

VISUALIZATION ROBOT SORTER

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This thesis is submitted as partial fulfillment of the requirements for the award of the
Bachelor of Electrical Engineering (Power System)

Faculty of Electrical & Electronics Engineering
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NOVEMBER, 2007

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Date : 27 NOVEMBER 2007

To my beloved mother and father

ACKNOWLEDGEMENT

Alhamdulillah, the highest thanks to God because with His Willingness I possible to complete the final year project in time. I would like to express my gratitude to my supervisor, Pn Nor Maniha Abd Ghani, for guiding me with her priceless ideas and as well as her knowledge in making this project.

I also would like to thank to all UMP lecturers and electrical technicians whom had helped directly or indirectly in what so ever manner thus making this project a reality.

Not forgotten to all my colleagues, for their guided, assisted, supported and encouraged me to make this project successful. Finally, very thanks to my dearest family which provided invaluable emotional support. Their blessing gave me the high-spirit and strength to face any problem occurred and to overcome them rightly. The great cooperation, kindheartedness and readiness to share worth experiences that have been shown by them will be always appreciated and treasured me.

“I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power System)”

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ABSTRACT

At the present time, standard robot usages have a very large contribution for an industries and most of production is depend on it. By using this method, it will expand robotic function and developed a new technology for industries. Visualization Robot Sorter is a project that illustrates an arm robot graphic that move according to a voltages changes. A concept of rheostat is used for hardware compartment in collecting changes of voltage reading. Physically, the rheostat hardware is more to distance detector looks. For interfacing process, PCI – 1710 is used to dispatch the voltage changes data to computer program. LAbVIEW8.0 is a program that will visualize the arm robot movement and graph for voltage changes. There will be four differences type of movement that functions directly to the voltage changes. This design is expected to be useful since visualization program offers flexible usage and inspection process become easier.

ABSTRAK

Pada zaman sekarang, penggunaan teknologi robotic telah memberi sumbangan yang besar kepada industri dan kebanyakan pengeluaran industri bergantung kepada teknologi ini. Dengan menggunakan projek ini, ia diharap dapat mengembangkan lagi penggunaan teknologi robotik dan menghasilkan teknologi yang baru. 'Visualization Object Sorter' adalah sebuah projek yang akan memaparkan grafik lengan robot yang bergerak mengikut perubahan voltan. Konsep reostat digunakan bagi mengambil bacaan perubahan voltan tersebut. Dari pandangan luaran, hardware yang direka akan kelihatan lebih kepada pengesan jarak. Bagi proses penghantaran data, PCI – 1710 digunakan bagi menghantar perubahan bacaan voltan kepada program di dalam komputer. LabVIEW8.0 digunakan sebagai program yang akan memaparkan pergerakan lengan robot. Ia akan mengandungi empat pergerakan yang berbeza yang berfungsi dengan setiap perubahan voltan yang diterima. Rekaan ini diharap akan menjadi sangat berguna oleh kerana paparan grafik memberi kegunaan yang fleksibel dan proses pantauan akan menjadi lebih mudah.

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LIST OF SYMBOLS

V	-	Voltage, Volt
I	-	Current
A	-	Ampere
R	-	Resistance
Ω	-	Ohm
VIs	-	LabView
K	-	kilo
μ	-	mikro

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Visualization Robot Sorter is a project that visualizes an arm robot movement that moves to pick and place an object according to a voltage change. Voltage change will be an input for LabVIEW8.0 program before it illustrates the operation in graphic movement. Concept of rheostat has been used to measure the voltage change and the physical looks for the hardware are more to distance detector. PCI-1710 (data acquisition card) is use to interface the voltage change data into the LabVIEW8.0 program. Graphic of robot movement and a voltage graph will be show to ease the user to inspect the process. The purpose of this project is to develop a new technology using LabVIEW8.0.

This project can be applied in industries in many ways. One of the applications is for detecting an error or troubleshooting. If there is any misplace product or object from a conveyer, a detector will detect the area and robot will start functioning to pick and place the product to the exact place and all of this process will be visualize. By using this project, the inspection can be done just not in the operation area.

At the present time, standard robot usages have a very large contribution for an industries and most of production is depend on it. It means that the robot must be functioning at the maximum level without any downtime or fault. Besides, they require advanced control methods to ensure the lowest possible of fault occur and most effective output. By using this technology, the inspection or maintenance can be done frequently and all the process can be visualize.

The fast and constant evolutions in robot technologies in last decade had given a large impact to production process in industries. Because of this reason, the purpose of the project is to design a visualization program using LabVIEW8.0 that can visualize the movement of robot according to an object voltage changes. The design is expected to be useful since visualization program offers flexible usage and inspection process become easier.

