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AUTOMATIC DETECTION USING HUMAN MACHINE INTERFACE (HMI)

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*Dedicated to my **lovely husband, Shaharuddin Bin Nordin, my parents, Mahidin Bin Seman and Rohani Binti Abdullah, my siblings and my beloved friends.***

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To my lovely husband, and also my parent who had relentlessly support me throughout the project and the accomplishment of this thesis. To my group colleague, Encik Zulafandi that helped a lot with his idea and suggestion. Thousands of appreciation to my fellow lecturers, for their willingness to listen, to point out their critique and voice out their comment towards the success of the project. Last but not least, my respected supervisor, Engr. Muzafar for his valuable advice and views. Finally, I would like to express my gratitude to the department that sponsored my study in UTEM, Majlis Amanah Rakyat (MARA). Thank you all.

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ABSTRACT

This thesis is about the Automatic Detection Using Human Machine Interface. This system consists of PLC programming network, and how every element merge such as sensor, input and output for every control made in the system called as Human Machine Interface. The flow of the system begins with the detection made by the sensor to quantify the hygiene level of the bottle which runs over in the conveyor system. The first sensor detect the existence of the bottle, second sensor will determine the hygiene level of the bottle with a pre-set mode, third sensor will fill up the bottle with water and the fourth one will detect a full bottle to the next process. PLC that had been programmed with the Ladder Diagram method is built to control every flows of the operation and connected with HMI concept. A Graphic User Interface (GUI) is built to help the observation made throughout the operation. The system operation's is set to operate in dual mode, manual or automatic. This developed project detects the hygiene level of the tested bottles. It suits nicely to be commercialized in a minimum bottles preparation system where each bottles tested to guarantee its quality are clean and safe. In addition, the system can also be used as additional teaching tools for student to elevate their understanding level in the industry including a latest developed technology.

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ABSTRAK

Tesis ini adalah mengenai Pengesanan Automatik Menggunakan Human Machine Interface. Sistem ini terdiri daripada rangkaian pengaturcaraan PLC, dan bagaimana setiap elemen digabungkan seperti sensor, masukan dan keluaran bagi setiap kawalan dilakukan didalam system tersebut yang dinamakan sebagai Human Machine Interface. Aliran sistem bermula dengan proses pengesanan yang dilakukan oleh sensor untuk mengukur tahap kebersihan botol yang bergerak diatas system konveyor. Sensor pertama mengesan kehadiran botol, sensor kedua akan menentukan tahap kebersihan botol yang diuji, sensor ketiga akan mengisi botol dengan air dan yang keempat akan mengesan botol penuh untuk proses selanjutnya. PLC yang telah diprogramkan dengan kaedah Ladder Diagram dibina untuk mengawal setiap arus operasi dan dihubungkan dengan konsep HMI. Sebuah Graphic User Interface (GUI) dibina bagi membantu pengamatan seluruh operasi. Operasi system ditetapkan untuk beroperasi dua mode; manual dan automatic. Projek ini dibangunkan mengesan tahap kebersihan botol yang diuji. Ianya sesuai digunakan untuk industri pembotolan air dimana setiap botol diuji untuk memastikan kualiti yang bersih dan selamat. Selain itu, system ini juga boleh digunakan sebagai alat bantu mengajar bagi pelajar untuk meningkatkan tahap pemahaman mereka dalam bidang industri termasuk teknologi yang sedang giat dibangunkan masakini.

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CHAPTER 1

INTRODUCTION

1.0 Background of Study

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result. The PLC also can interface with HMI system in order to supervise the system. This thesis presents Automatic Detection Using Human Machine Interface. In this study, the complete display is in the form of graphic user interface [GUI], to perform manual mode and automatic mode of the system implementation. A complete system has been developed and performed the task accordingly.

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1.1 Objectives

The followings are the objective of the project;

a) To develop a mini simulation model of Automatic Detection Using Human Machine Interface in the industrial control.
b) To design a graphic user interface that will facilitate in monitoring the process of the system.
c) To demonstrate how the HMI applications can be used in the industry.
d) To apply the knowledge in the manufacturing, instrumentation and control application.

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1.2 Problem statement

Nowadays, industry manufacturing brought widespread use of tools and machines to workplace and grown in number and complexity day by day. The tools and machinery mainly controlled by the PLC. The switch and actuators are controlled manually, semi-automatic or fully automatic from the input through to the output. To reduce the complexity of connection or wiring between the input and output, also to ensure the safety and easier in monitoring process, a technology called as Human Machine Interface (HMI) was introduced to set the convenience and easier to used. The technology that applied touch screen display was built to control the flow of information from the machine to the user and from the user to the machine. A display called as Graphic User Interface (GUI) which was built in to interface the program from the PLC to the HMI. In the area of current drinking water bottling, the bottle are recycled is sent to the manufacturer for the process of refilling water. Cleanliness bottles are inspected at random. To ensure the cleanliness and high quality, each bottle should be inspected. The inspected process used laser sensor to detect the bottle.

1.3 Scope of work

This project involves the study on knowledge acquisition of interfacing among HMI, PLC and Hardware. This project will design the GUI for HMI system. The project achievement is to design a graphic user interface that will facilitate in monitoring the process of the system and to demonstrate how the HMI applications can be used in the industry. PLC programming and Graphic User Interface development will not covered in this paper.

1.4 Methodology

Several steps have been taken in order to implement the study. The designs are employed to this project due to automatic detection using human interface. For better understanding the research methodology is shown in Figure 1.1. The study involved the followings:-

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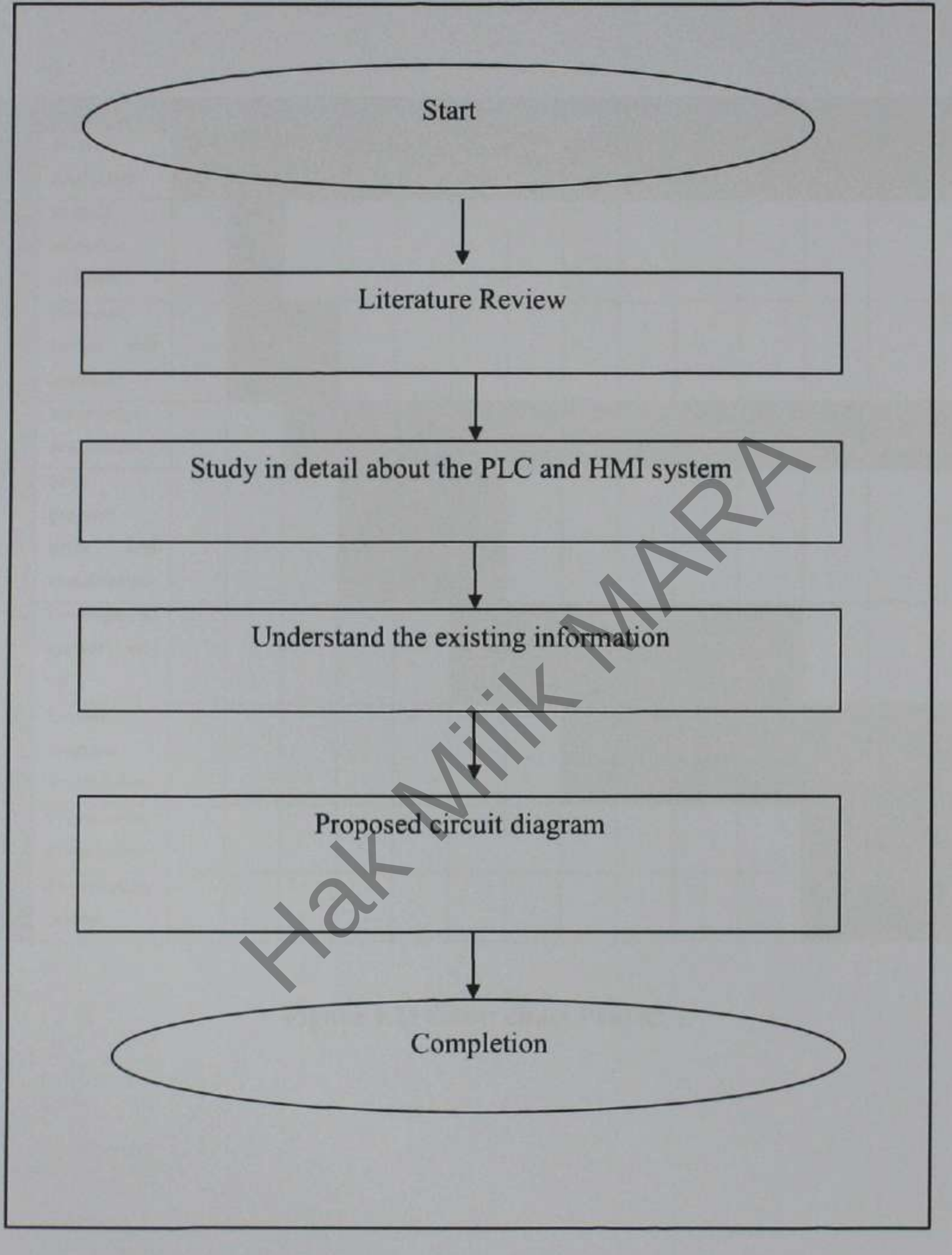

