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OURE RESEARCH REPORT

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ABSTRACT

The dermvis research group at the University of Missouri-Rolla is seeking to identify melanoma automatically. They now have reported up to 90% diagnostic accuracy for malignant melanoma (1) and recently obtained about 93% correct melanoma identification, the highest obtained by research groups in North America. The goals of the OURE project described here were threefold:

1. Digitize images from existing photographic slides of dermoscopy images taken with the Heine Dermaphot unit.

2. Digitize images from patients with malignant melanoma or benign lesions in the infrared region using a new camera with hot mirror removed.

3. Determine microprocessor serial cable codes for the Nikon Coolpix 950 camera so serial images may be taken from the camera, both visible and infrared.

Results and sample images from the two kinds of image acquisition are presented along with the microprocessor serial cable codes.

BACKGROUND

Malignant melanomas cause the majority of deaths from skin cancer, approximately 7,000 per year in the United States in 2004. Image processing can yield information on structures within the lesions. There are two types of digital images used for malignancy detection. Clinical images were the usual images until the mid-1990s, with good quality images taken at approximately 1:1 magnification, sometimes using a dual flash system.

In the past decade, dermoscopy images have become the standard imaging system for pigmented lesions. Taken with a flash unit at 10:1 magnification with a liquid interface of alcohol or mineral oil, dermoscopy images provide more detail than the clinical images. In addition, the interface and epiluminescent lamination can eliminate the contribution from the skin surface, making deeper structures more apparent.

Digitization of dermoscopy images is necessary for automatic processing of the images. Digital dermoscopy images may be acquired by either direct digitization in the clinic or by digitizing photographic slides. In this project, photographic slides were digitized by the Poaroid Sprintscan 35 Plus slide digitizer.

The second goal was to digitize images in the infrared region and obtain in vivo infrared spectra from patients using a new infrared camera developed by the group and a FieldSpec Pro infrared spectrometer. In this way, both detailed images within the infrared region and the spectrum itself could be obtained for further study. When enough spectra are acquired, they will be analyzed to determine the optimum wavelengths for melanoma discrimination. Groups in the UK and in New York (2,3) are obtaining infrared spectral images, but to our knowledge, no other groups are using an open, non-dedicated camera system, none are analyzing images for specific structures, and none are obtaining spectra.

METHODS

1. Sixty digital clinical and dermoscopy images were digitized using the Poaroid Sprintscan 35 Plus slide digitizer. Care was taken to use the appropriate resolution and remove casts when detected. In addition, the EDRA pigmented lesion disk, EDRA Medical Publishing, Milan, was the source of images for selection of specific white and blue areas.

2. Seven patients were studied using a Nikon 950 Coolpix camera modified by removing the hot mirror as shown in Figure 1. From each patient, spectra were obtained using the ASD FieldSpec Pro. A representative melanoma image from the visible and infrared regions are shown in Figures 2 and 3.

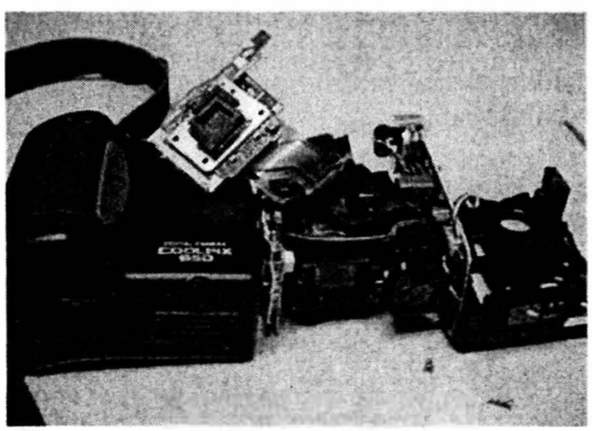

Fig. 1. Nikon 950 Coolpix disassembled, hot mirror removed.

