APPENDIX

APPENDIX A

Eye gaze tracking system setup

A1. The method for IP camera connection

The method for the IP camera connection to the computer can be divided into two possible methods: by connecting with the local area network (LAN), and by connecting to the stand-alone switch Hub. In this experiment, the stand-alone switch Hub method was used because it is simple and faster than the other method in image acquisition. The configuration of the IP camera connection is represented in Figure A.1. The Ethernet port of the IP camera was connected to the Hub port via the RJ-45 connector. Then, the Ethernet port of the computer was connected to the switch Hub port. After that, the IP address of the computer was set up to provide the IP address for the IP camera.

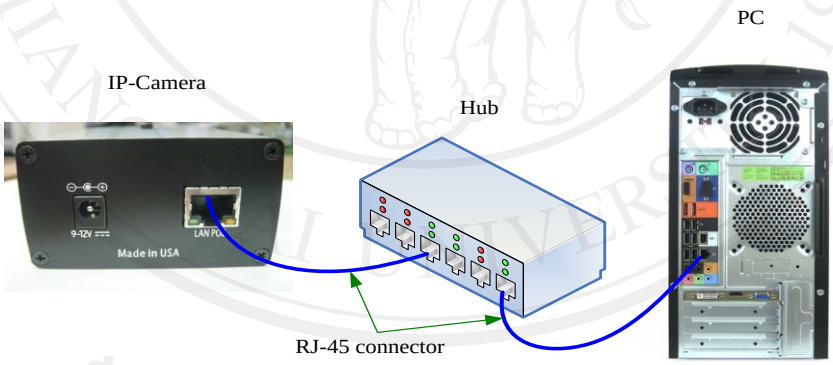

Figure A.1 Configuration of IP camera connections.

A2. Software setup for IP camera

The BOSCH (NWC-0900) IP camera has a dual-sensor which includes day mode and night mode which is sensitive to near-infrared illumination. An image in the data streams can be

transferred via the Ethernet connection port with the maximum rate of the data transferring up to 55 Mbps. The images can be sent over the network in a compressed motion JPEG format by using the trivial file transfer protocol (TFTP) through the software or the hypertext transfer protocol (HTTP) [46]. The software is provided for viewing and recording images. The camera can operate after the software DiBos8 was installed. Then, the IP address of the local area connection of the computer was set up by the TCP/IPv4. An example of TCP/IPv4 configuration is illustrated in Figure A.2. The IP address tested was 192.168.1.10 with subnet mask which was 255.255.255.0.

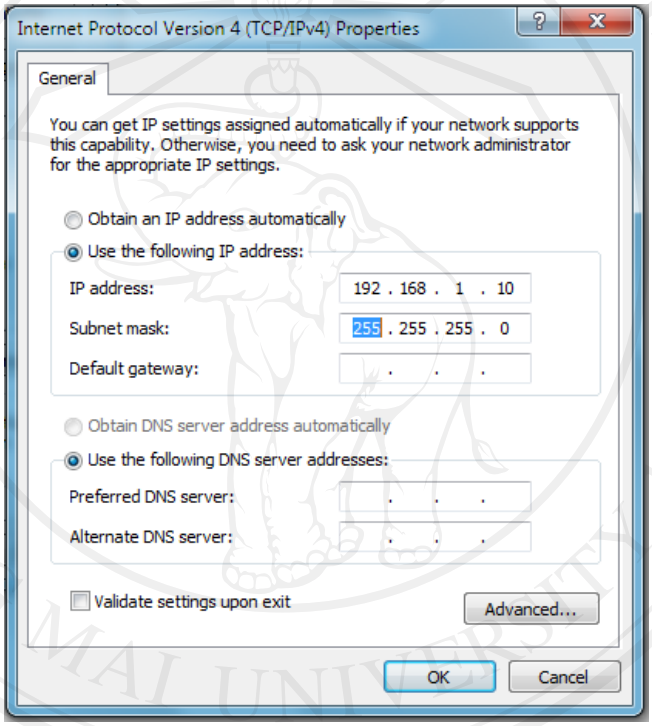

Figure A.2 TCP/IPv4 setting provides for IP camera.

After the IP address of the computer had been assigned, the IP-camera was connected to the IP camera network as shown in Figure A.1. Then, the BOSCH application manager software menu button on the screen was clicked in order to represent the windows for setting the IP camera as shown in Figure A.3.

Figure A.3 Bosch application manager window.

The IP camera was able to be operated by clicking on the camera's installer menu as shown in Figure A.3. This menu is used to detect all cameras which exist in the local area network. After the run button had been pressed, the windows of the BOSCH camera installer appeared as represented in Figure A.4. Then, it can be seen that there was no camera connection represented in the windows. Inside the windows, there are automatic button, and save/exit menu button. To detect the camera in the network, the automatic button was pressed. Then, the camera located in the network was detected as shown in Figure A.5.

Figure A.4 BOSCH IP camera installer menu.

Figure A.5 Result of IP camera detection.

Figure A.5 presents the status of the connected IP camera which Ethernet address and the current IP. Then, save/exit menu button was clicked to record a camera's parameter. After the IP camera setup had been finished, the live video button was clicked as represented in Figure A.3. The video streaming could be read out by DiBos8 program as shown in Figure A.6.