Figure 1.1: Research Methodology

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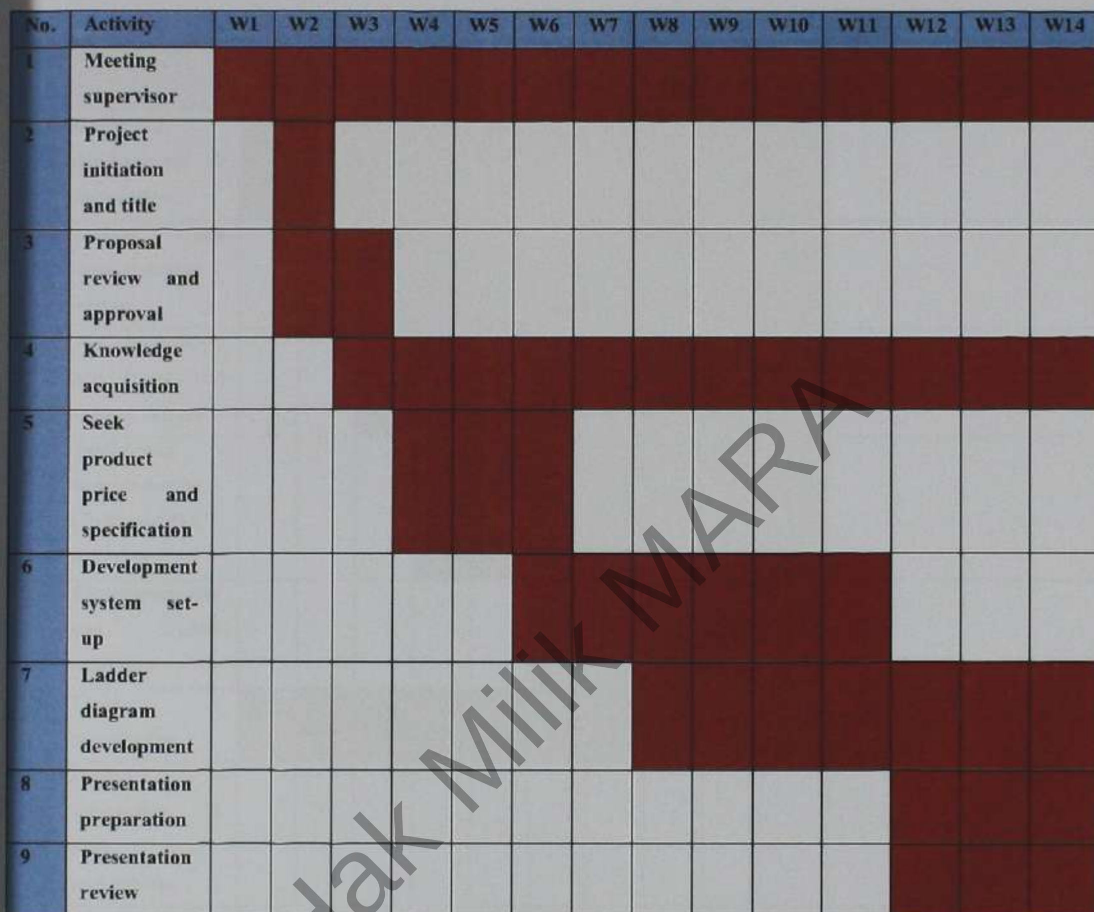

Figure 1.2: Gantt chart Project 1

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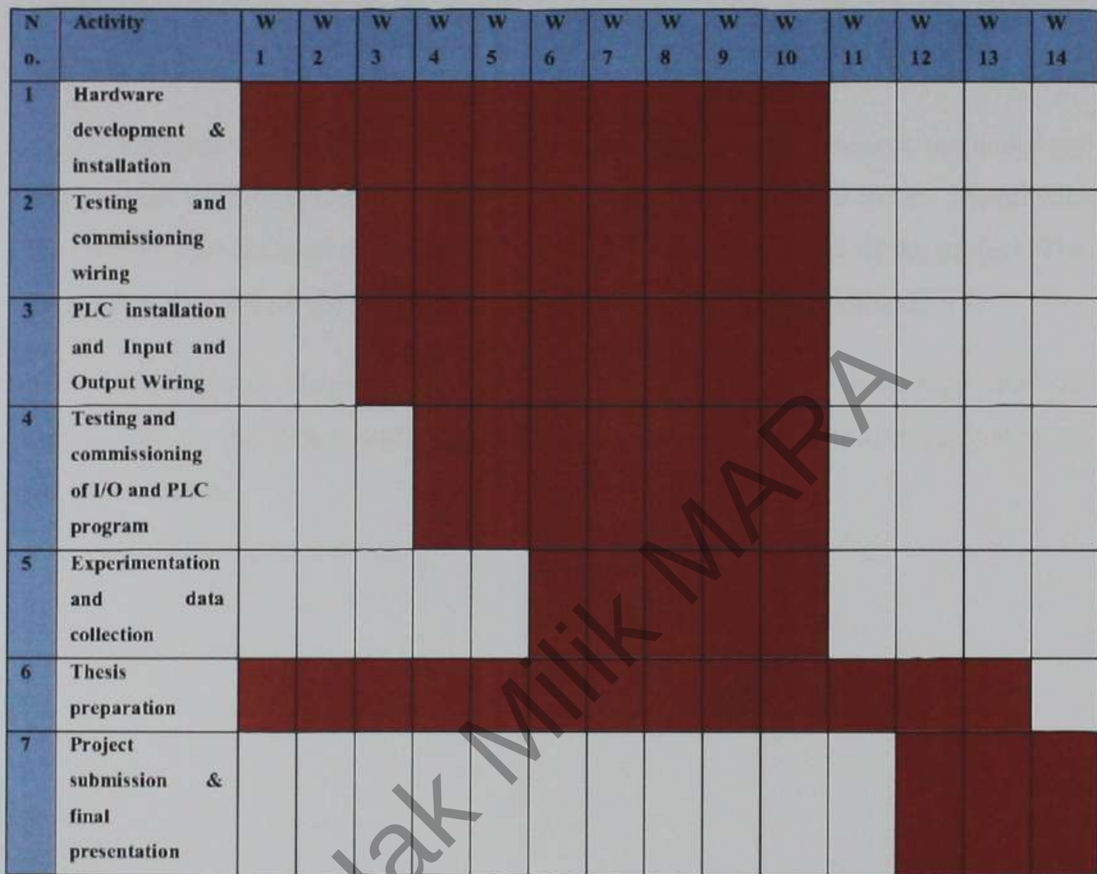

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Figure 1.3: Gantt chart Project 2

1.5 Organization of the Thesis

This thesis consists of five chapters including this introduction follow the university thesis standard which including objectives, scope of the works, problem statement and methodology. In second chapter present the literature review of introduction and uses of the equipment used in this project; PLC, HMI, GUI and sensors.

Presents the study which includes most of the related research methodology and process of the experiment detailed will be present at chapter three. Meanwhile the chapter four focused on presenting the results and discussions of the project. The discussion focused on the analyses with referring to the results obtained.

Beside that chapter five present the result, analysis, discussion and the conclusions of the topics with regards to this topics and the future development of the experiments.

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CHAPTER 2

LITERATURE REVIEW

2.0 Programmable Logic Controller System

PLC programs are typically written in a special application on a personal computer, and then downloaded by a direct-connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory. Often, a single PLC can be programmed to replace thousands of relays. Figure 2.1 illustrates the block diagram for a general PLC system.

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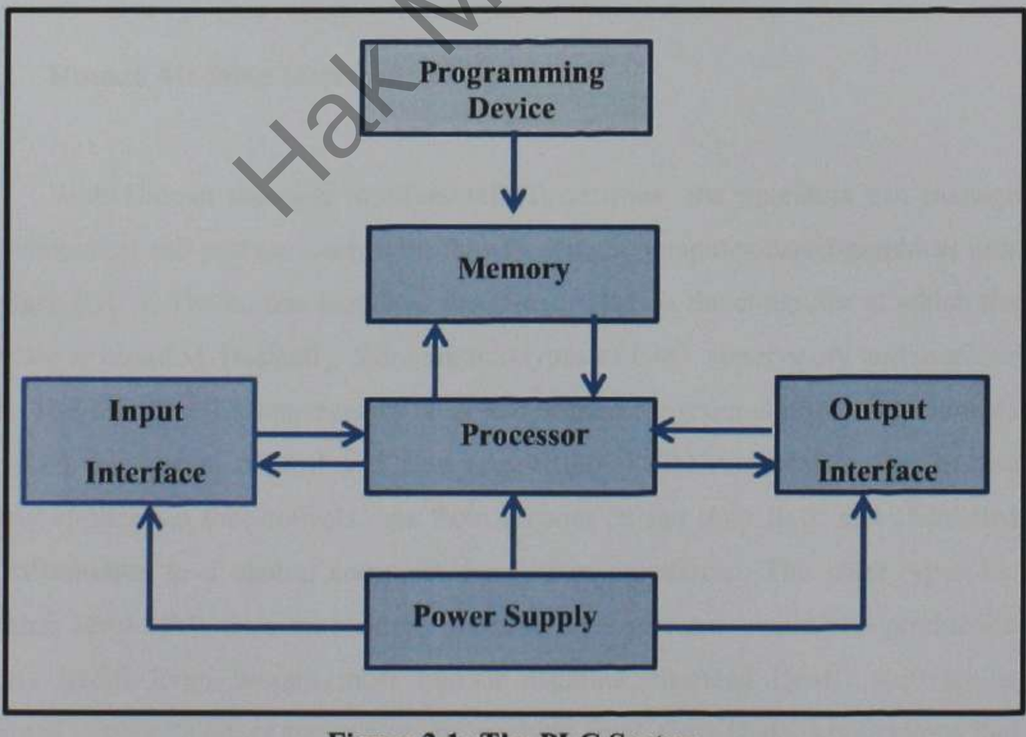

Figure 2.1: The PLC System

PLCs can be programmed using standards-based programming languages. A graphical programming notation called Sequential Function Charts is available on certain programmable controllers. Initially most PLC's utilized Ladder Logic Diagram Programming, a model which emulated electromechanical control panel devices (such as the contact and coils of relays) which PLC's replaced. This model remains common today.