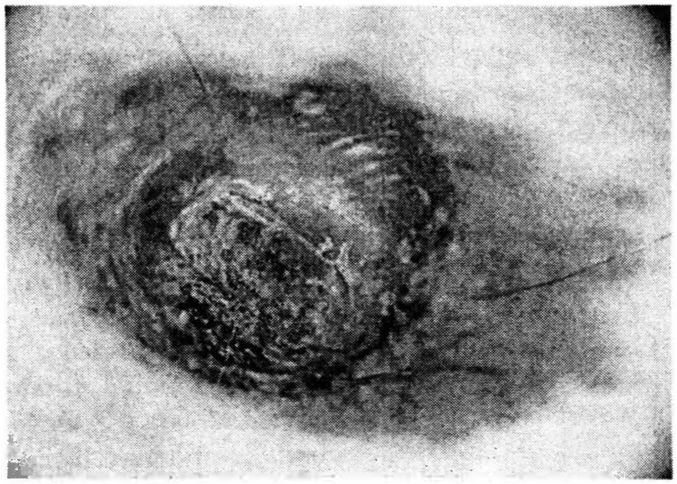

Fig. 2. Malignant melanoma visible-light image.

Fig. 3. Same patient, infrared image.

3. The method used to establish communication with the camera was a Simon Board. The Simon Board is a single board computer based on the P89LPC932 processor from Philips. The original purpose for this single board computer was to play the electronic game Simon. A Simon Board is shown in Figure 4.

In order to establish communication, open source software called "pcphoto" was found on the internet. This software was loaded on the computer and was then compiled. After compilation the software was ready to be used.

Once the software was installed a serial cable was connected from the computer to the camera and certain commands were given to the camera. These included, "take a picture", "set the date and time" of each picture, "copy the picture" from the camera to the computer, "delete" the unwanted pictures etc. Once this was done, it was now time to somehow learn what sequence of data was making the camera do the desired operations. In order to do that, a specially modified serial cable was made in the lab, with pin outs for the logic analyzer. The cable has serial pin connectors on each end and in the middle a special connector was added which was hooked up to the logic analyzer. This new serial cable was then connected to the camera and the logic analyzer and the command for taking a picture was given which generated a set of data. This data was captured by the logic analyzer. It was not clear what one was to expect but after constantly changing the settings on the logic analyzer like periods, time intervals, length of the data sequence etc. A set of data emerged which after some investigation looked right.

The next step was to take this data and write a program where instead of a PC, a Simon board could send this sequence of data and establish communication with the camera. This data sequence basically is a set of singly binary digits which are then converted to hexadecimal numbers for programming and these hexadecimal numbers are then sent to the camera. This data is by no means structured specifically for the Nikon Coolpix 950 camera but for any camera which uses the Fujitsu chipset.

The microcontroller was programmed using assembly language. Before programming the microcontroller a flow chart was made (see Figure 3) to better understand the logical progression of how the program should be written. The program sends a hexadecimal 00 to wake the camera up, and then wait till it receives a hexadecimal 15 at which time it lights the yellow LED on the board indicating that it has received a signal from the camera. The yellow LED is just one of four available LED's on the Simon board and it was chosen randomly. It is then ready to send the data sequence which is a long list of data to the camera, and once that is sent, it again waits for a reply from the camera which in this case is a hexadecimal 06. Once that is received it lights the Green LED indicating that the communication has been established and we are ready to go forward with next phase which is to take a picture. To make the Simon board take a picture was beyond the scope of this project. But what this project has done is to establish a way one can use the Simon board to accomplish the ultimate goal of creating a stand-alone system which can be used to control the camera and the Dermlite lens module which contains different sets of LED's.

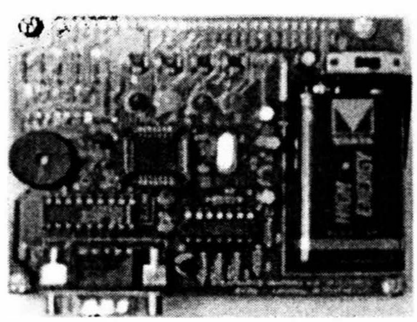

Figure 4: Simon Board

RESULTS

Images were made available to the group and analysis is pending. One promising feature was the combination of white and blue. Digital images were analyzed and white and blue areas were outlined using Paint Shop Pro. Filemaker was used in making the EDRA disk and store the images, but images with melanoma features and catalogued images had to be matched by hand because no direct image access method was possible.

