CHAPTER IV

Hardware

4.1 PixeLINK Camera Model PL-A741-BL.

4.1.1 Specifications

The PL-A741-BL that shown in figure 5.1 is a board level, 1.3 megapixel monochrome CCD camera designed specifically for machine vision applications. Fully IIDC 1.31 compliant, the PL-A741-BL uses a standard FireWire interface for plug-and-play operation with the host computer.

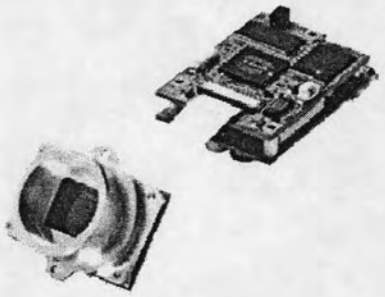

Figure 4.1: PixeLINK Camera model PL-A741-BL.

4.1.2 Extended Machine Vision Interface

PL-A741-BL has an EMV (Extended Machine Vision) interface connector provide 3.3V TTL-level connections for one external trigger and four general purpose outputs. The original connector, which is a Molex 51021-0800, has been mapped into standard 9-pin serial port with the pin-out description as table 4.1.

Table 4.1: 9-pin serial port pin-out description of EMV interface.

Pin	Pin Name	Function
1	3.3V	+3.3 VDC power output
2	TRIGGER	TRIGGER input
3	GROUND	Logic and chassis ground
4	GP1	General Purpose Output 1
5	GP2	General Purpose Output 2

6	GP3	General Purpose Output 3
7	GP4	General Purpose Output 4
8	n/c	No connection
9	n/c	No connection

4.1.3 Synchronous Image Capturing Using PL-A741-BL

Synchronous image capturing module has been used to make all cameras capture image simultaneously. It can be performed between PL-A741-BL cameras. One is set to primary and others are secondary. The trigger mode of primary camera has been set to software type to receive capturing command from control application. After the primary camera receives capturing command, trigger will be generated through GPO immediately. Secondary cameras, whose trigger mode are already set to hardware type, receive trigger signal form primary camera and capture images. The vendor of camera guarantees that delay between capturing in primary and secondary camera is about 9 microseconds. In this research, GP2 (pin 5) of primary camera, which activated with strobe mode and negative polarity, has been used to generate trigger signal.

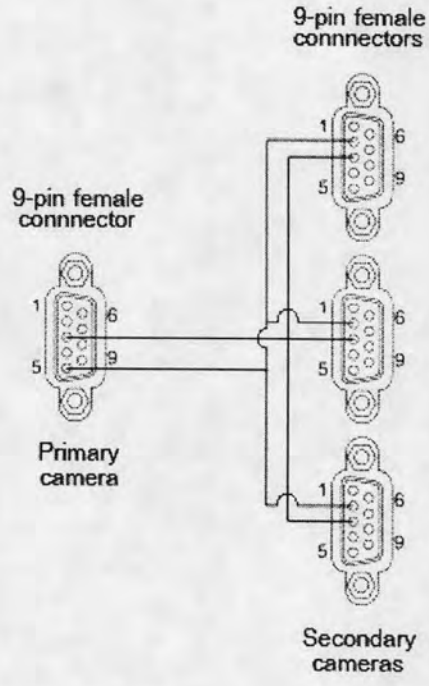

Figure 4.2: Schematic of camera system for synchronous image capturing.

4.2 PixeLINK 16-mm Lens Model PL-16MM-CM

Four PixeLINK 16-mm lens model PL-16MM-CM have been used with PL-A741-BL cameras. PL-16MM-CM has 16 mm focal length with 2/3" C-mount as show in figure 4.3.

Figure 4.3: PixeLINK 16-mm Lens Model PL-16MM-CM.

4.3 dataBLIZZARD PCI to PCI Data Mover Card Model DB0-PCI-PCI.

dataBLIZZARD PCI to PCI data mover card model DB0-PCI-PCI is a high speed point to point system communication interface with integrated DMA (direct memory access) engine. The maximum transfer rate is 80 MB/sec. Two cards use a fiber optic cable to connect to each other as show in figure 4.4. A pair of card has been used to communicate between main computer and remote computer.

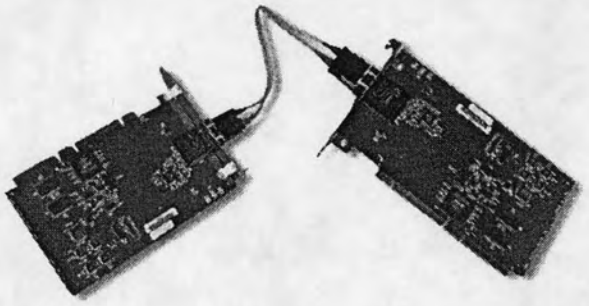

Figure 4.4: dataBLIZZARD PCI to PCI Data Mover Card model DB0-PCI-PCI.

dataBLIZZARD's card can be considered as both transmitter and receiver. It will be considered as transmitter when it is used to send data and to be a receiver when it is used to receive data. The dataBLIZZARD's cards communicate between each other with programmed interrupt. There are two types of programmed interrupt including programmed interrupt to transmitter (PT) and programmed interrupt to receiver (PR).

