EVENT ANALYSIS ON CONVEYOR SORTER SYSTEM WITH IOT GATEWAY APPLICATION

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DECLARATION

I declare that this thesis entitled “EVENT ANALYSIS ON CONVEYOR SORTER SYSTEM WITH IOT GATEWAY APPLICATION is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have checked this report entitled “Event Analysis On Conveyor Sorter System With IoT Gateway Application” and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

Signature : .....

Supervisor Name : .....

Date : .....

DEDICATIONS

To my beloved mother and father

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ABSTRACT

Nowadays, the words “smart factories” are very popular in this information age due to the presence of forth industry. In Malaysia, many industry rather than investing in automation and IT, they prefer to keep their foreign workers. Hence, many manufacturing systems is not able to handle big data integration. The problem statement of this project is to verify the reliability of sensing control program, engineer needs to actually run of the manufacturing process to avoid the occurrence of a program error. The objective is to obtain the status of inputs and outputs (I/O) condition from conveyor sorter system by using Arduino Uno, to study the integration between Arduino Uno and raspberry pi for sending the data to the cloud and to compare between two different cloud data base in term of efficiency on timing. The first part of the report was an introduction of the project. The detail of the motivation, problem statement, objective and scope is mentioned in detail. In chapter 2, the literature review has conclude the previous and latest work that related to the project. Python programming language is studied to conduct the IoT gateway application using Raspberry Pi. In chapter 3, the method used and experiment was discussed in detail to achieve the objective. There was two programming platform that involve in this project which are Arduino IDE and Python language. Furtermore, some experiment is carried out to test the reliability of the data transmit between physical device with cloud server. Then, the analysis of the result is conducted by using different method of communication. Furthermore, the suitability of each method used in different condition is also discussed.

ABSTRAK

Pada masa kini, kata-kata "kilang-kilang pintar" sangat popular di zaman maklumat ini kerana kehadiran industri. Di Malaysia, banyak industri daripada melabur dalam automasi dan IT, mereka lebih suka mengupsh pekerja asing mereka. Oleh itu, banyak sistem perkilangan tidak dapat mengendalikan integrasi data yang besar. Pernyataan masalah projek ini adalah untuk mengesahkan kebolehpercayaan program kawalan sensing, jurutera perlu menjalankan proses pembuatan untuk mengelakkan berlakunya kesilapan program. Objektifnya adalah untuk mendapatkan status input dan output (I / O) dari sistem pengikat penghantar dengan menggunakan Arduino Uno, untuk mengkaji integrasi antara Arduino Uno dan raspberry pi untuk menghantar data ke atas talian dan membandingkan antara dua perkhidmatan talian yang berbeza pangkalan data dalam jangka masa kecekapan. Bahagian pertama laporan itu adalah pengenalan projek. Perincian motivasi, pernyataan masalah, objektif dan skop dinyatakan secara terperinci. Dalam bab 2, kajian literatur telah menyimpulkan kerja sebelumnya dan terkini yang berkaitan dengan projek. Bahasa pengaturcaraan Python dikaji untuk menjalankan aplikasi gateway IoT menggunakan Raspberry Pi. Dalam bab 3, kaedah yang digunakan dan percubaan dibincangkan secara terperinci untuk mencapai matlamat. Terdapat dua platform pengaturcaraan yang melibatkan projek ini iaitu bahasa Arduino IDE dan Python. Tambahan pula, beberapa uji kaji dijalankan untuk menguji kebolehpercayaan pemindahan data antara peranti fizikal dengan pelayan awan. Kemudian, analisis keputusan dijalankan dengan menggunakan kaedah komunikasi yang berbeza. Selain itu, kesesuaian setiap kaedah yang digunakan dalam keadaan yang berbeza juga dibincangkan.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	-	Internet of Things
I/O	-	Inputs and Outtputs
GPIO	-	General Purpose Input Output
PLC	-	Programmable Logic Controller
CPU	-	Central Processing Units
ROM	-	Read Only Memory
RAM	-	Random Access Memory
LD	-	Ladder Diagram
FBD	-	Function Block Diagram
IR	-	Infrared

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In an information age, internet playing an important role in our lifestyle, education, commercial hub, industrial zone, military, seafaring district, aerodrome, spaceport, and so on. Today, so call “smart factories” are mainly focus on monitor centered optimization and intelligence via the internet. Moreover, greater intelligence can be achieved by interacting with completely different encompassing systems, which have an instantaneous impact on machine performance [1].