IEC 61131-3 currently defines five programming languages for programmable control systems: FBD (Function block diagram), LD (Ladder diagram), ST (Structured text, similar to the Pascal programming language), IL (Instruction list, similar to assembly language) and SFC (Sequential function chart). The first PLCs were programmed with a technique that was based on relay logic wiring schematics. These techniques emphasize logical organization of operations. While the fundamental concepts of PLC programming are common to all manufacturers, differences in I/O addressing, memory organization and instruction sets mean that PLC programs are never perfectly interchangeable between different makers. Even within the same product line of a single manufacturer, different models may not be directly compatible [4].

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2.1 Human Machine Interface (HMI)

With Human machine interface (HMI) software, the operators can manage their industrial and process control machinery using a computer-based graphical user interface (GUI). The human machine interface or HMI is the computer in which the software is installed. Basically, there are two types of HMI: supervisory and machine level. The first type i.e. supervisory level is designed for room control environments and used for system control and data acquisition (SCADA), referring to process control application that collects data from sensors on the shop floor and channeled the information to a central computer for further processing. The latter types i.e. machine level HMI uses embedded, machine-level devices within the production facility itself. Even though most human machine interface (HMI) software is designed to operate either supervisory or machine level, there is also applications that suits for both types. Those software applications are more expensive, but the benefits will eliminate redundancies and cut down long-term costs.

An analysis of products specifications and features are vital on selecting human machine interface (HMI) software. Besides that, other important considerations are; system architectures, standards and platforms; ease of implementation, administration, and use; performance, scalability, and integration; and total costs and pricing. Some human machine interface (HMI) software provides data logging, alarms, security, forecasting, operations planning and control (OPC), and ActiveX technologies. Others support data migration from legacy systems. Communication on multiple networks can support up to four channels. Supported networks include ControlNet and DeviceNet. ControlNet is a real-time, control-layer network that provides high-speed transport of both time-critical I/O data and messaging data. DeviceNet is designed to connect industrial devices such as limit switches, photoelectric cells, valve manifolds, motor starters, drives, and operator displays to programmable logic controllers (PLC) and personal computers (PC).

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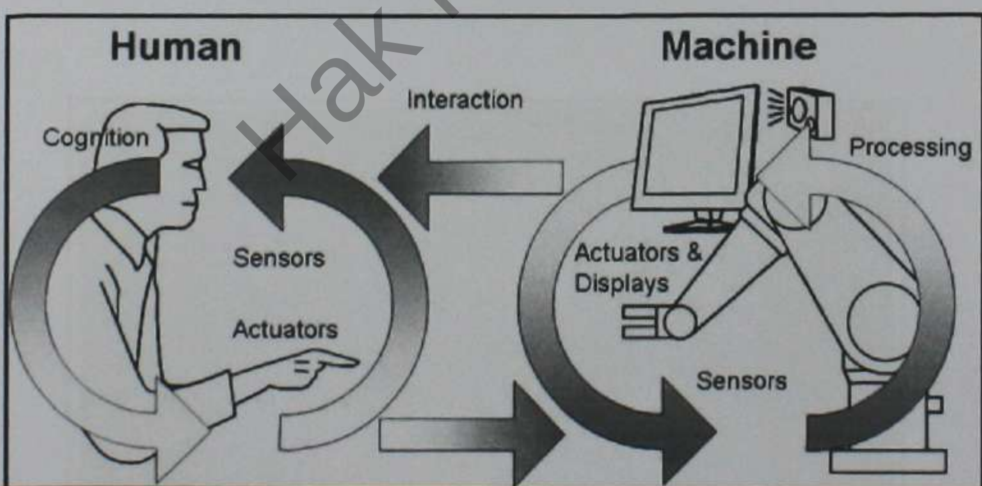

Figure 2.2: The interaction between human and machine

2.2 Graphic User Interface

Graphic User Interface (GUI) is one model of interaction between human and computer. Currently, it is almost software manufacturer trying to make GUI more attractive so that users will also be interested in using the software. It is demanded of the GUI is no longer user friendly but also usability. Usability has 3 aspects;

a) Learnability – easy for new user to be able to use the system effectively and achieve the most optimal performance.
b) Flexibility – variation method/model for users and system in the exchange of information.
c) Effectiveness/robustness – level of support provided for users to achieve their goals with success and provide an assessment of behavior that is directed by a goal.

The third aspect above is if attained, will give the value of attitude (comfort for the user). Evaluation of GUI views of the principle of user friendly and usability can be done by looking at how the development of the GUI from time to time.

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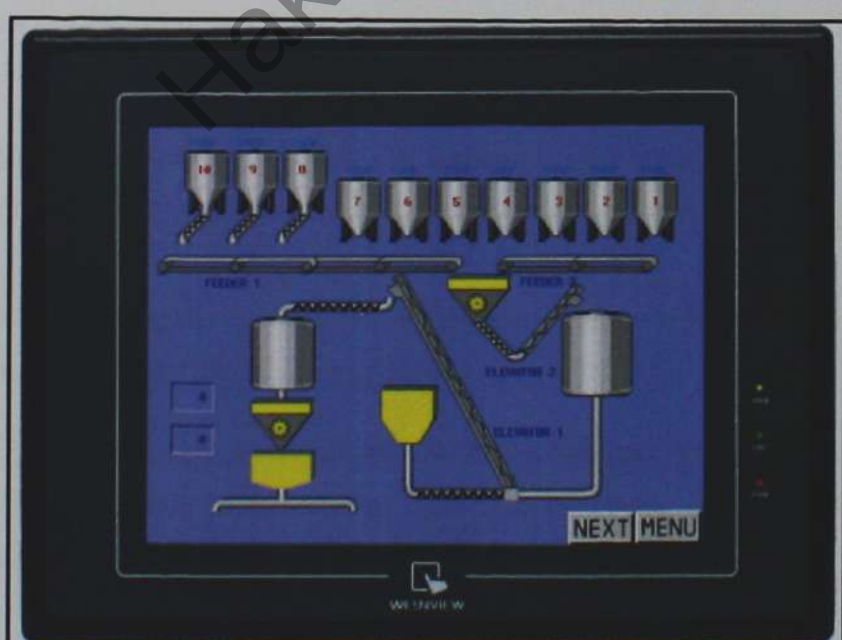

Figure 2.3: The Graphic User Interface

2.3 Sensors

In relation to electronic systems, sensors and transducers can generally be viewed as a device that functionality changing of a physical quantity into electrical quantity so that the output can be processed by electric circuits or digital systems. Today, almost all modern equipment has in it. In environmental control systems and robotics, sensors provide functions like the eyes, ears, nose, and tongue which will then be state electronic device that wrapped tightly to protect from the effects of vibration, fluid, chemical, and corrosive excessive.

Classification Sensor

In general, based on function and usage sensors can be grouped into 3 parts:

a) thermal sensor (thermal)
b) mechanical sensors
c) optical sensor (light)

Thermal sensor is a sensor used to detect changing in heat or temperature at one dimensional object or a particular spatial dimension. For example, bimetallic, thermistor, thermocouple, RTD, photo transistor, photodiode, photo multiplier, photovoltaic, infrared pyrometer and etc.

Mechanical sensor is a sensor that detects changes in mechanical motion, such as displacement or shift or position, straight and circular motion, pressure, flow, level etc.

Example; strain gage, deferential linear variable transformer (LVDT), proximity,potentiometers, load cells, Bourdon tube, etc.

Optic or light sensors are sensors that detect changes in light from the light source, light reflection or refraction of light that hit object. Example: photo cell, photo transistor, photo diode etc.

