter, (c) the image after closing operation, (d) the image after small area discard.

## 2.3 Pseudo-Colorizing for Object Image

How to colorize the object of a grayscale image? The pseudo colorizing technique is a suitable method. In our approach, we select four colors for colorizing the human object's hair, skin, cloth, and pants as the Fig. 6 shown, respectively. Due to we confined the object is a man, thus we can easily to classify the object into hair, skin, cloth, and pants by using location judgment. At the beginning, we using the location judgment to obtain the hair part because the hair must be located on the top region of the object. Next, according to the face is neighboring to the hair and is a major part of the head, so that a major check method can exactly extract the face from head image. In fact, the face color can be defined as the skin color. Successively, we consider the same luminance with the face which is located at end of the object as the skin like hand. Finally, we divided other part into two classes, one is cloth and other is pants. The pseudo-colorizing and palette mapping is shown in Fig. 6.



Fig. 6 The pseudo-colorizing and palette mapping

## 3 Experiment results

Several test sequences with size  $(640 \times 480)$  were used in simulation for demonstrating the performance of the proposed scheme. In experiment, a reference color image used to colorize the background part of grayscale image by using block-based vector quantization of luminance mapping. A background subtraction method used to extract the object image from video sequence.

In order to give a detailed description of the simulation results, several figures (Fig. 7 – Fig. 11) were used to express the processing steps of our algorithm. The Fig. 7 is a resultant image, in Fig. 7(a) is a grayscale image, it is one of series video frames, and Fig. 7(b) is the background image which is generated by background subtraction method from video sequence. Fig. 7(c) shows the background image without the object image included. Fig. 7(d) shows the object image which is generated by current scenes subtract the background. Fig. 7(e) is the reference color image, it is used to offer the color reference

when the colorizing. Fig. 7(f) shows the colorized background image, which is after colorized using color transferring techniques. Fig. 7(g) is the object image which is colorized by pseudo-colorizing. Fig. 7(h) shows the overall image that combined with the colorizing background image and object image. Finally the Fig. 7(i) is the colors of the palette while pseudo-colorizing operation.

In addition, we compare the different reference color image and different colors of the palette for the same image and show the results in the Fig. 8 and Fig. 9. According experimental result, we see the colors of

the target image are all following by the reference color image and on the color transferring color mapping rules.

On the other hand, we compare the object image between the Fig. 8 and Fig. 10 for demonstrating the performance of the proposed scheme. In Fig. 8, we select the colors; brown, black, pink, and gray, for object colorizing. In other case, Fig. 10 shows the colorized result using yellow, brown, red, and pink as a palette. From above situation, can approve our scheme is an effective algorithm for grayscale colorizing.