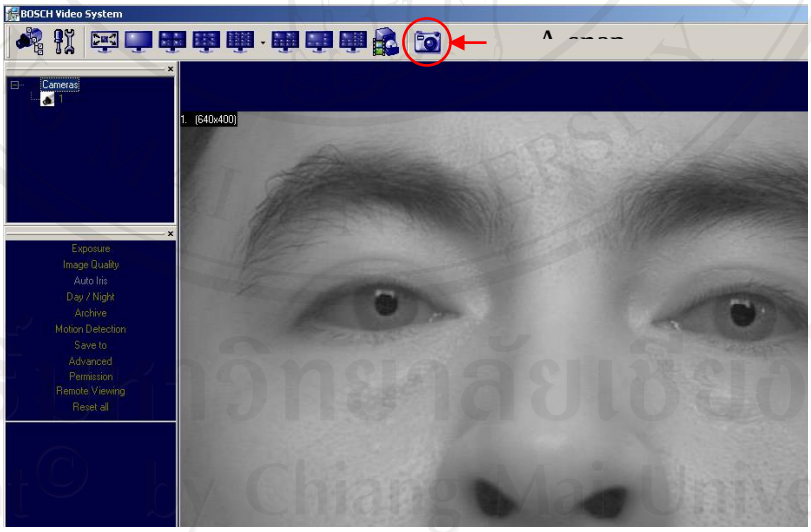

Figure A.6 Windows of the live video.

Figure A.6 shows the live video form the IP camera. In order to record images onto the storage hard disk, a snapshot of the camera button can be used. However, it is

inconvenient to be used for image capturing because it can capture only one image per time. Therefore, the ability to real-time in capture an image is required. There is the method for the real time image capturing by using HTTP command string parameter method. The advantage of this method is that it can be used with the DiBos8 software via both MATLAB programming or visual C programing. In this work, MATLAB programming was used to record the video streams to the storage hard disk. The method for the HTTP command string parameters configuration is described next:

A2.1 HTTP command string parameters setting

Information of generic HTTP command string is summarized in Table A.1. The format of HTTP command string is needed to be set before using the DiBos8 program for capturing an image automatically. The format of the generic HTTP command string is as follows:

http://<ip_address>/image?res=<resolution_value>&x0=<x0_value>&y0=<y0_value>&x1=<x1_value>&y1=<y1_value>&qualty=<quality_value>&doublescan=<doublescan_value>[&mdn=<port_no>]

Table A.1 HTTP Command String Parameters

PARAMETER	DESCRIPTION	COMMENT
<ip_address>	The IP address of the camera	e.g. 192.168.2.75
/image?	Image request command	
<resolution_value>	Specifies whether the camera should decimate the image by the factor of 2 in each direction	full or half, e.g. res=half=> an image with 1600x1200 will become 800x600
<x0_value>	The left hand coordinates of the requested image window	default: x0=0

<y0_value>	The top coordinates of the requested image window	default: y0=0
<x1_value>	The right hand coordinates of the requested image window	e.g. x1=1600
<y1_value>	The bottom coordinates of the requested image window	e.g. y1=1200
<quality_value>	The compression quality of the JPEG image with the range from 1 to 21	default: quality=12. 21 gives highest quality
<double scan_value>	Double scan is the parameter that allows the user to specify whether the camera should delay the image output until the new image is scanned (double scan=0) or the image request should be serviced immediately by outputting the content of the current image in the image buffer (double scan=1) (the image will be displayed faster on the screen)	e.g. double scan=0
<port_no>	The camera sends "ismotion" to the specified port No. if motion is detected and "no motion" if motion is not detected.	e.g. port_no=3028 This parameter is optional.

From Table A.1, HTTP command string parameters for IP camera was set up as describe in following:

The IP address was set to 192.168.1.10. Then, the image resolution was set to the value of full resolution. The x1 and y1 were set to the 1,920 × 1,200 pixels. The quality value of the image is 15. The last field is the double scan value and port number which is the random number.

This experiment used the night mode of IP camera for capturing the eye gaze image because it is sensitive to the near infrared light source. Therefore, the infrared light sources were reflected on the user's cornea and the maximum resolutions of images was 1,920 × 1,200 pixels. The purpose of the experiment is to capture an image by using MATLAB programming. The result of IP camera configuration format which was used for automatic image capturing is shown as follows.

```
http://192.168.1.10/image?res=full&x0=0&y0=0&x1=1920&y1=1200&quality=15&
doublescan=0&ssn=1268647746657&id=1268650403590
```

MATLAB code which was used to save captured image onto the storage hard disk is shown in Figure A.7.

```
%//    EXAMPLE OF FROGRAM FOR IP CAMERA CAPTURING IMAGES    //%
% //    THIS PROGRAM CAN BE SAVING 100 IMAGES TO HARD DISK      //%

clc;
close all
clear all
for k=1:100
  image = imread('http://192.168.1.10/image?res=full&x0=0&y0=0&x1=1920&
  y1=1200&quality=15&doublescan=0&ssn=12686477466657&id=
  1268650403590');
  eval(['imwrite(image,"D:\imagefortest\image('num2str(k) ').jpg");']);
end
```

Figure A.7 MATLAB programming for IP camera connection

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Publications W.Ponglangka, N. Thera-Umpon, and S. Auephanwiriyakul, "Eye-gaze distance estimation based on gray level intensity of image patch," *IEEE Int. Conf. on Intelligent Signal Processing and Communication Systems (ISPACS)*, pp.1-5, 7-9 Dec. 2011.

Wirot Ponglangka, Nipon Theera-Umpon, Sansanee Auephanwiriyakul, "Eye-gaze distance estimation using eigenvalues of iris region," *The 1 International conference on Information, System and Convergence Applications (ICISCA 2014)*, pp.95-97, 2-5 July. 2014.

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