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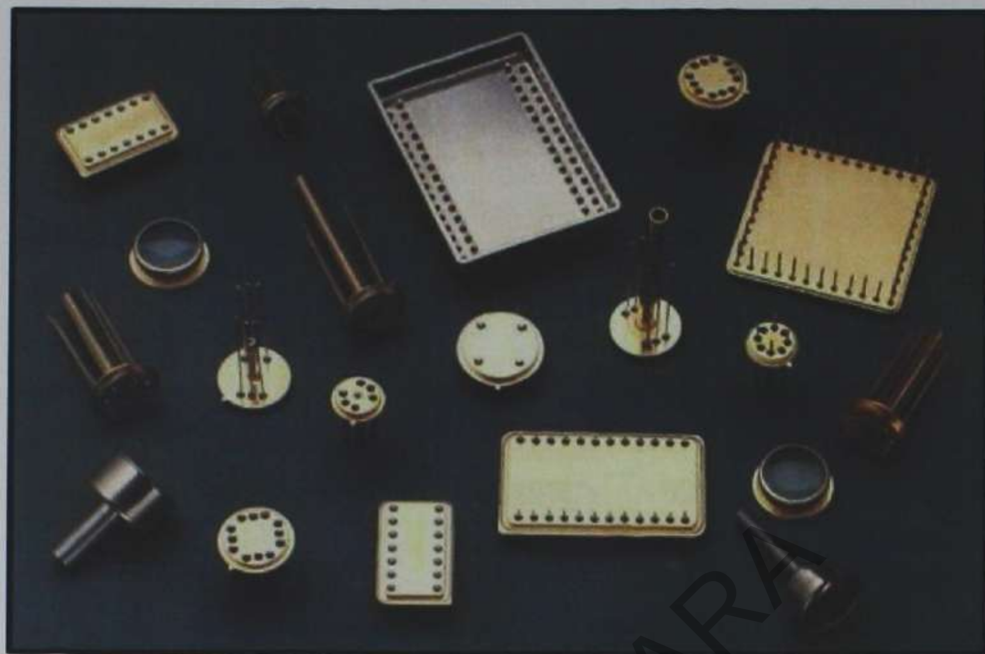

Figure 2.4: Varieties of sensors

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CHAPTER 3

RESEARCH METHODOLOGY AND PROCESS

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3.0 Introduction

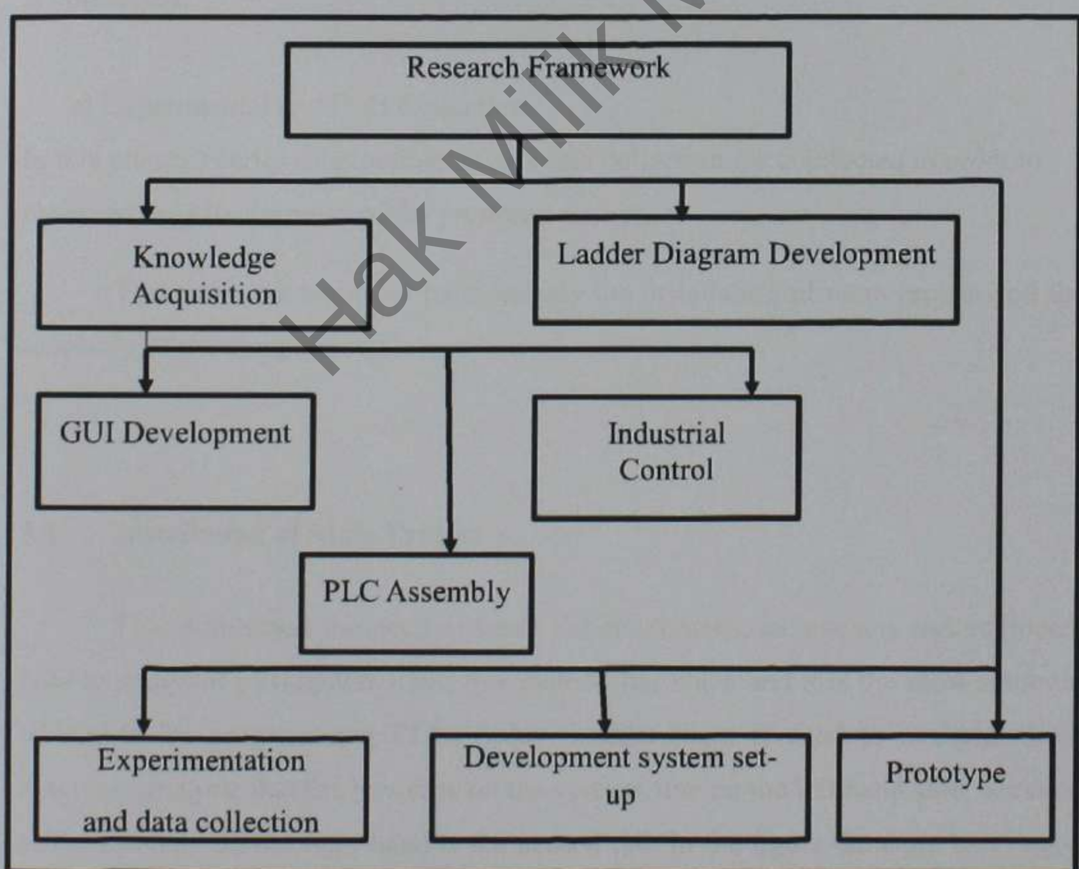

Figure 3.1: Research Methodology

a) Knowledge acquisition

In this phase, knowledge in GUI development, PLC assembly and industrial control modelling are acquired in order to give basic understanding for the project.

b) Development of the system set up

In this phase, development of the system set-up is conducted in order to implement the basic idea of the project. Hardware set-up is involve this phase.

c) Ladder Diagram Development

In this phase, ladder diagram is developed in order to execute the automatic flow of the system process. This phase will control the whole process for the dirt detection in the system.

d) Prototype Development

In this phase, the complete system is develop which involve the complete prototype is conducted.

e) Experimental and Data Collection.

In this phase, a series of experiments and data collection are conducted in order to observed the effectiveness of the proposed design.

This project consists of parts namely the installation of main project and the assembly of the components:

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3.1 Installation of Main Project

This eliminated the need to teach the electricians, technicians and engineers how to *program* a computer - but, this method has stuck and it is the most common technique for programming PLCs today. Ladder logic is used to interpret these diagrams imagine that the power is on the vertical line on the left hand side, is called as the hot rail. On the right hand is the neutral rail. In the figure there are two rungs, and on each rung there are combinations of inputs (two vertical lines) and outputs (circles). If the inputs are opened or closed in the right combination the power can flow from the hot rail, through the inputs, to power the outputs, and finally to the neutral rail [4]. An input can come from a sensor, switch, or any other type of sensor. An output will be some device outside the PLC which can be switched on or off, such as lights or motors. In the top rung the contacts are normally open and normally closed. This means that if input A is „on" and input B is „off", then power will flow through the output and activate it. Any other combination of input values will result in the output *X* being off [3].

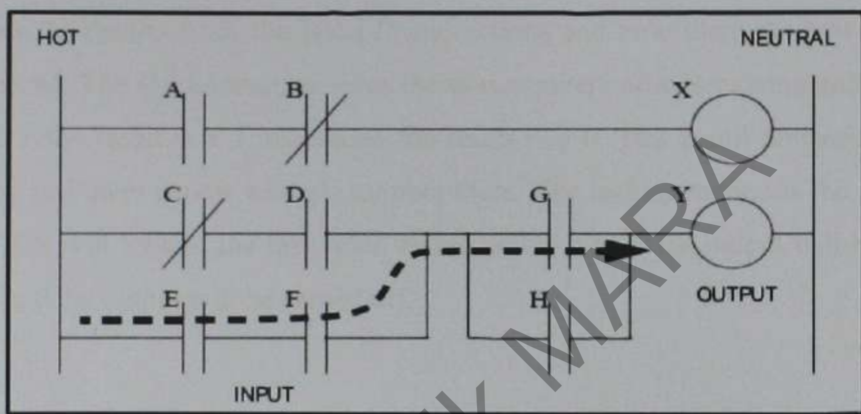

Figure 3.2: A Simple Ladder Logic Diagram

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The second rung of Figure 3.2 is more complex, there are actually multiple combinations of inputs that will result in the output *Y* during the turning on. On the left side most part of the rung, power could flow through the top if *C* is off and *D* is on. Power could also (and simultaneously) flow through the bottom if both *E* and *F* are true. This would get power half way across the rung, and then if *G* or *H* is true the power will be delivered to output *Y*.

There are other methods for programming PLCs. One of the earliest techniques involved mnemonic instructions [2]. These instructions can be derived directly from the ladder logic diagrams and entered into the PLC through a simple programming terminal. An example of mnemonics is shown in Figure 3.3. In this example the instructions are read one line at a time from top to bottom. The first line *00000* has the instruction *LDN* (input load and not) for input *00001*. This will examine the input to the PLC and if it is off it will remember a *1* (or true), if it is on it will remember a *0* (or false). The next line uses an *LD* (input load) statement to look at the input. If the input is off it remembers a *0*, if the input is on it remembers a *1* (note: this is the reverse of the *LD*). The *AND* statement recalls the last two numbers remembered and if the are both true the result is a *1*, otherwise the result is a *0*. This result now replaces the two numbers that were recalled, and there is only one number remembered. The process is repeated for lines *00003* and *00004*, but when these are done there are now three numbers remembered. The oldest number is from the *AND*, the newer numbers are from the two *LD* instructions. The *AND* in line *00005* combines the results from the last *LD* instructions and now there are two numbers remembered. The *OR* instruction takes the two numbers now remaining and if either one is a *1* the result is a *1*, otherwise the result is a *0*. This result replaces the two numbers, and there is now a single number there. The last instruction is the *ST* (store output) that will look at the last value stored and if it is *1*, the output will be turned on, if it is *0* the output will be turned off.