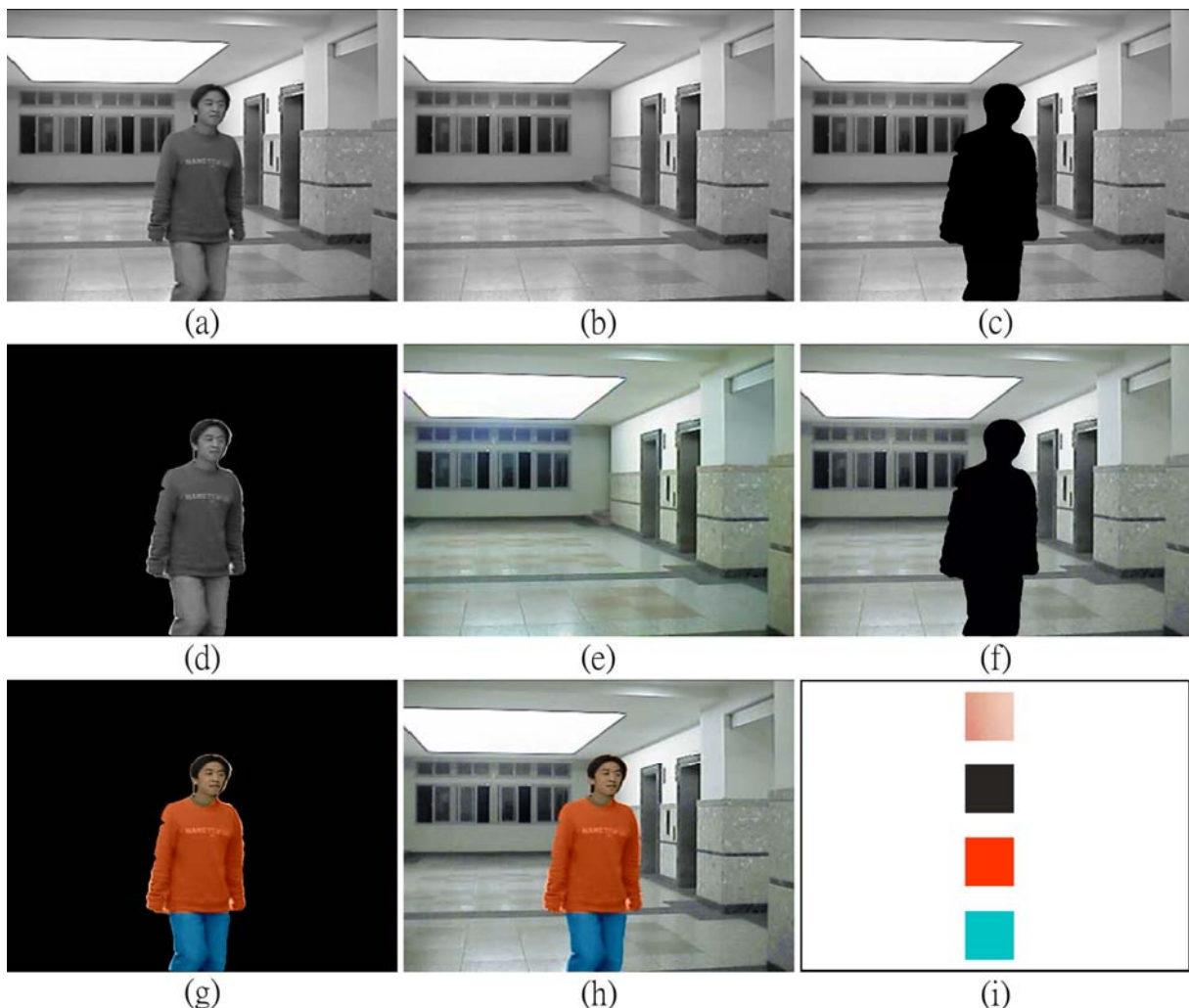


Fig. 7 the processing steps of our algorithm; (a) a grayscale image, (b) the background image, (c) the background image without the object image included, (d) the object image, (e) the reference color image, (f) the colorized background image, (g) the object image which is colorized by pseudo-colorizing, (h) the overall image that combined with the colorizing background image and object image, (i) the colors of the palette while pseudo-colorizing operation.