1.2 Problem Statement

Robotic technologies have become important machinery for industries and this technology has developed fast to make sure it provide an excellent result. However, the future of robotic technologies until recently seemed unimpressive due to their low maintenance and high fault possibility. By using this method, it will expand robotic function and the process will be inspect all the time. Other than that, this method just not limited to be implemented in distance (voltage change) value. It also can be applied in weight, color, temperature, tag, size, etc.

1.3 Objective

The aim of this project is to design a visualization program using LabVIEW8.0 that image an arm robot movement according to a voltage change. Distance detector (rheostat) will be the measurement device to evaluate the voltage changes. This device is connecting with PCI-1710 (DAQ card) to interface the input voltage into LAbVIEW8.0 program.

The main objectives of this project are:

- i) To design visualization program using LabVIEW8.0.
- ii) To design distance detector using rheostat concept that interface with PCI-1710.

1.4 Scope of Project

This project design is for a visualization program using LabVIEW8.0 that image a movement of arm robot according to a voltage changes. In this project, three elements of scope that is the main target to be achieved at the end of this project are:

- i) To design distance detector hardware.
 - Rheostat concept will be applied at the hardware.
- ii) To familiarize Data Acquisition Card.
 - PCI-1710 that will examine a voltage change and interface with a computer program.
- iii) To design a visualization program using LabView8.
 - Analyze the input data (voltage value) and display the process of movement

1.5 Literature Review

In order to perform this project, literature review have been made from various sources likewise journal, books and other references such as article. In simple term, the reference sources emphasize on few aspects and the important aspect is the cam assembly mechanism analysis and how to design LabVIEW8.0 program that will interface with PCI-1710 that give input data (voltage) and visualize the amount of voltage and the pick and place arm robot movement. This part will describe about distance detector, rheostat circuit, PCI-1710 12/16-bit multifunction Card and LabVIEW8.0program.

1.5.1 Distance Detector

The first part that will operate in this project is distance detector. Many ideas had been discussed in selecting the component that will be use in designing the hardware. At last, rheostat concept selected to be implement for this task. Basically, voltage will be control by variables resistances and the value will convert to a digital form by using data acquisition card (DAQ card). So, distance of this device will influence the variable resistor to make this process flow properly.

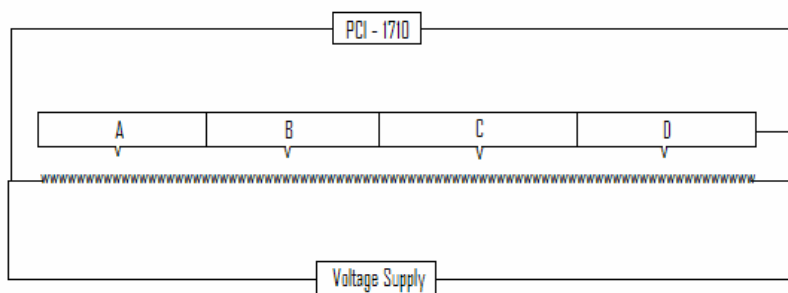


Figure 1.1 Basic rheostat circuit

There will be four plates (A, B, C and D) that will move down and touch the resistors and affect the voltage change. This basic circuit has been used to build a distance detector to make it more reliable. The basic idea is when there is an object on the plates, it will change the voltage reading.



Figure 1.2 Distance Detector

1.5.2 PCI-1710 (12/16- bit Multifunction card)

The Advantech PCI-1710/ is a powerful data acquisition (DAS) card for the PCI bus. It features a unique circuit design and complete functions for data acquisition and control, including A/D conversion, D/A conversion, digital input, digital output, and counter/timer. PCI-1710 provides specific functions for 12-bit, 100kS/s Multifunction card.

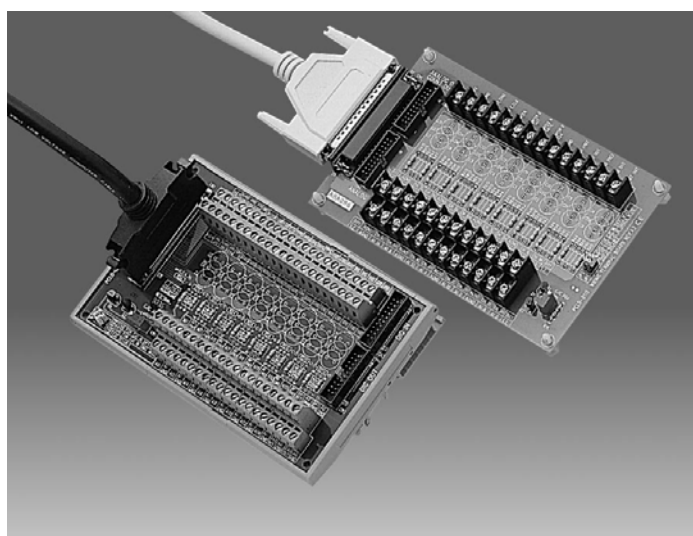


Figure 1.3 Advantech PCI-1710

Advantech PCI-1710 provides users with the most requested measurement and control functions as below:

- i) PCI-bus mastering for data transfer
- ii) 16-channel Single-Ended or 8 differentials A/D Input
- iii) 12-bit A/D conversion with up to 100 kHz sampling rate
- iv) Programmable gain for each input channel
- v) On board samples FIFO buffer (4K for PCI-1710)
- vi) 2-channel D/A Output (PCI-1710/1710HG/1711/1716)
- vii) 16-channel Digital Input

- viii) 16-channel Digital Output
- ix) Programmable Counter/Timer
- x) Automatic Channel/Gain Scanning
- xi) Board ID

1.5.2.1 Plug-and-Play Function

The Advantech PCI-1710 is a Plug-and-Play device, which fully complies with the PCI Specification. During card installation, all bus-related configurations such as base I/O address and interrupts are conveniently taken care of by the Plug-and-Play function [1].

1.5.2.2 Flexible Input Type and Range Settings

The PCI-1710 features an automatic channel/gain scanning circuit. This circuit design controls multiplexer switching during sampling. Users can set different gain values for each channel according to their needs for the corresponding range of input voltage. The gain value settings thus selected is stored in the SRAM. This flexible design enables multi-channel and high-speed sampling for high-performance data acquisition[1].

1.5.2.3 On-board FIFO (First-In-First-Out) Memory

The PCI-1710 provides an on-board FIFO memory buffer, storing up to 4K A/D samples. Users can either enable or disable the interrupt request feature of the FIFO buffer. While the interrupt request for FIFO is enabled, users are allowed to specify whether an interrupt request will be sent with each sampling action or only when the FIFO buffer is half saturated. This useful feature enables a continuous high-speed data transfer with a more predictable performance on operating systems [1].

1.5.2.4 16 Digital Inputs and 16 Digital Outputs

The PCI-1710 provides 16 digital input channels and 16 digital output channels. Users are left with great flexibility to design and customize their applications according to their specific needs [1].

1.5.2.5 On-board Programmable Counter

The PCI-1710/ is equipped with a programmable counter, which can serve as a pacer trigger for A/D conversions. The counter chip is an 82C54 or its equivalent, which incorporates three 16-bit counters on a 10 MHz clock. One of the three counters is used as an event counter for input channels or pulse generation. The other two are cascaded into a 32-bit timer for pacer triggering [1].

1.5.2.6 Short Circuit Protection

The PCI-1710 is equipped with short circuit protection device (polyswitch) on the +12VDC/+5VDC power supply pins. If any of the power supply pins is shorted to ground (i.e. short circuit occurs), the protection device will shut off the current output automatically. After the short circuit has been released for about two minutes, the power supply pins will return to output current [1].

1.5.2.7 Software

Advantech offers a rich set of DLL drivers, third-party driver support and application software to help fully exploit the functions of your PCI-1710 card:

- i) DLL driver (on the companion CD-ROM)
- ii) LabVIEW driver
- iii) Advantech ActiveDAQ
- iv) Advantech

1.5.2.8 Signal connection

The I/O connector on the PCI-1710 is a 68-pin connector that enables it to connect to accessories with the PCL-10168 shielded cable. The PCL-10168 shielded cable is especially designed for the PCI-1710 to reduce noise in the analog signal lines [1].

Figure 1.4 shows the pin assignments for the 68-pin I/O connector on the PCI-1710:

AI0	68	34	AI1
AI2	67	33	AI3
AI4	66	32	AI5
AI6	65	31	AI7
AI8	64	30	AI9
AI10	63	29	AI11
AI12	62	28	AI13
AI14	61	27	AI15
AIGND	60	26	AIGND
DA0_REF	59	25	DA1_REF
DA0_OUT	58	24	DA1_OUT
AOGND	57	23	AOGND
DI0	56	22	DI1
DI2	55	21	DI3
DI4	54	20	DI5
DI6	53	19	DI7
DI8	52	18	DI9
DI10	51	17	DI11
DI12	50	16	DI13
DI14	49	15	DI15
DGND	48	14	DGND
DO0	47	13	DO1
DO2	46	12	DO3
DO4	45	11	DO5
DO6	44	10	DO7
DO8	43	9	DO9
DO10	42	8	DO11
DO12	41	7	DO13
DO14	40	6	DO15
DGND	39	5	DGND
CNT0_CLK	38	4	PACER_OUT
CNT0_OUT	37	3	TRG_GATE
CNT0_GATE	36	2	EXT_TRG
+12V	35	1	+5V

Figure 1.4 I/O connector pin assignments for the PCI-1710

1.5.2.9 Analog Input Connections

The PCI-1710 supports both 16-channel Single-Ended and 8 differentials A/D Input. Each individual input channel is software-selected.