In today’s information society, the quality and the correctness of the systems is one of the challenges to manage big data integration in industry field. The big data platform is to handle the data in new ways in which as compared to the normal online database, hence many industries face the challenges of big data integration. For example, big data talent gap, data in a big data structure, data synchronization across data sources, data extracting in big data integration, uncertainty of data management and so on. This all about the integration of big data and some of the challenges facing through Industry 4.0 during implementation. Therefore, formal verification and validation tools are needed to improve the consistency checker which produces detailed feedback about the detected error.

The key milestones in this evolution and the use of formal verification methods have enhanced the dependability of manufacturing software. This is very important to all production and manufacturing industry because when the delivery systems go wrong: delayed progresses, item transferred to the wrong department and end up in the remote place, there will be big trouble for the industries. Over the years, there is a number of researchers have done to increase the level of dependence of manufacturers on automation systems that are expected to be safe and reliable which is increase the dependability of the management systems.

1.2 Motivation

Nowadays, computerized decision making and huge data that proliferated by the internet are the challenges to the companies and competitive business environment. Many manufacturing systems don't seem to be able to handle big data integration due to the lack of intelligent management tools. For this reason, the German government has promoted the methods of computerization of manufacturing which is 4th Generation Industrial Revolution (Industry 4.0) base on Cyber-Physical System (CPS) to improve overall performance and maintenance management.

In Malaysia, many company and industry rather than investing in automation and IT, they prefer to keep their foreign workers. As a result, Malaysia is considered to be stuck at Industry 3.0 level in terms of manufacturing technology. In order to achieve flexible and efficient production, industry 4.0 is obtainable a brand new incentive which is Internet of Things (IoT).

The implementation of IoT nowadays is important in our lifestyle, education, commercial hub, industrial zone, military, seafaring district, aerodrome, spaceport, and so on. In industrial field, 60% of global manufacturers can use analytics data tracked using a connected device to analyze and optimize processes. With IoT, machinery can transmit the operation data information to the partners like original equipment manufacturers or field engineers to remotely manage the factory units and take advantage of process automation and optimization[2]. Besides that, the facility management which enables condition-based maintenance alert also can achieve with the implementation of IoT.

1.3 Problem Statement

In a massive automation control system or production line, there always face a similar problem which is when the error occurs in the system or machine, the operator should investigate the problem in the systems. If this happens frequently obviously will affect productivity. That's because of the physical system is not sufficient to do the analysis for the data from the systems. Therefore, Implementation of IoT to the physical systems is needed of industrial field use for investigation and authentication at any part of complex systems. The implementation of IoT not only benefit the industrial field in term of efficiency in the production flow, accuracy

facility management, inventory management, plant safety and security, quality control, packaging optimization and logistics, and supply chain optimization, it also benefits to others professional field. For example, architecture design, gathering necessities, blueprint, maintenance, implementation, examination, and development

Therefore, to verify the reliability of the sensing control program prior to an actual run of the manufacturing process is very crucial in order to avoid the occurrence of control program errors. Engineers of the manufacturing lines must ensure that the control program meets the predetermined requirements and specifications for any particular system.

1.4 Objective

The objective of the project are:

1. To obtain the status of inputs and outputs (I/O) condition from conveyor sorter system by using Arduino Uno.
2. To study the integration between Arduino Uno and raspberry pi for sending the data to the cloud.
3. To compare between two different cloud database in term of efficiency on timing.