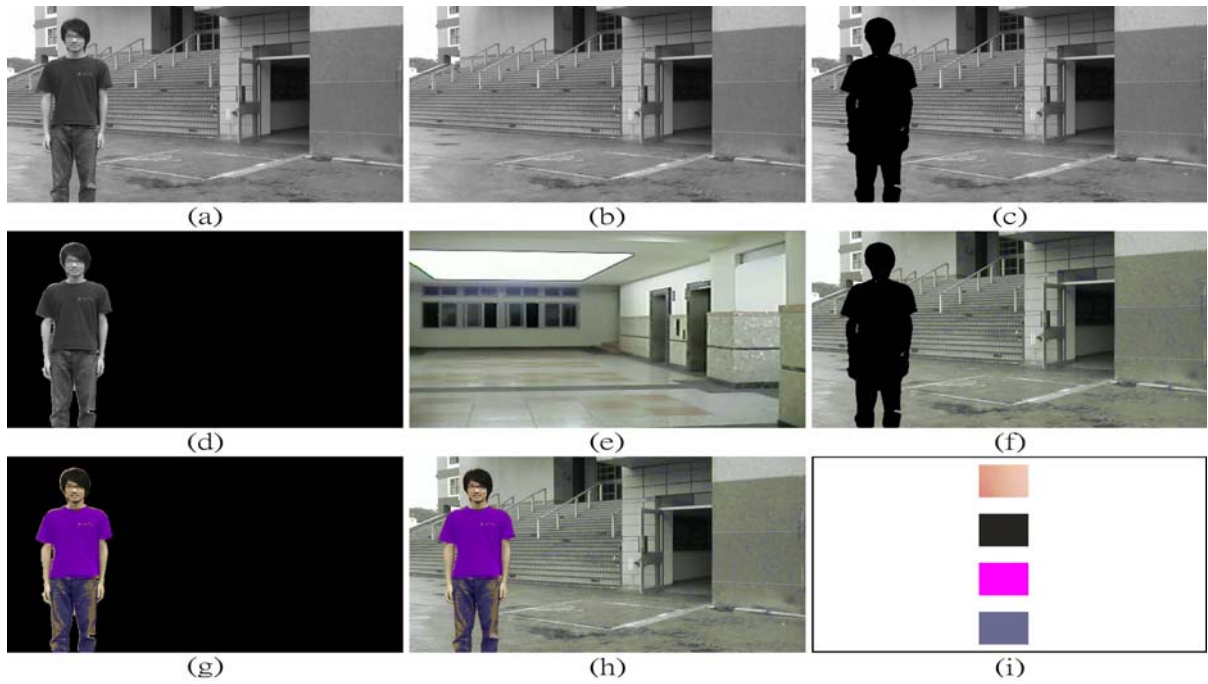


Fig. 8 the processing steps of our algorithm; (a) a grayscale image, (b) the background image, (c) the background image without the object image included, (d) the object image, (e) the reference color image, (f) the colorized background image, (g) the object image which is colorized by pseudo-colorizing, (h) the overall image that combined with the colorizing background image and object image, (i) the colors of the palette while pseudo-coloring operation.