1.5.2.10 Single-ended Channel Connections

The single-ended input configuration has only one signal wire for each channel, and the measured voltage (V_m) is the voltage of the wire as referenced against the common ground. A signal source without a local ground is also called a “floating source”. It is fairly simple to connect a single-ended channel to a floating signal source. In this mode, the PCI-1710 provides a reference ground for external floating signal sources. Figure 1.5 shows a single-ended channel connection between a floating signal source and an input channel on the PCI-1710 [1].

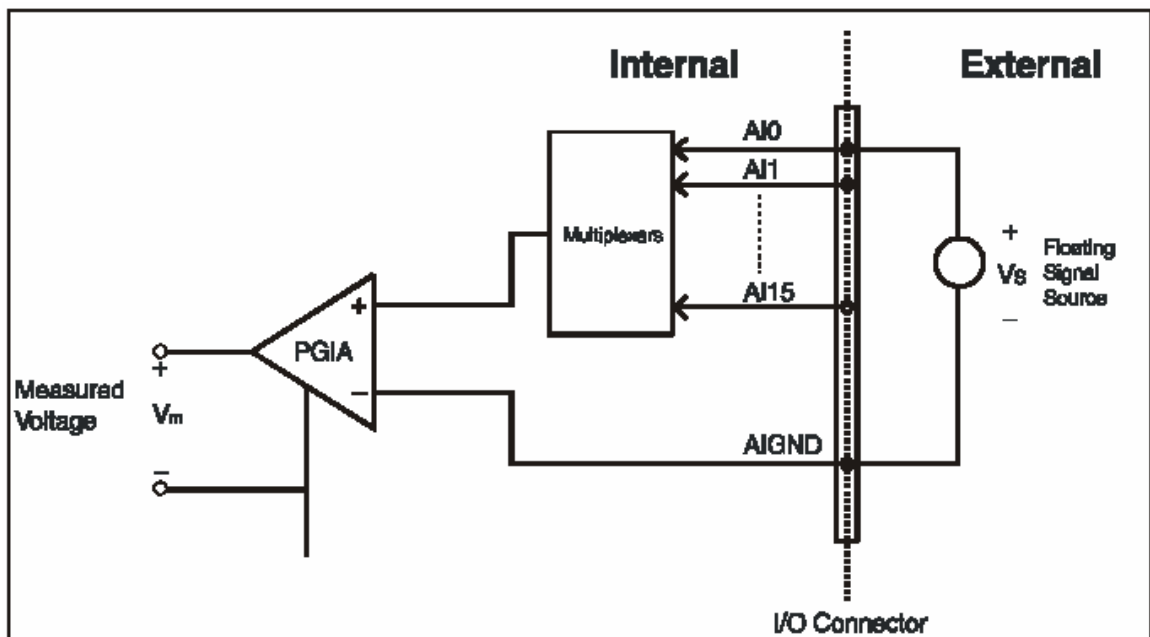


Figure 1.5 Single-ended input channel connection

1.5.2.11 Differential Channel Connections

The differential input channels operate with two signal wires for each channel, and the voltage difference between both signal wires is measured. On the PCI-1710 when all channels are configured to differential input, up to 8 analog channels are available.

If one side of the signal source is connected to a local ground, the signal source is ground-referenced. Therefore, the ground of the signal source and the ground of the card will not be exactly of the same voltage. The difference between the ground voltages forms a common-mode voltage (V_{cm}).

To avoid the ground loop noise effect caused by common-mode voltages, you can connect the signal ground to the Low input. Figure 1.6 shows a differential channel connection between a ground-reference signal source and an input channel on the PCI-1710. With this connection, the PGIA rejects a common-mode voltage V_{cm} between the signal source and the PCI-1710 ground, shown as V_{cm} in Figure 1.6.

