CHAPTER VI

CONCLUSIONS

BW2COLOR, a software to compose color images by using a b/w image input device, was developed in this research and based on a number of color image theories, such as additive color system, color models, and color image processing techniques. The software composes output color images by importing source color images through a b/w image input device applied with RGB cellophane filters and calibrated with a calibration card of four gray bands. Color images can also be generated from original gray scale images by using a heuristic approach to pseudo coloring. A gray-level-to-color transformation technique designed in this research aims to maintain continuity and perceived brightness of colors on the output color images.

There are two types of the LUT's designed in this research, fixed LUT and unfixed LUT. The fixed LUT was constructed by quantizing possiible colors into a number of interval. To construct an unfixed 256-color LUT, a temporary fixed LUT of more than 256 colors was constructed first. Then the 256 colors which were most frequently used in the temporary image were stored into the final LUT. A temporary fixed LUT of 4,096 colors was considered acceptable as a larger number of colors consumed a longer execution time and needed more memory.

A measurement scheme of color image quality was designed and a tool to measure color distortion was also developed and used in this research. Color distortion was tested by normalized mean error (NME) on the magnitude of **RGB** difference vectors. For the unfixed LUT, the average color distortion was 20.86% when a calibration card with four gray bands and a set of RGB cellophane filters were applied. For the fixed LUT, the average color distortion was 22.42%. Though the composed images with fixed LUT's have only slightly

greater NME's, the transitions or contours between colors are much more conspicuous to viewers. Thus, the unfixed LUT should be selected for application.

The color distortion partly resulted from color approximation in using an LUT of 256 colors instead of all 16,777,216 (or 16 M) colors. It was caused mainly by the imperfection of the color filters, and if, in the future, better color filters can be acquired, such distortion will then be reduced. In an experiment, when the light red cellophane filter was used instead of the red cellophane filter, the average color distortion increased from 20.86% to 27.25%. The result of the experiment suggested that using a worse filter can yield a significantly worse color quality. Some errors was also caused by wrinkles on the cellophane filters. In addition, some might be caused by the limitation in the contrast calculation of the image input software, as described earlier in Chapter III.

On capturing each gray scale image of the source color picture, the automatic exposure feature of the image input device, if available, should be used. The exposure set via the automatic exposure feature is the best exposure for a particular image so that the information on the image obtained will be most manifest. However, if the automatic exposure feature is not available, the exposure should be adjusted to a proper setting of brightness and contrast that makes use of gray level range to highly efficient while maintaining highlights and shadows of the source picture.

Apart from composing color images and pseudo coloring, the BW2COLOR software also serves as a brightness and contrast adjustment and image viewer tool for 256 color PCX image files.

Suggestions for Further Development

Another approach of filter characteristic detection to recognize the effect of other primary colors which can pass through a filter is to use a color calibration card composed of a pile of known color bands. There should be some marks on the calibration card to allow the software to detect the position of each band on an image of the calibration card, and the

software to detect the position of each color band should be developed. Such color calibration card will help solving the impurity problem of the color filters in use. However, a color calibration card is so specific that the software will lose its portability. Furthermore, the detection of the color band positions require a large number of calculations which will cause the filter characteristic detection process to consume a longer execution time. Thus, if a set of filters with acceptable quality, as cellophane, can be acquired, and the effect of other primary colors which can pass through a primary color filter can be ignored, the color calibration card approach will not be necessary.

The user interface of the software may be improved by applying Graphical User Interface (GUI). The software can also be further extended to support more image file formats, such as GIF, TIFF, BMP, or even compressed formats, like JPEG, MPEG, to result in more portability.