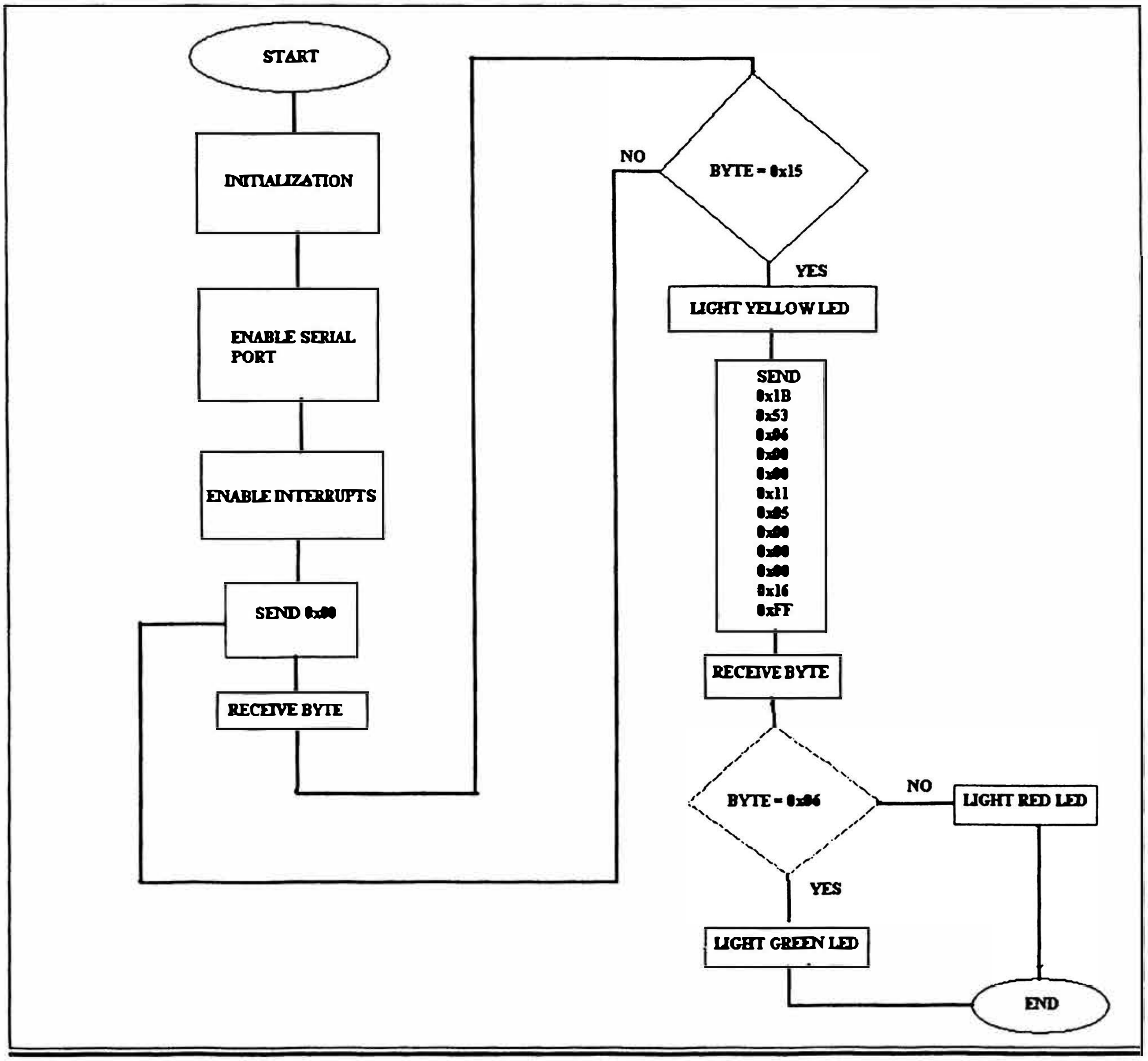

Figure 5. The flow chart utilized for programming the microcontroller is shown above. The hexadecimal commands were found using the logic analyzer and Simon Board.

ACKNOWLEDGEMENTS

I would like to thank Dr. Shrestha for giving me a chance to do undergraduate directed research. His faith in my abilities to perform the required task really helped me overcome a lot of challenges I faced during the project. I was guided by his belief that if something is to done, it be done with absolute perfection, His help and guidance has been a great source of inspiration.

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I would like to offer a very special thanks to Mr. Roger Younger for taking time out from his busy work schedule to help me program the Simon Board. He helped me a great deal in understanding how a Simon Board works and how one needs to go about writing the assembly code for the microcontroller.

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