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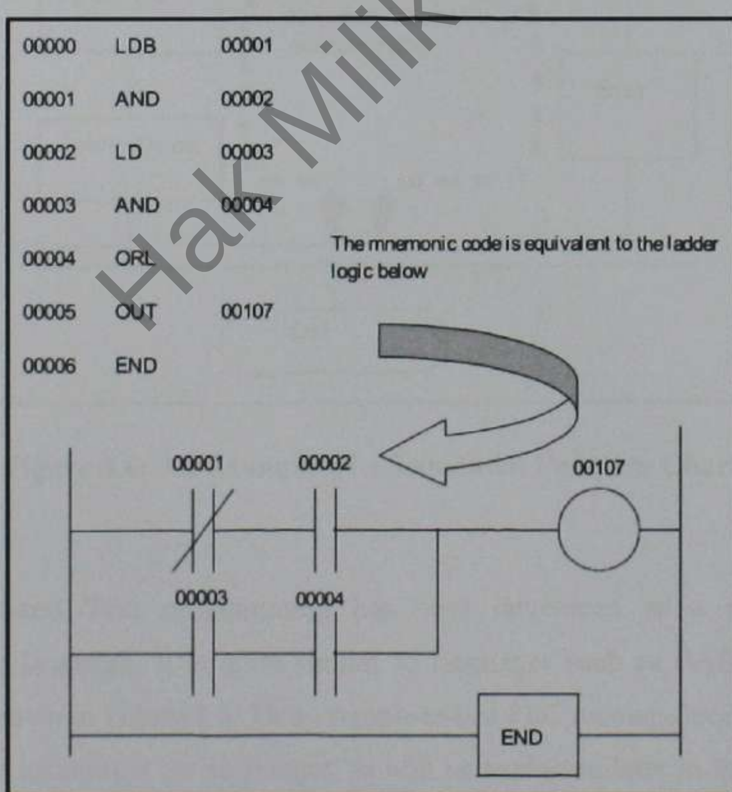

Figure 3.3: An Example of a Mnemonic Program and Equivalent Ladder Logic

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Sequential Function Charts (SFCs) have been developed to accommodate the programming of more advanced systems. These are similar to flowcharts, but much more powerful. The example seen in Figure 3.4 performs two different things. To read the chart, start at the top where is says *start*. Below this unit there is the double horizontal line that says both paths. As a result the PLC will start to follow the branch on the left and right hand sides separately and simultaneously. On the left side there are two functions with the first one is the *power up* function. This function will run until it decides it is done, and the *power down* function will come after. On the right hand side it is the *flash* function, this will run until it is done. These functions look unexplained, but each function, such as *power up* will be a small ladder logic program [6]. This method is much different from flowcharts because it does not have to follow a single path through the flowchart.

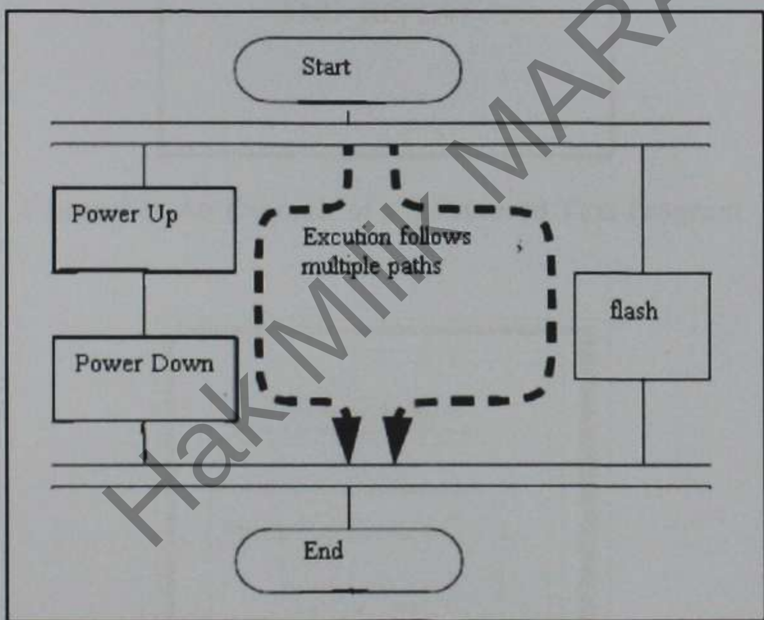

Figure 3.4: An Example of a Sequential Function Chart

Structured Text programming has been developed as a more modern programming language. It is quite similar to languages such as BASIC. A simple example is shown in Figure 3.5. This example uses a PLC memory location N7:0 [6]. This memory location is for an integer, as will be explained later in this thesis. The first line of the program sets the value to 0. The next line begins a loop, and will be where the loop returns to. The next line recalls the value in location N7:0, adds 1 to it

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and returns it to the same location. The next line checks to see if the loop should quit. If N7:0 is greater than or equal to 10, then the loop will quit, otherwise the computer will go back up to the REPEAT statement continue from there. Each time the program goes through this loop which N7:0 will increase by 1 until the value reaches 10.

```
N7 : 0 : =0;
REPEAT
N7 : 0 : = N7 : 0 + 1 ;
UNTIL N7 : > = 10
END_REPEAT :
```

Figure 3.5: An Example of a Structured Text Program

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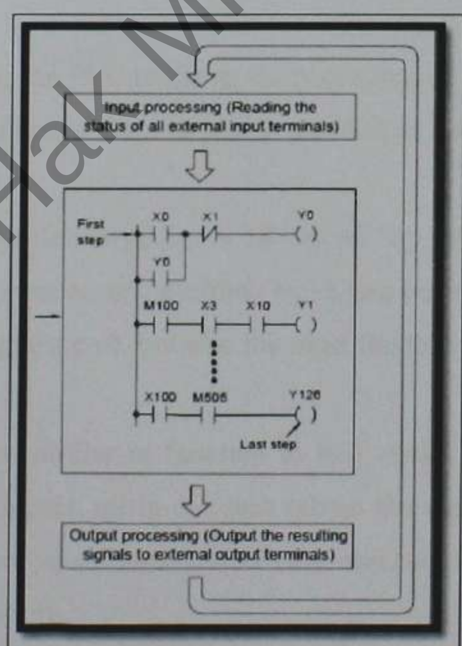

Figure 3.6: PLC sequentially executes the stored program and gets new output result.

Many PLC configurations are available, even from a single vendor. But, in each of these systems there are common components and concepts. The most essential components are:

a) Power Supply - This can be built into the PLC or be an external unit. Common voltage levels required by the PLC (with and without the power supply) are 24Vdc, 120Vac, 220Vac.

b) CPU (Central Processing Unit) - This is a computer where ladder logic is stored and processed.

c) I/O (Input / Output) - A number of input/output terminals must be provided so that the PLC can monitor the process and initiate actions.

d) Indicator lights - These indicate the status of the PLC including power on, program running, and a fault. These are essential when diagnosing the problems.

The configuration of the PLC refers to the packaging of the components. Typical configurations are listed below from largest to smallest as shown in Figure 3.6.

a) Rack - A rack is often large (up to 18" by 30" by 10") and can hold multiple cards. When it is necessary, multiple racks can be connected together. These tend to be the highest cost, but also the most flexible and easy to maintain.

b) Mini - These are similar in function to PLC racks, but about half the size. Shoebox - A compact, all-in-one unit (about the size of a shoebox) that has limited expansion capabilities. Lower cost, and compactness make these ideal for small applications.

c) Micro - These units can be as small as a deck of cards.

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Figure 3.7: Typical Configurations for PLC

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3.2. Human Machine Interface

Human-Machine Interface (HMI) is a modification of the original term MMI (man-machine interface).The term user interface is often used in the context of computer systems and electronic devices. The user interface of a mechanical system, a vehicle or an industrial installation is sometimes referred to as the human-machine interface (HMI)[2].

Figure 3.8: Human Machine Interface of Mytek

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3.2.1 Multi HMI Connection

Multi HMI connection provides two type of connection:

a) 1: RS485 connection / 2 to 1 server
b) 2: Ethernet connection – Data Sharer
c) RS485 connection : 2-to-1 server connection

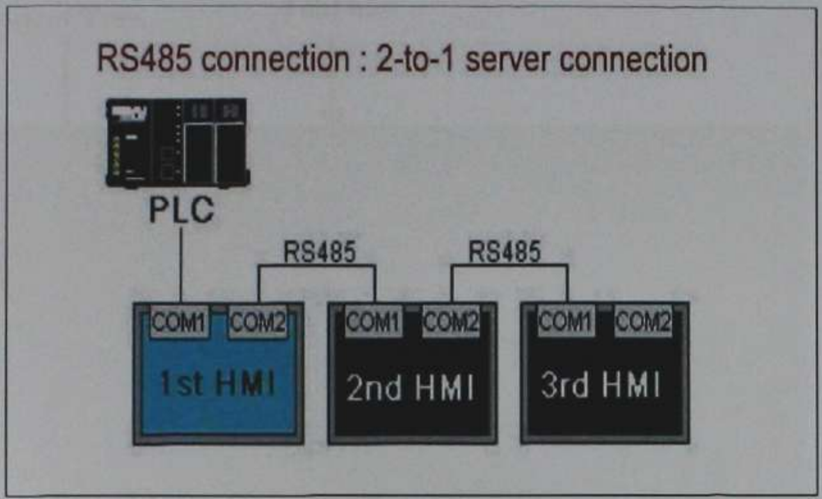

Figure 3.9: Multi HMI Connection

Hardware equipment needs before installing PanelMaster, the computer hardwares must meet with the following requirements:

a) At least Pentium CPU III
b) At least 100MB space avaliable in the hard drive.
c) At least 64MB in available system memory.
d) Serial port or LAN port（Use for communication between PanelVisa's HMI and downloading files from PC）
e) A PanelMaster installing CD.
f) OS System：Windows 2000/XP (For using Unicode text system)

3.2.2 Program structure and operation of Panel Master

When a new project is opened, the screen shows a working area as in Figure 3.9. There are two management areas in the screen. There are 11 function menus in the menu list, which are "File" , "Edit", "View", "Screen", "Draw", "Object", "Project", "Panel", "Tool", "Windows", "Help". The function menus provide a lot of items for panel designs.