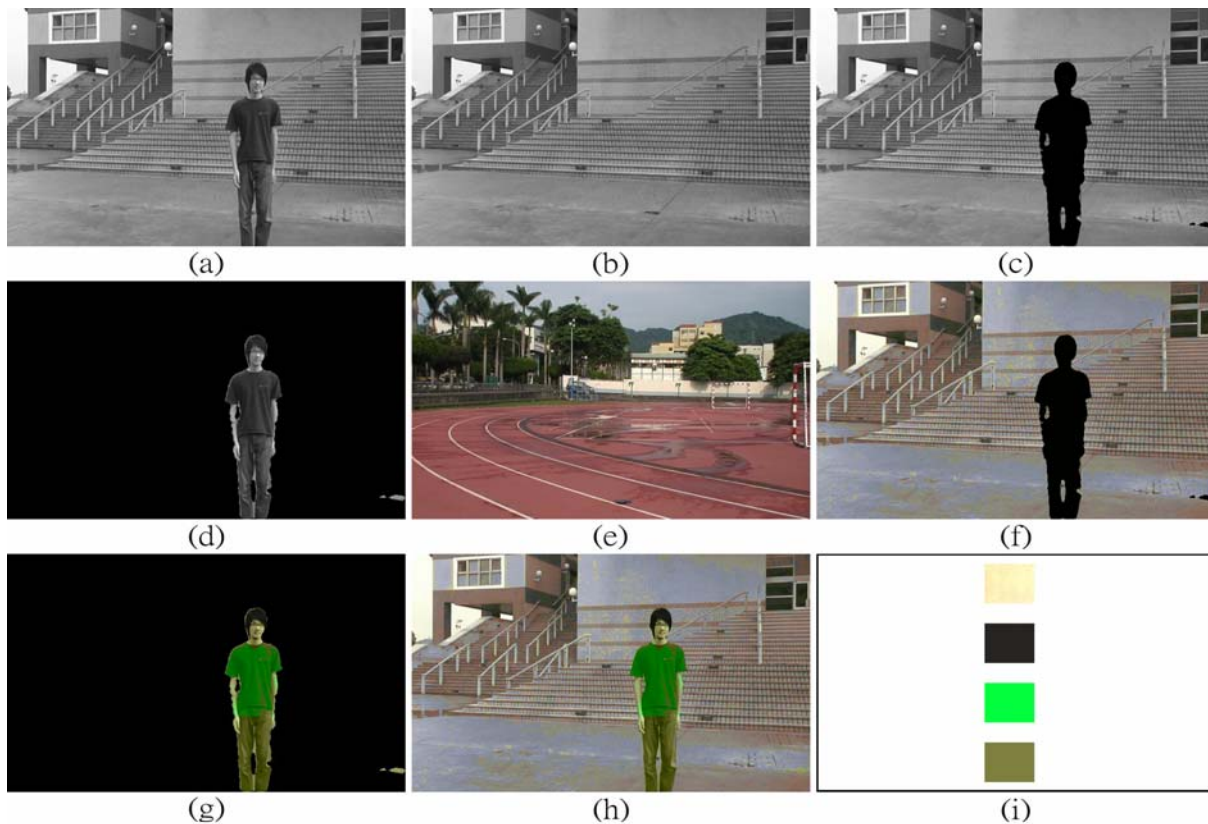


Fig. 9 the processing steps of our algorithm; (a) a grayscale image, (b) the background image, (c) the background image without the object image included, (d) the object image, (e) the reference color image, (f) the colorized background image, (g) the object image which is colorized by pseudo-colorizing, (h) the overall image that combined with the colorizing background image and object image, (i) the colors of the palette while pseudo-coloring operation.

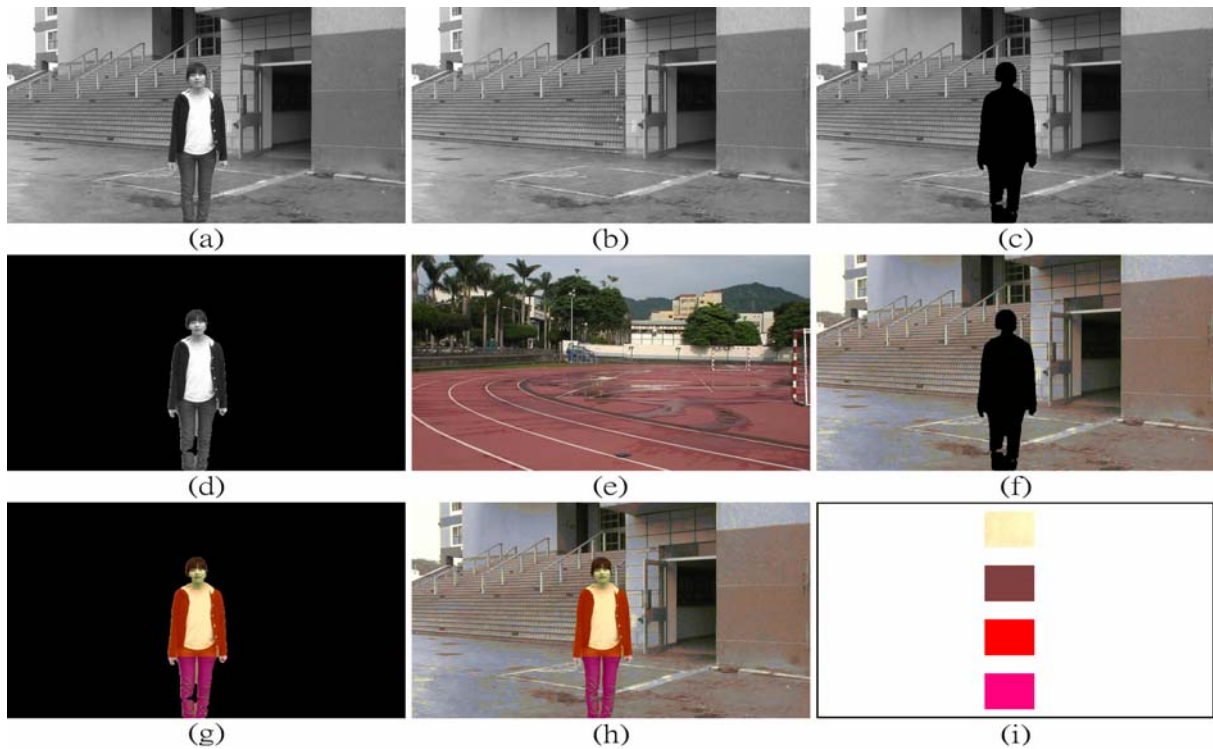


Fig. 10 the processing steps of our algorithm; (a) a grayscale image, (b) the background image, (c) the background image without the object image included, (d) the object image, (e) the reference color image, (f) the colorized background image, (g) the object image which is colorized by pseudo-colorizing, (h) the overall image that combined with the colorizing background image and object image, (i) the colors of the palette while pseudo-coloring operation.