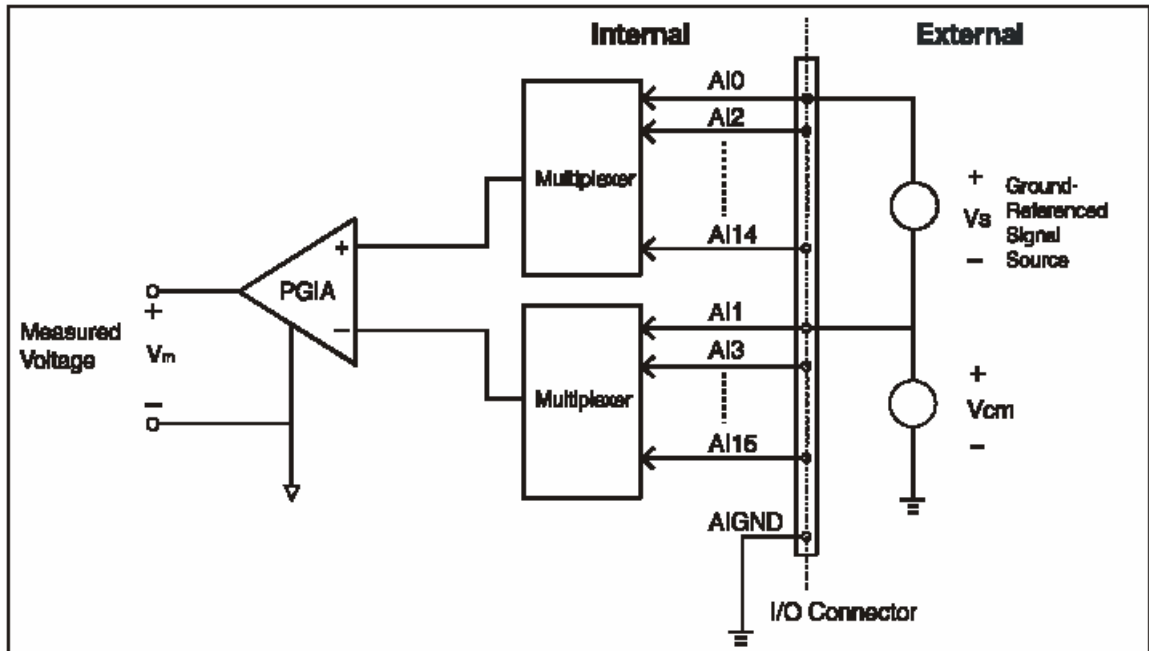


Figure 1.6 Differential input channel connection – ground reference signal source

If a floating signal source is connected to the differential input channel, the signal source might exceed the common-mode signal range of the PGIA, and the PGIA will be saturated with erroneous voltage-readings. Therefore reference the signal source against the AIGND.

Figure 1.7 shows a differential channel connection between a floating signal source and an input channel on the PCI-1710. In this figure, each side of the floating signal source is connected through a resistor to the AIGND. This connection can reject the common-mode voltage between the signal source and the PCI-1710.

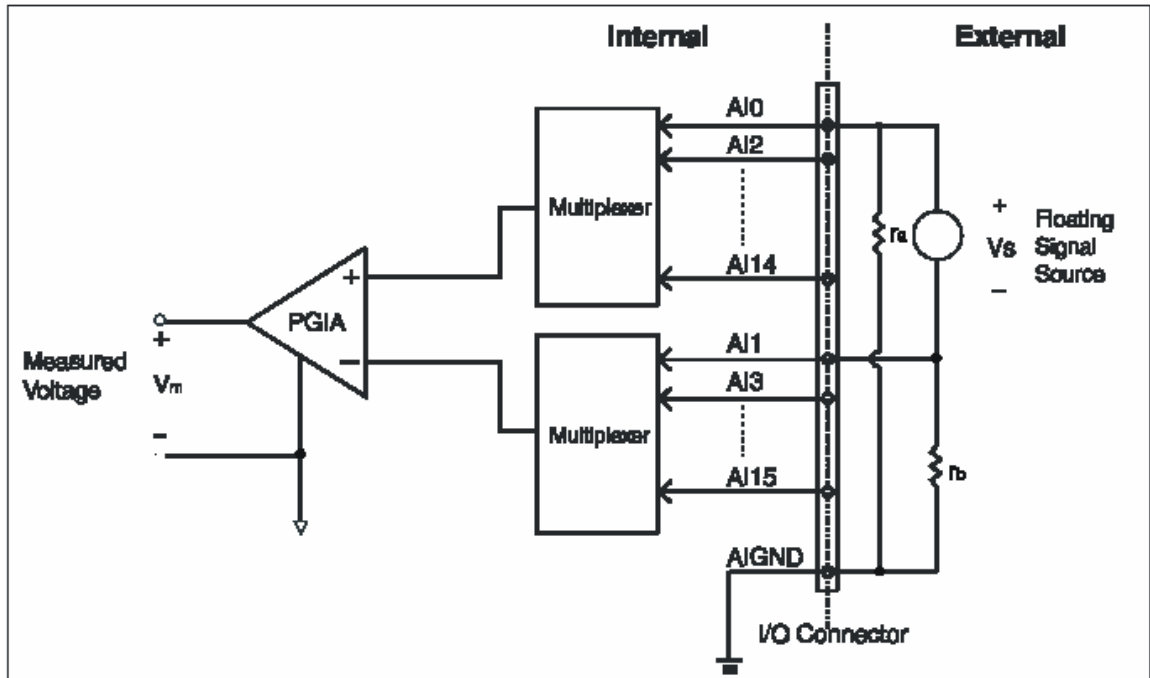


Figure 1.7 Differential input channel connection – floating signal source

However, this connection has the disadvantage of loading the source down with the series combination (sum) of the two resistors [1].