1.5 Scope

The scopes of the project are:

1. A conveyor sorting system with several sensors which is a capacitive proximity sensor, a fiber optic sensor, inductive proximity switch, magnetic sensor, and an infrared sensor is used as the model of the system.
2. An Omron CP1E Programmable Logic Controller (PLC) is used as the control unit in the system.
3. Ladder Diagram is used as the programming tool for the PLC.
4. Software used in this project is C++ programming and python.

1.6 Summary

In overall, 4 subtopics which are the motivation of the project, the problem statement of the project, objectives and scope of the research were discussed. The objective of this project is to design a conveyor sorter system with IoT that can determine the behavior of the conveyor sorter system by using online model checking. Besides, this project also aims to develop a communication system between the conveyor sorter system and cloud by using the Arduino Uno and raspberry pi for real-time data transmission. Last but not least, to analyze the behavior of the conveyor sorter system. The next chapter will discuss the journal that related to the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the background of the project will be explained thoroughly for a more robust understanding of the project. A review of some connected works are going mentioned to get some fundamental data by synthesizing their project to make this research successful.

2.2 Programmable Logic Controller

The phrase programmable logic controller (PLC) also known as a programmable controller. PLC can be defined as an industrial solid-state computer that controls inputs and outputs and also makes a logic-based decision for automation processes [3]. Actually, this PLC is not the latest technology but it provides the fundamental learning of control system. Since the late 1960s, PLCs were introduced by inventor Richard Morley to provide the same functions as a relay logic systems [3]. Basically, the PLC itself is using programmable memory to store the coding command and execute the instructions through the logic control, sequencing, timing, counting and arithmetic [4]. PLC hardware components consist of a central processing unit (CPU) which function as the brain of the PLC and memory which provide the permanent storage to the operating system for the CPU [3]. PLC contains two types of memory, one is a read-only memory (ROM) which stores the data permanently for the operating system, and another one is random access memory (RAM) which is to stores status information for input and output devices [3]. Besides this, to operate the PLC, a program or language is needed upload to the CPU, either using a console or computer. Figure 2.1 shows the basic requirement to operate a PLC.

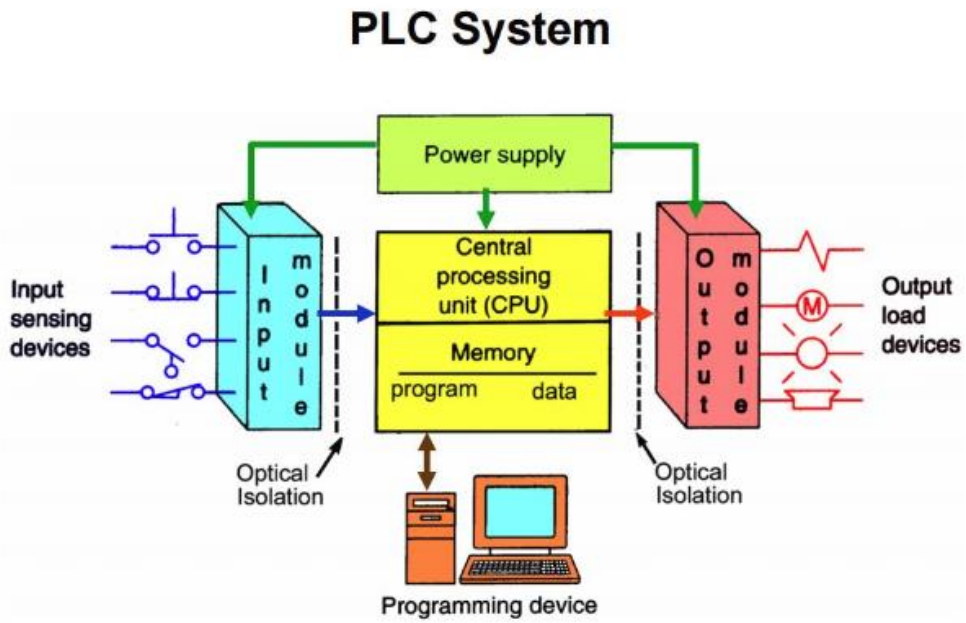


Figure 2.1 Basic Requirement to Operate a PLC [3]

In this project, PLC Omron CP1E is used to control the conveyor sorter systems with the programming method by using CX-Programmer with Ladder Diagram languages. For PLC Omron CP1E, it consists of a total 20 of input and output points (I/O), which is 12 inputs and 8 outputs control [4].