Programmed Interrupt to Transmitter allows a card to generate an interrupt on the other card's bus without making a remote cable access. The local processor sets the out going PT interrupt bit in a local control and status registers (CSR). dataBLIZZARD hardware then sends this interrupt request to the remote card using a cable interrupt (CINT) line. The remote processor can then acknowledge the PT interrupt by writing to a remote CSR.

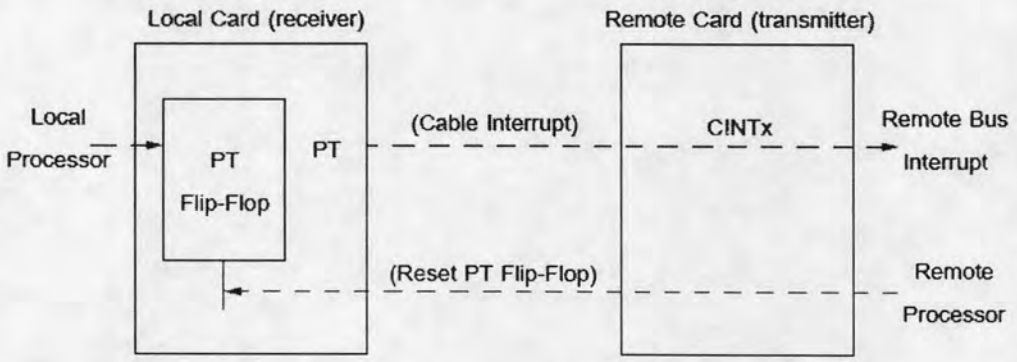

Figure 4.5: Programmed Interrupt to Transmitter

Programmed Interrupt to Receiver allows a dataBLIZZARD card to receive an interrupt and acknowledge it without a remote cable access. A local processor set the send PR interrupt bit in a remote CSR. This causes an interrupt to be asserted on the remote bus. The remote processor can then acknowledge the PT interrupt by writing a local CSR.

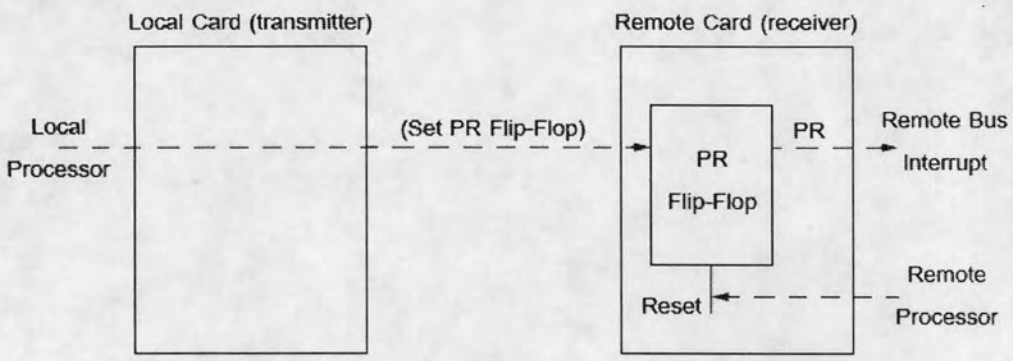

Figure 4.6: Programmed Interrupt to Receiver

In this research, the programmed interrupt has been used as command signal, which the transmitter sends to the receiver to make the receiver work synchronously. Detail of communication process will be described in section 5.3.1, chapter 5.

4.4 Mitsubishi PA10-7C Robotic Arm

Mitsubishi PA10-7C robotic arm is a 7-DOF general purpose robot with open architecture shown in figure 4.7. The accuracy and repeatability of this robot are 0.2 mm. It has been used to generate 3-D motion for 3-D tracking experimental.

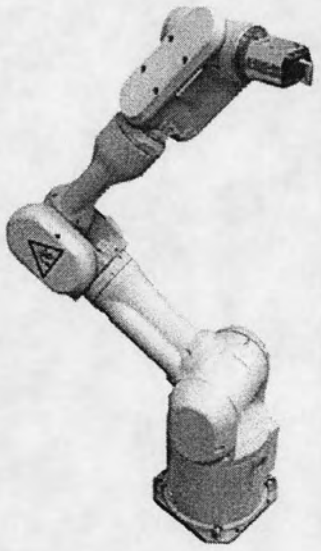

Figure 4.7: Mitsubishi PA10-7C Robotic Arm.

4.5 Chessboard Calibration Pattern

Chessboard calibration pattern is planar rectangular pattern with known size. There are two chessboard calibration patterns used in this research. First one (No.1), is 8×8 rectangles chessboard with 20 mm in width and height as show in figure 4.8. It has been used when the distance between camera center and calibration pattern less than 2 meter.