1.5.2.12 Trigger Source Connections

The PCI-1710 includes one 82C54 compatible programmable Timer/Counter chip which provides three 16-bit counters connected to a 10 MHz clock, each designated specifically as Counter 0, Counter 1 and Counter 2. Counter 0 is a counter which counts events from an input channel or outputting pulse. Counter 1 and Counter 2 are cascaded to create a 32-bit timer for pacer triggering. A low-to-high edge from the Counter 2 output (**PACER_OUT**) will trigger an A/D conversion on the PCI-1710. At the same time, it can also use this signal as a synchronous signal for other applications [1].

1.5.2.13 External Trigger Source Connection

In addition to pacer triggering, the PCI-1710 also allows external triggering for A/D conversions. When a +5 V source is connected to **TRG_GATE**, the external trigger function is enabled. A low-to-high edge coming from **EXT_TRG** will trigger an A/D conversion on the PCI-1710. When **DGND** is connected to **TRG_GATE**, the external trigger function is thereby disabled [1].

1.5.2.14 Field Wiring Considerations

When use the PCI-1710 to acquire data from outside, noises in the environment might significantly affect the accuracy of your measurements if due cautions are not taken. The following measures will be helpful to reduce possible interference running signal wires between signal sources and the PCI-1710:

- i) The signal cables must be kept away from strong electromagnetic sources such as power lines, large electric motors, circuit breakers or welding machines, since they may cause strong electromagnetic interference. Keep the analog signal cables away from any video monitor, since it can significantly affect a data acquisition system.
- ii) If the cable travels through an area with significant electromagnetic interference, it should adopt individually shielded, twisted-pair wires as the analog input cable. This type of cable has its signal wires twisted together and shielded with a metal mesh. The metal mesh should only be connected to one point at the signal source ground.
- iii) Avoid running the signal cables through any conduit that might have power lines in it.
- iv) If it has to place the signal cable parallel to a power line that has a high voltage or high current running through it, keep a safe distance between them. Or, it should place the signal cable at a right angle to the power line to minimize the undesirable effect.
- v) The signals transmitted on the cable will be directly affected by the quality of the cable. In order to ensure better signal quality, we recommend that you use the PCL-10168 shielded cable [1].

1.5.3 LabVIEW8.0

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. LabVIEW contains a comprehensive set of tools for acquiring, analyzing, displaying, and storing data, as well as tools to help you troubleshoot code you write.

In LabVIEW, it builds a user interface, or front panel, with controls and indicators. Controls are knobs, push buttons, dials, and other input mechanisms. Indicators are graphs, LEDs, and other output displays. After build the user interface, add code using VIs and structures to control the front panel objects. The block diagram contains this code [2].

LabVIEW provides built-in template VIs that include the subVIs, functions, structures, and front panel objects you need to get started building common measurement applications. LabVIEW also includes a set of Express VIs that help you analyze signals and extensive documentation for new and experienced LabVIEW users. Documentation resources include the Context Help window, the *LabVIEW Help*, examples, and manuals.

The Context Help window displays basic information about LabVIEW . The *LabVIEW Help* contains information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools [2].

An instrument driver is a set of software routines that control a programmable instrument. Each routine corresponds to a programmatic operation such as configuring, reading from, writing to, and triggering the instrument. Use an instrument driver for instrument control when possible. National Instruments provides thousands of instrument drivers for a wide variety of instruments [2].

LabVIEW uses colored icons to distinguish between functions, VIs, and Express VIs. Icons for functions have pale yellow backgrounds, most icons for VIs have white backgrounds, and icons for Express VIs appear surrounded by pale blue fields. Express VIs appear on the block diagram as expandable nodes with icons surrounded by a blue field. Unlike Express VIs, most functions and VIs on the block diagram appear as icons rather than expandable nodes [2].

1.6 Methodology

Below is the flowchart of Visualization Robot Sorter project:

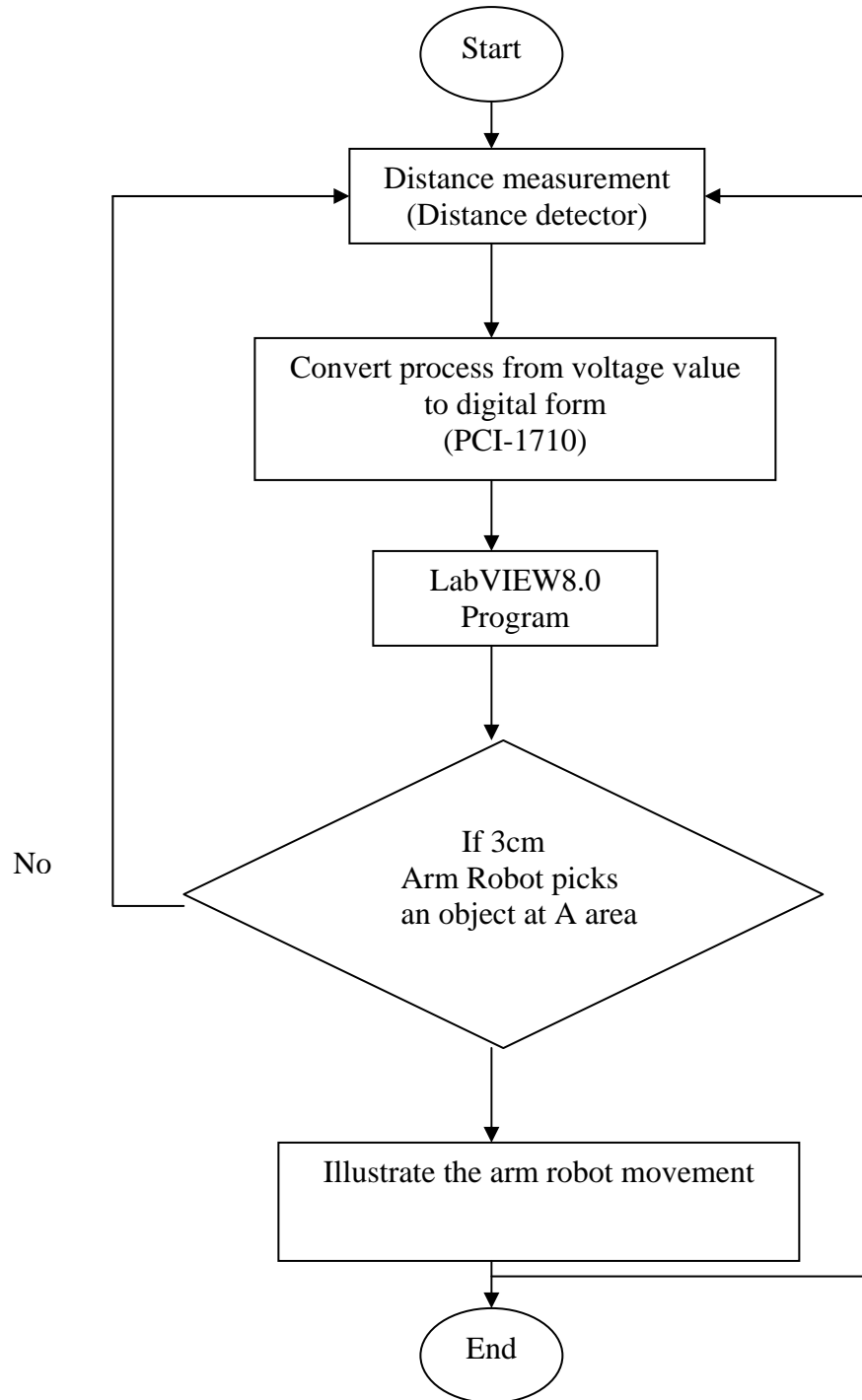


Figure 1.8 Flowcharts

1.6.1 Flowchart Explanation

This project flows begins with voltage measurement that will determine by distance detector. In this process, voltage will act as a distance value. If the voltage value is large, than the distance is far from the fixed place. If the voltage value is small it means that the distance is near from the fixed place. Then, the voltage value will be change to a digital form by using Data Acquisition Card (PCI-1710). This process is important because computer program cannot be read an analog input. It must be converted to a digital form to allow the program analyze the input. LabVIEW8.0 will be the program that will analyze the input data and visualize the pick and place robot movement. Four variable will be detect either it far or near from the fixed area.

- i) If 0.5V to 1.0V – Robot pick an object at A area and place it to a fixed place.
- ii) If 1.0V to 3.0V – Robot pick an object at B area and place it to a fixed place.
- iii) If 3.0V to 4.0V – Robot pick an object at C area and place it to a fixed place.
- iv) If 4.0V to 5.0V – Robot pick an object at D area and place it to a fixed place.

User can see the entire pick and place process just by looking in the LabVIEW8.0 program.

CHAPTER 2

HARDWARE

2.1 Introduction

Distance detector is the first devices that will be operate in this project. It act like rheostat that measure potential (or voltage) in a circuit by tapping off a fraction of a known voltage from a resistive slide wire and comparing it with the unknown voltage by means of a galvanometer. DC supply will be source for the circuit.

The present popular usage of the term potentiometer describes an electrical device which has a user-adjustable resistance. Usually, this is a three-terminal resistor with a sliding contact in the center (the wiper). If all three terminals are used, it can act as a variable voltage divider. If only two terminals are used (one side and the wiper), it acts as a variable resistor. Its shortcoming is that of corrosion or wearing of the sliding contact, especially if it is kept in one position.

Figure 2.1 show a common rheostat. In this project, rheostat concept will be used but the physical look will be customize to distance detector.