2.3 PLC Programming Language

The programming language, the elfevident is a formal language that use to create a standard form of commands that machine can be understood. In PLC, there are 4 popular languages for implementation. First, also the most popular use of language for programming PLCs which is Ladder Diagram (LD). The phrases ladder diagram (LD) also known as line diagrams or elementary diagrams. LD is used to show the function of the relay circuit and the association of the device but they don't show the type of components used in the circuit and actual physical position [5]. The LD programs are transferred to the PLC, according to the program and connect the input and output device to I/O module and execute the system [6]. Figure 2.2 shows a simple ladder logic diagram.

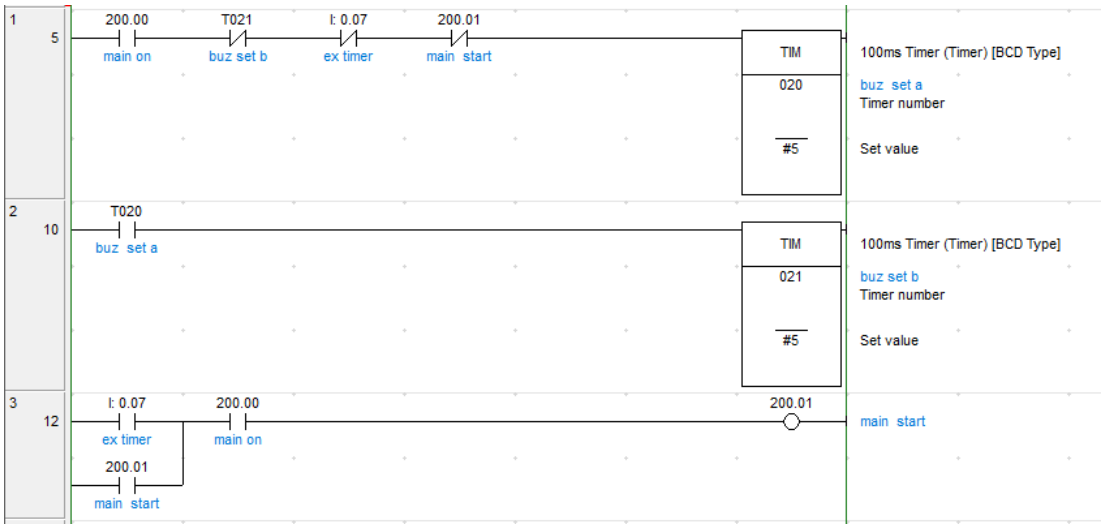


Figure 2.2 A Simple Ladder Logic Diagram

Second, function block diagram FBD is used for PLC programs express in term of graphical block [6]. In other words, FBD also known as a graphical language for depicting signal and data flows through inputs blocks. The logic gates, counter, timer or those function that defined by the user all can call a standard function in FBD [6]. FBD is also known as a set of an elementary block in which the input and output variable is connected to blocks by connection lines [7]. Figure2.3 shows a basic function block diagram.