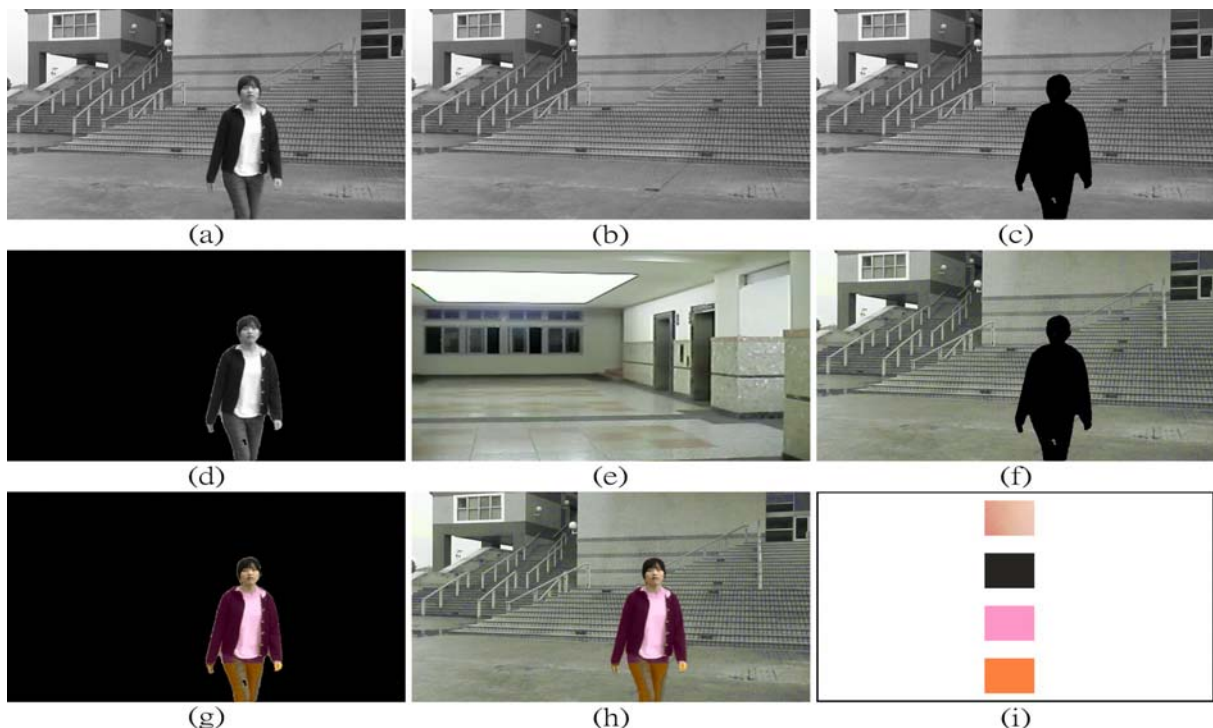


Fig. 11 the processing steps of our algorithm; (a) a grayscale image, (b) the background image, (c) the background image without the object image included, (d) the object image, (e) the reference color image, (f) the colorized background image, (g) the object image which is colorized by pseudo-colorizing, (h) the overall image that combined with the colorizing background image and object image, (i) the colors of the palette while pseudo-coloring operation.

#### 4. Conclusion

The transferring techniques decompose the color image from RGB planes to  $\ell\alpha\beta$  because the  $\ell\alpha\beta$  planes with less correlations of colors. In this paper, a block-based Vector Quantization of Luminance Mapping (VQLM) method is used to generate a codebook of reference color image. And then a transferring colorizing (TC) and VQLM methods are used to colorizing the background scenes automatically. In colorizing step, a grayscale sequence is divided into two part, a background part and object image part. For background part colorizing, we use VQLM to search the nearest block in codebook which is generated by reference color image. After the index is obtained, the corresponding blocks the  $\alpha_G$  and the  $\beta_G$  replenished from the  $\alpha_c$  and the  $\beta_c$ . Repeat this procedure, finally, the background image is colorized. For the object colorizing, we pre-select several colors serves as palette associate with the pseudo-colorizing (PC) can easily to colorize the human hair, skin, cloth, and pants, respectively. Compared to other colorizing schemes, our proposed method has two advantages: 1) The VQLM and TC techniques perfectly colorize the background scenes automatically; 2) The PC associated with several pre-selected colors can effective colorizes the object image;

To explore the utility, simulations under various input images were conducted. The experiment results showed that our proposed algorithm can colorize the desired scenes.

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