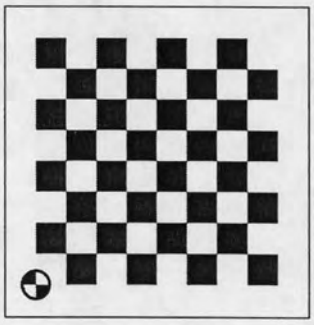

Figure 4.8: 8×8 rectangles chessboard pattern with 20 mm in width and height.

Another one (No.2) has been used when the distance between camera center and calibration pattern greater than 2 meter. It has 6×6 rectangles with 40 mm in width and height as show in figure 4.8.

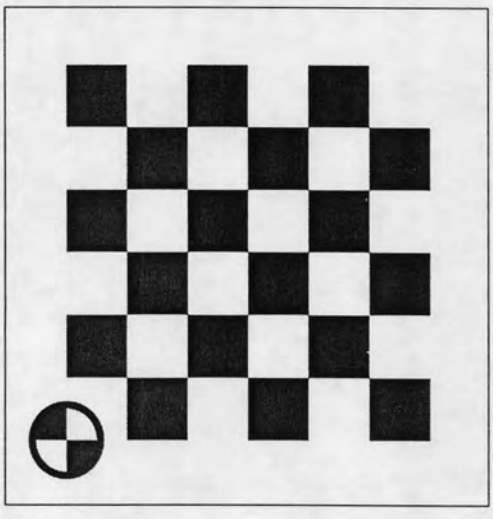

Figure 4.9: 6×6 rectangles chessboard pattern with 40 mm in width and height.

Note that circle mark in each chessboard pattern used to indicate orientation of chessboard pattern in image.

4.6 Personal Computer

Two personal computers (PCs) have been used in this research, one is called local computer and another one is called remote computer.

1) Local computer is Pentium 4 Dual Core 3.4 GHz with 2 GB RAM. It uses Microsoft Windows XP operating system. It has been used to control overall system. It performs image capturing, camera calibration, pattern recognition and 3-D reconstruction. The user interfaces are also provided in the local computer.

2) Remote computer is Pentium 4, 2 GHz with 512 MB RAM. It also uses Microsoft Windows XP operating system. It performs only image capturing and pattern recognition. The 2-D image position, which is retrieved from the pattern recognition, is then sent to the local computer to perform 3-D reconstruction.

4.7 System Setup

The overall system that is shown in figure 4.10 has been set up with the following steps:

1) Install dataBLIZZARD data mover card model DB0-PCI-PCI to each PC.
2) Connect two computers with fiber optic cable.
3) Connect two cameras to local computer and another two cameras to remote computer.
4) Select the primary camera and then set its trigger mode to software type and GP2 mode to strobe with negative polarity.
5) Set trigger mode of all secondary cameras to hardware type.
6) Connect trigger cable to each cameras using figure 4.2.

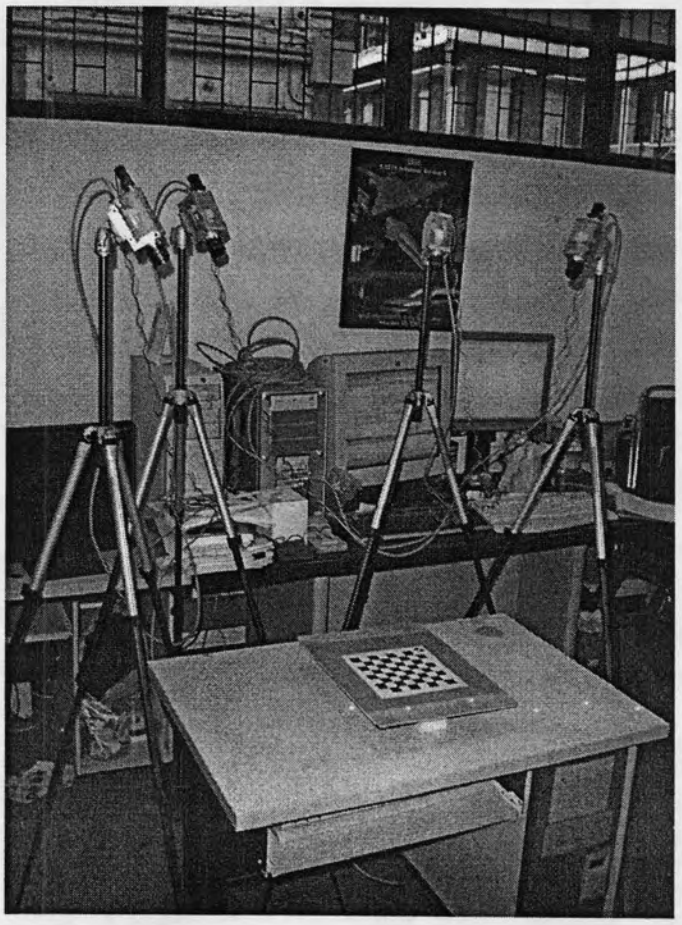

Figure 4.10: System with completely setting up