Figure 2.1 Common Rheostat

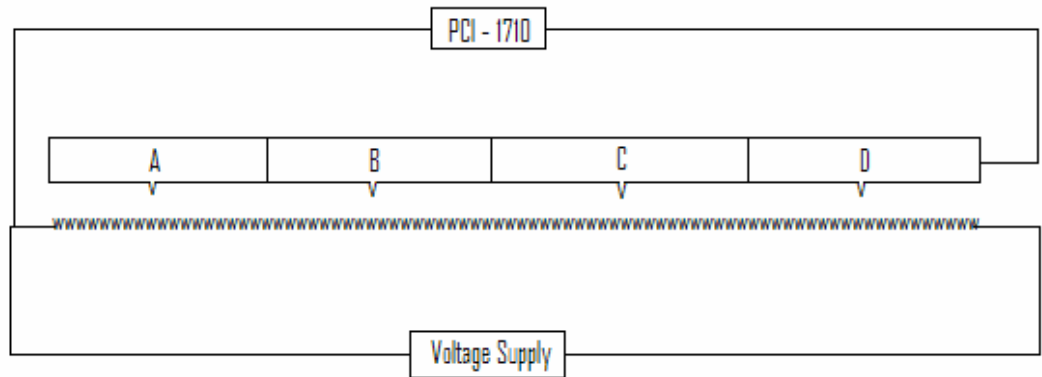


Figure 2.2 Basic rheostat circuits

Platform (A, B, C and D) for the object be place will act like a piano system. According to Figure 2.2, if an object placed at A area, the platform will fall onto variable resistor and effect to voltage reading. Higher resistance will make lower voltage. Each area will effect differently in voltage measurement and the voltage data will be interface to LabVIEW8.0 program via PCI-1710 (Data Acquisition Card).

2.2 Hardware Component

Visualization Robot Sorter hardware for distance detector used about 23 resistors. These resistors are used to fulfill the concept of rheostat in measuring voltage change. All of these resistors are connected in series. At the end of each edge, 6V DC supply is mounted to give supply in the circuit.

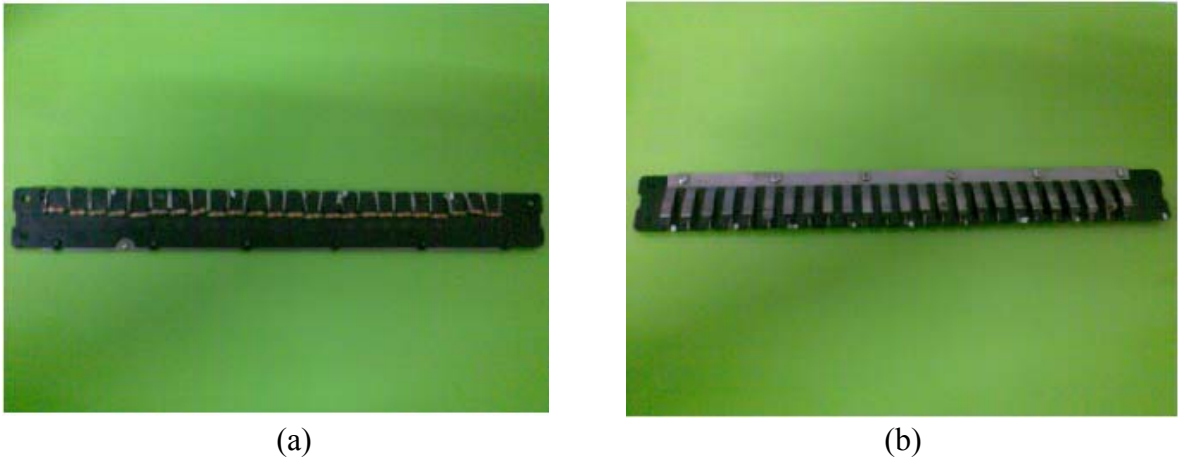


Figure 2.3 Series connected resistor a) Down side look for hardware
b) Upper side look for plat component.

Figure 2.3(a) is a series connection of 23 resistors. Each resistor has different resistance and all of it is placed on a plastic board. Figure 2.3(b) is an upper side of the plastic board. There is a metal plats that can move down if there is a force on it and return to initial condition when the force is remove. This hardware will act as a rheostat when there is supply (6V).

There are two connections that will connect with PCI-1710 for interfacing process. One connection is at the metal plat and one is at the series resistors. So when the plats touch any of the resistors, there is a voltage reading and PCI-1710 will evaluate the value and interface it into LabVIEW8.0 program.

2.3 Hardware Casing

Wood is a material that been used for hardware casing. This material is used because it has good pressure strength to become hardware casing. This material is just for prototype design and it more suitable for metal material to be used for industry usage.

It is designed to seem as distance detector. There are four plates (A, B, C and D) on the casing and the series resistors are place below the plates. Figure 2.4 shows the hardware casing. The hardware is just in prototype design so there are only four plates.



Figure 2.4 Hardware Casing