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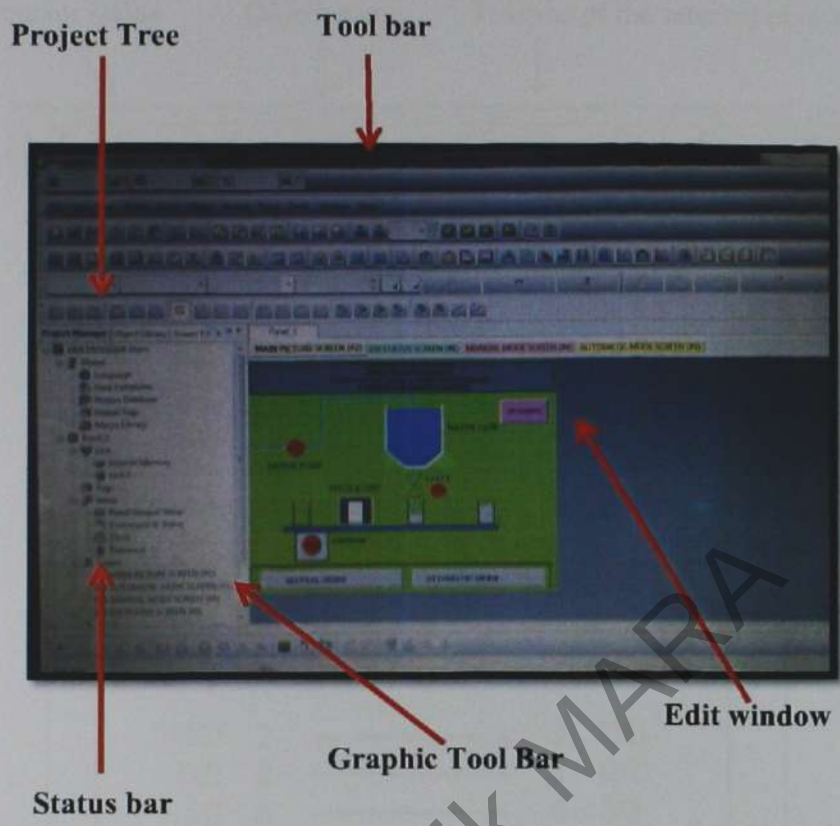

Figure 3.10: Panel Master Software

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In the project manager and screen manager tree are on the left side of the program screen. This area is for quick setting of the main functions and for overview. The edit window is a larger area on the right side. It is used for texts, objects, screens and macro designing. Different functions and screens on this area can be edited. The screens are of different sizes according to panel models that can be chosen, which are the actual sizes as shown in HMIs.

The status bar at the bottom of screen is shown below. From here displays the x-y-coordination of the cursor and basic information of the selected object.

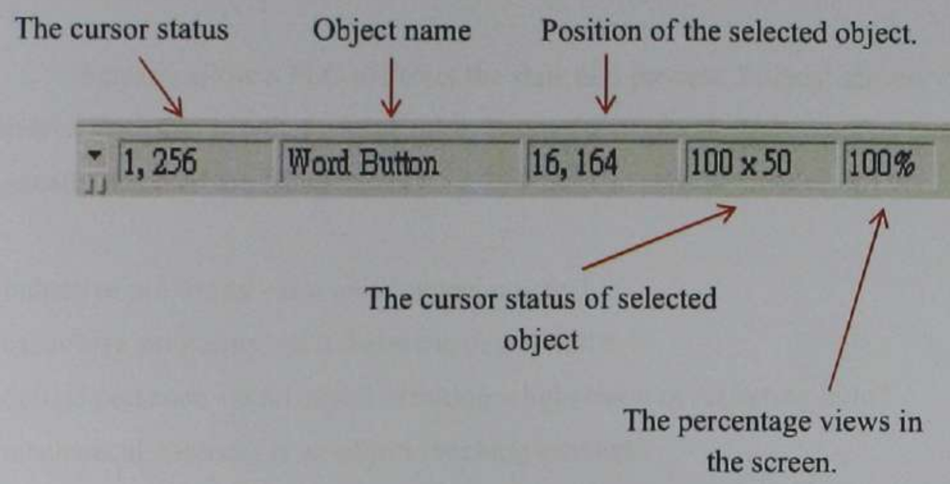

Figure 3.11: The wiring of communication cable between computer and the Panel

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3.3 Logical Sensors

Sensors allow a PLC to detect the state of a process. Logical sensors can only detect a state that is either true or false. Examples of physical phenomena that are typically detected are listed below.

- inductive proximity - is a metal object nearby?
- capacitive proximity - is a dielectric object nearby?
- optical presence - is an object breaking a light beam or reflecting light?
- mechanical contact - is an object touching a switch?

Laser (an abbreviation of the English: Light amplification by stimulated Emission of radiation) device that uses quantum mechanical effect, stimulated emission, to produce a light of medium coherence controlled purity, size and shape. A laser medium also serve as an optical amplifier when the on-seed with light from other source. Amplified signal can be very similar to the input signal in term of wavelength, phase and polarization. This is of course important in optical communication.

Several type of laser, such as dye laser and solid-state vibronic laser can produce light over a wide period waves, these properties make them for the creation of short pulse of light is short (10-15 seconds).

Recently, the cost of sensors has dropped and they have become commodity items, typically between $50 and $100. They are available in many forms from multiple vendors such as Allen-Bradley, Omron, Hyde Park and Keyence. In applications sensors are interchangeable between PLC vendors, but each sensor will have specific interface requirements.

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3.4 Installation of control panels and boxes

The task is to develop the control and power circuit. Table 3.1 and Table 3.2 tabulated the components needed in order to complete the installation of control panels. All these components are assembled at portable steel station.

Table 3.1: List of wall station components

No	Name of Item	PCS/M
1	Earthling contact socket 230v	1
2	CEE – Socket 400V/16A;5 pole	2
3	CEE – Plug 400V/16A;5 pole	1
4	Terminal box 300 x 150 x 120mm	1
5	Terminal block	20
6	Junction box	9
7	Push button green complete with 1 NO/NC	1
8	Push button red complete with 1 NO/NC	1
9	Indicator lamp 24 V red complete	1
10	Indicator lamp 24 V green complete	3
11	Indicator lamp 24 V yellow complete	3
12	Indicator lamp 24 V blue complete	1
13	Frequency Converter 3 x 400V	1
14	Capacitive proximity switch	4
15	Limit switch with 1NO/1NC	4
16	Laser sensor analog 0-4V LV-300	1
17	Trucking 60 x 40 x 100 mm	1
18	Plastic tube VR20	3m
19	End cap vertical ladder	1
20	Mounting angle 70 x 50 mm with M10 x 25	4
21	Wall duct base + cover 90 x 60 mm	1m
22	Cable gland M16 x 1.5	15
23	Cable gland M20 x 1.5	8
24	Cable gland M25 x 1.5	4
25	Cable gland M32 x 1.5	1
26	Lock nut M16 x 1.5	15
27	Lock nut M20 x 1.5	8
28	Lock nut M25 x 1.5	4
29	Lock nut M32 x 1.5	1
30	Wire H07VV-K3G 0.75mm	12m
31	Wire H07VV-K5G 2.5mm	12m
32	Wire H07VV-K25G 0.75mm	12m

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In the installation part; main components are being put in place before the electrical wiring and connection of circuits in the system is done.

Table 3.2: List of components in control box

No	Name of Item	PCS/M
1	Compact enclosure B 600 x H 800 x T 250mm	1
2	Cable gland M16 x 1.5	1
3	Cable gland M20 x 1.5	2
4	Cable gland M25 x 1.5	4
5	Cable gland M32 x 1.5	1
6	Lock nut M16 x 1.5	1
7	Lock nut M20 x 1.5	2
8	Lock nut M25 x 1.5	4
9	Lock nut M32 x 1.5	1
10	Wiring duct base B80 x H60	2m
11	Wiring duct cover B80 x H60	2m
12	Wiring duct base B40 x H60	4m
13	Wiring duct cover B40 x H60	4m
14	Top hat rail TS 35 x 7.51mm	1m
15	2-conductor trough terminal block 2, 5/4 grey	62
16	2-conductor trough terminal block 2, 5/4 gn/ye	8
17	Adjacent jumper 2, 5/4	15
18	MCCB 3 phase 3 pole	1
19	MCB 1pole	4
20	Motor circuit switch	2
21	Contactor 24 VDC	5
22	Push button green complete with 1NO/1NC	1
23	Push button black complete with 1NO/1NC	3
24	Push button red complete with 1NO/1NC	1
25	Indicator lamp 24 VDC red complete	2
26	Indicator lamp 24 VDC green complete	4
27	Wire 2.5mm2 black	5m
28	Wire 2.5mm2 red	5m
29	Wire 2.5mm2 yellow	5m
30	Wire 2.5mm2 blue	5m
31	Conductor sleeve 0.75mm2	200
32	Programmable Logic Controller KV-1000 Keyence	1
33	Human Machine Interface MyTek	1

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3.5 Installation of wiring systems

In this project installation of wiring systems is very critical and important. Figure 3.9 illustrates the control circuit for the project.