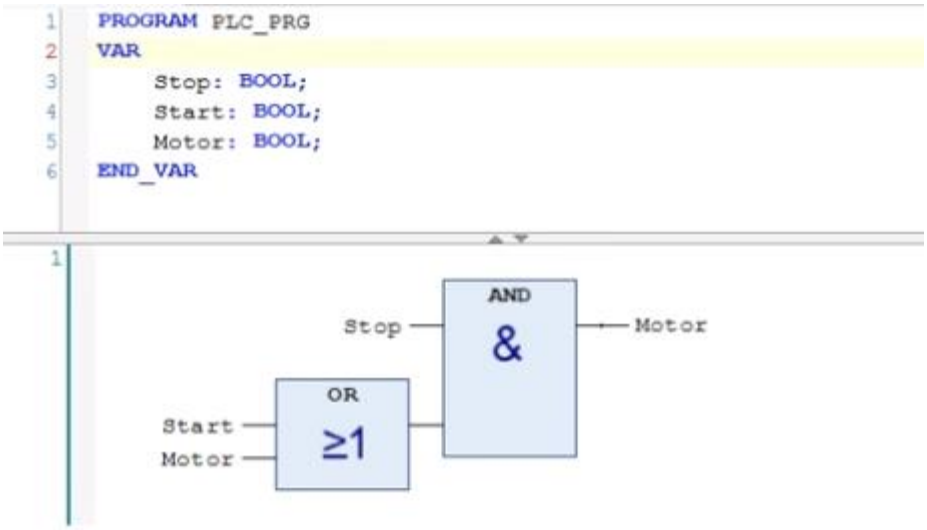
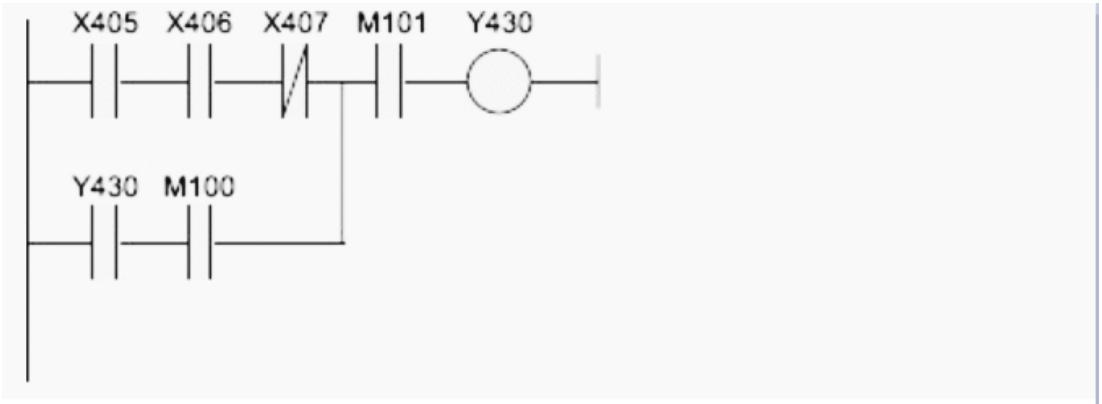


Figure 2.3 A Simple Function Block Diagram

Third, instruction list (IL) is one of the 4 languages supported by PLC. It is a low-level language and resembles assembly, and only available on a few brands of

PLC [6]. The variable and function in the circuit diagram are defined by the common elements, hence the advantage is different language can be used in the same program. Figure 2.4 shows the simple operation in ladder diagram form a PLC with an equivalent instruction list.



Line	*Instruction*	*Comment*
0	LD X405	LD starts rung or branch
1	AND X406	*Xnnn* are inputs (AND-ing is for series connection)
2	ANI X407	ANI is AND with not
3	LD Y430	LD starts a new branch leg
4	ANI M100	*Mnnn* are internal storage
5	ORB	OR the two branch legs (OR-ing for parallel connection)
6	AND M101	
7	OUT Y430	End of rung with output

Figure 2.4 Simple Operation in Ladder Diagram form a PLC with Equivalent Instruction List [6]

Fourth, logic functions also known as one of the languages supported by PLC. The logic function itself is a program that implementing a Boolean Algebra. Boolean Algebra deals with the theory which in the values of the variables are either true or false or in other words 1 and 0 respectively [8]. In logic function, 1 represent On or closed circuit, 0 represent Off or open circuit. Figure 2.5 shows a different logic function with its symbol, truth table, FBD, and LD.

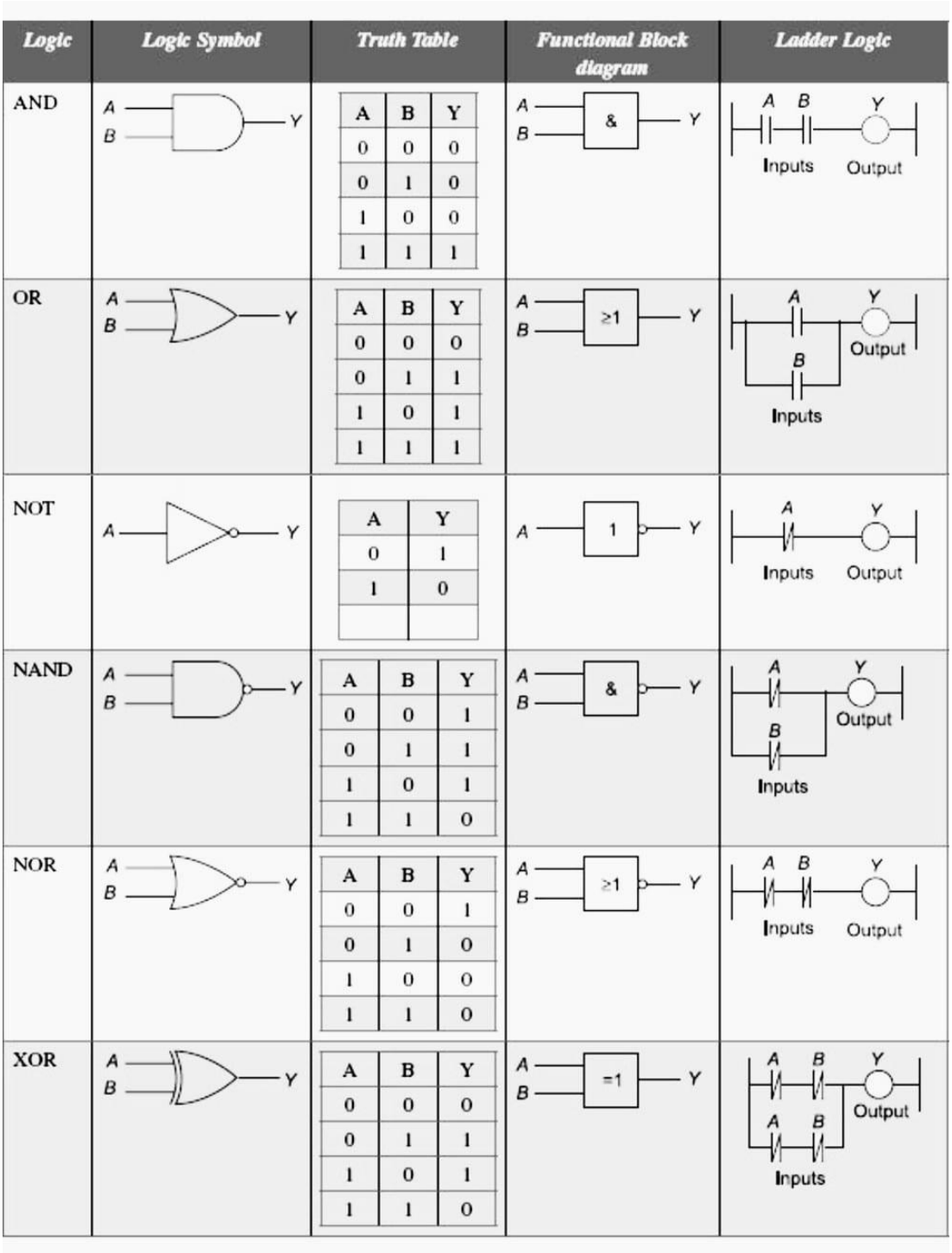


Figure 2.5 A Different Logic Function with its Symbol, Truth Table, FBD, and LD [6]