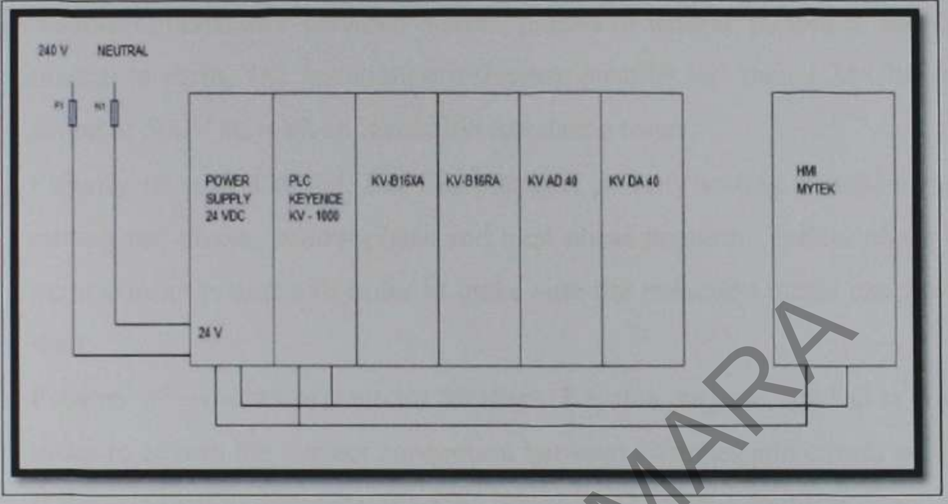

Figure 3.12: Control - Circuit.

3.6 Installation of wiring and cabling

In the installation of power circuit, Cable size 2.5mm2 is used in the installation. Normally power circuit cable is red , yellow and blue colour. For control circuit, 1.5mm2 cable size is allow adequate capacity for the flow of current, which is standard in the industrial control. Normally two colours are used, they are red for positive and blue for negative but other colour can also be used for control circuit.

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3.7 Testing and Commissioning

The test is important to in order identify whether the insulation follows the specification the testing and commissioning of wiring and relay logic in which the following tests are to be completed should adhere the following terms;

a) Insulation resistance between phases, phases to neutral, phases to earth, and neutral to earth. The installation resistance must be less then 1 M Ohm when tested at 500V dc with an insulation resistance tester.
b) Polarity of socket outlet. For this purpose, polarity testing is used to locate among red phase, yellow phase and blue phase position. Yellow phase must be in correct position in order to make sure the induction motor can function well.
c) Polarity of switches and circuit breakers. For this purpose, the test is done in order to ensure the correct connection between switches and circuit breakers. If the connection dislocate or wrong position the breaker will trip.
d) Electrical safety to ensure the safety of the users.
e) Correct wiring to specification based on power diagram and control circuit.
f) Commissioning to ensure the faults are identified and correct, live testing completed and function to specification.

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3.7.1 PLC Programming and Interfacing

In this study Normally Open, Normally Closed, coils, timers, counters are used as the main components to solve the objective of this project. Then, after the design of programming completed, the interface HMI technique is applied.

3.8 Function Description

When the system starts, the system already placed into automatic mode with stable setting for PLC algorithm. The user can alter to manual mode in order to maintain the device and also if fault happen of the system. Below is the simplified explanation of this system: The flow chart and block diagram are shown in figure 3.13, 3.14 and 3.15.

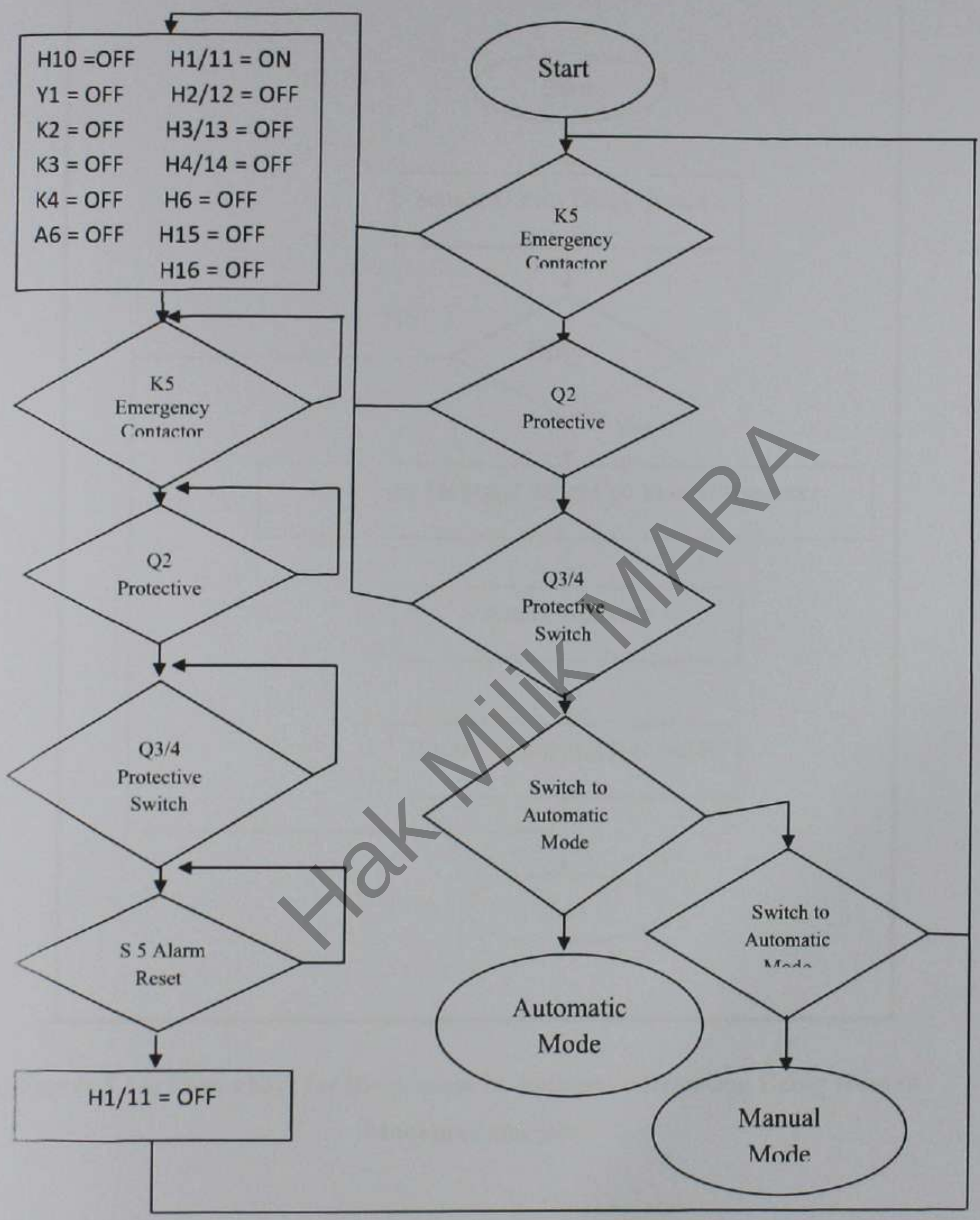

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Figure 3.13: Flow Chart Before System Chosen Automatic mode or Manual mode

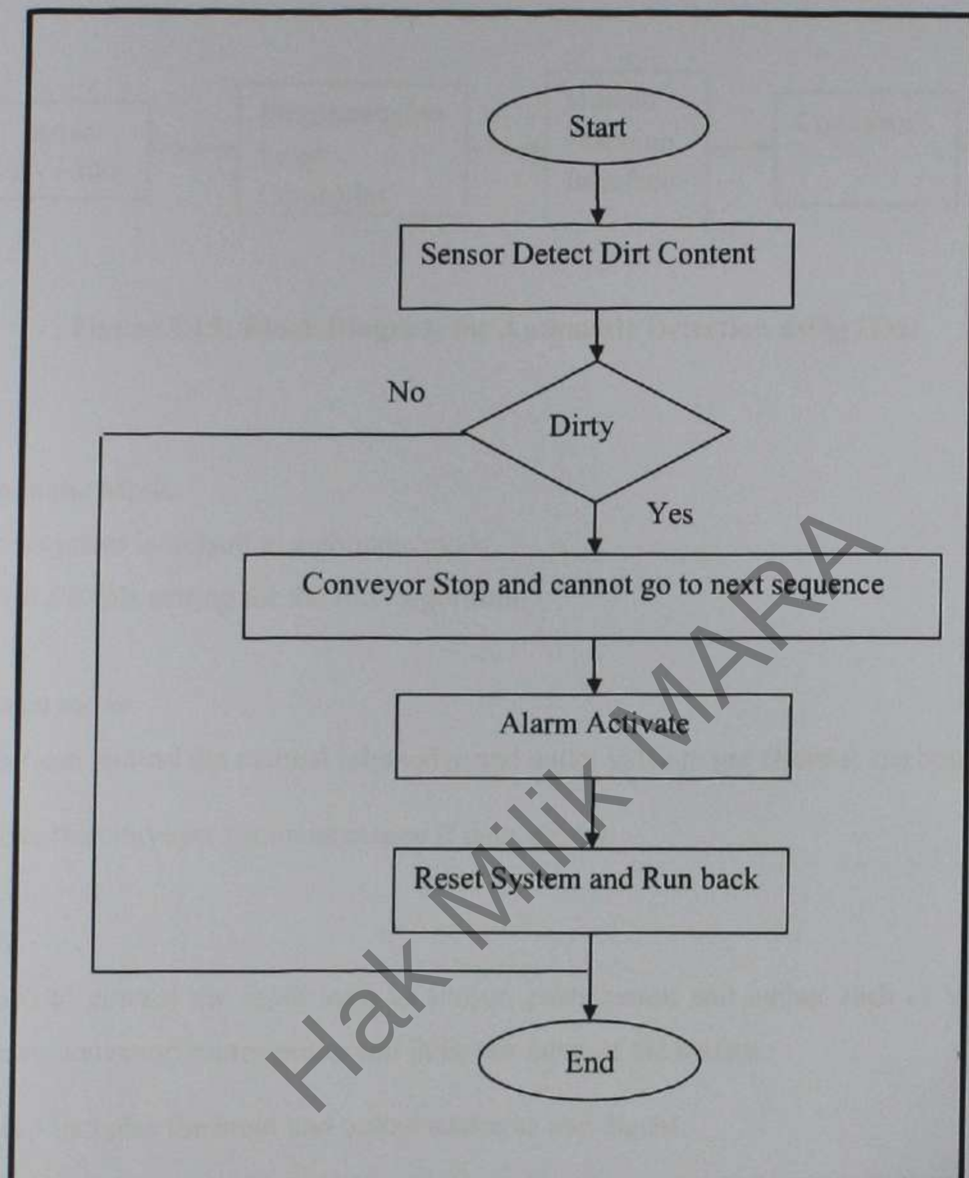

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Figure 3.14; Flow chart for the process in Automatic Detection Using Human Machine Interface

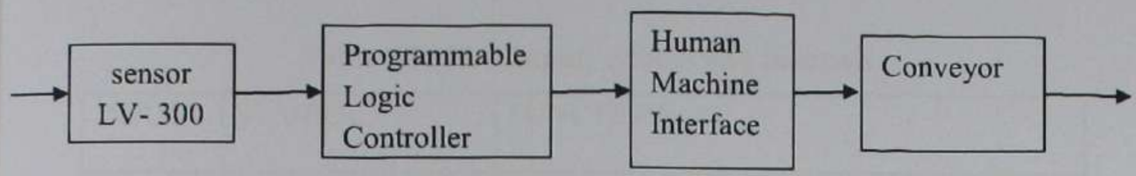

Figure 3.15: Block Diagram for Automatic Detection using HMI

Automatic Mode:

- This system is default at automatic mode.
- With a stable setting for the PLC algorithm.

Manual mode:

- User can control the manual inlet valve and outlet valve to get closer to the bottle.
- Move the conveyer for maintenance if fault occurs.

PLC:

- Used to control the input such as sensor, push button and output such as valve, motor conveyor, motor pump and indicator lamp of the system.
- It also includes the input and output analogue and digital.

Induction Motor:

- Three phase motor with delta connection and able to control the frequency called frequency as convertor to move the conveyor
- Three phase motor with star and delta connection to pump the water.

HMI

- Use to supervise or monitor in the monitor and control the input and output of the system.

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To completely for programming to PLC input and output were identified as shown table 3.3 and table 3.4.

Table 3.3: PLC Input, symbol and function

INPUT	SYMBOL	FUNCTION
I0	B10	Sensor conveyor start position
I1	B11	Sensor conveyor test position
I2	B12	Sensor conveyor bottleling position
I3	B13	Sensor conveyor end position
I4	S14	Limit switch level empty
I5	S15	Limit switch level 2
I6	S16	Limit switch level 3
I7	S17	Limit switch level maximum
I8	K5	Auxiliary contactor emergency stop
I9	Q2	Circuit breaker main circuit
I10	Q3/4	Motor circuit switch M2
I11	S2	Push button M2 on/off
I12	S3	Push button M1 on/off
I13	S4	Push button cleanness test on
I14	S5/18	Push button error reset
I15	S6/19	Push button Y1 on/off
Analog IN	B20	Sensor continuous value cleanness

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Table 3.4: PLC Output, symbol and function

OUTPUT	SYMBOL	FUNCTION
Q0	H10	Lamp cleanness
Q1	Y1	Valve for bottling
Q2		Contactor M2 slow
Q3	K3	Contactor M2 fast
Q4	K4	Contactor M2 fast
Q5	A6	Enable frequency converter
Q6	RES	
Q7	RES	
Q8	H1/11	Signal lamp error
Q9	H2/12	Signal lamp motor M2 is on
Q10	H3/13	Signal lamp motor M1 is on
Q11	H4/14	Signal lamp bottle is clean
Q12	H5	Signal lamp bottle is dirty
Q13	H6	Signal lamp valve Y1 is open
Q14	H15	Signal lamp actual level < level 2
Q15	H16	Signal lamp actual level > level 3
Analog Output	A_6 SPEED	Continuous speed motor M1

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CHAPTER 4

RESULT AND DISCUSSIONS

4.0 Introduction

This chapter describes the results obtained during the experiments. This chapter also presents GUI of Virtual HMI and the results for the system representing the dirt level with respect to voltage level.

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4.1 GUI of Virtual HMI

The development of automatic dirt detection system has been success fully developed, utilizing PLC as the main programming language. The GUI unit has been developed using the Human Machine Interface (HMI) and is shown in Figure 4.1. This figure displays the main screen of the entire automation system. The operation can be chosen either in "manual" and "automatic" mode. These buttons can be selected in order to choose the system mode of operation. On the other hand, Figure 4.2 illustrates the display screen for the automatic mode of the system. This system is equipped with four sensors in order to detect the movement of the bottles. The dirt content is detected using laser sensor. The water tank is used to fill in the clean bottle on the conveyor. Only clear bottle will be filled by water. Dirty bottle will not be filled with water. The water level sensors are used to detect the water level of the water tank. The highest level sensor will cause the motor to stop. On the other hand, the lower sensor will cause the water tank to be refilled with water. Figure 4.3 illustrates the display screen for the system during the manual mode. In this mode any required function can be performed by pressing the related button. Figure 4.4 illustrates the display screen for on and off status of equipment.

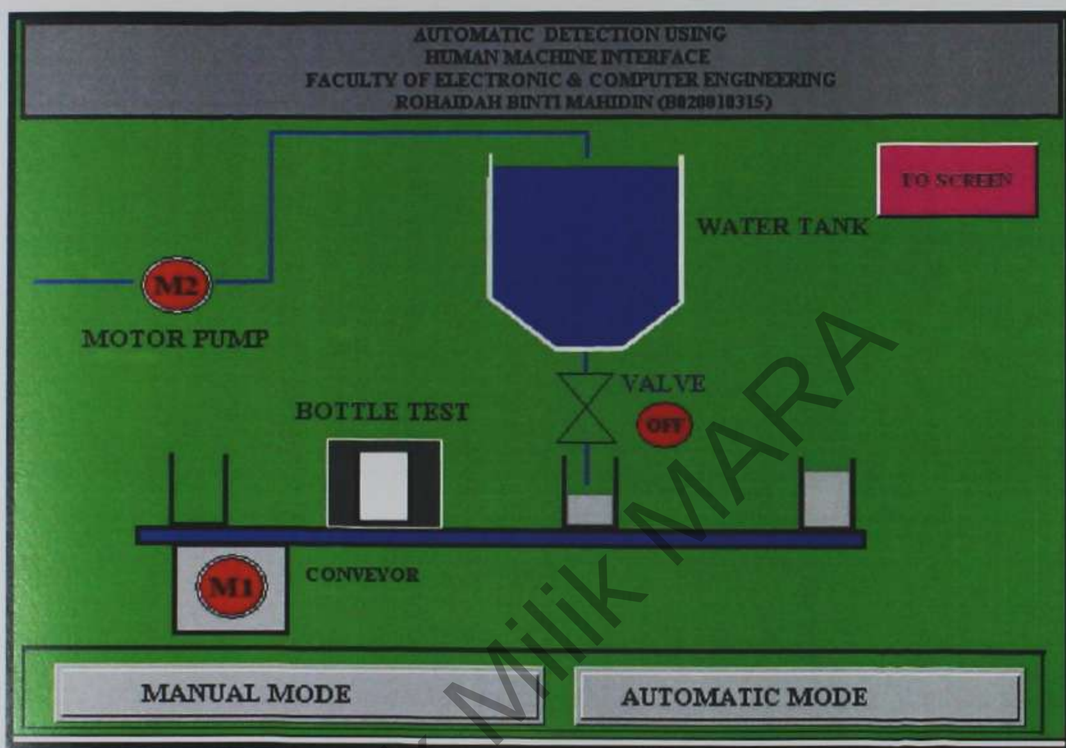

Figure 4.1: GUI of Virtual HMI Main Screen

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The main screen shows two option for users to choose mode of operation either manually or automatically. The screen also shows the components involved in controlling the process. M1 is the motor for controls the movement of conveyors and M2 is for pumped water into the tank for storage. There are also a valve that can open or closed during filling process which controlled by PLC programming. There are four stages to go through for each bottles during this process. The input and output condition is located on the right of the screen, in order to ease user in monitoring and maintaining process.

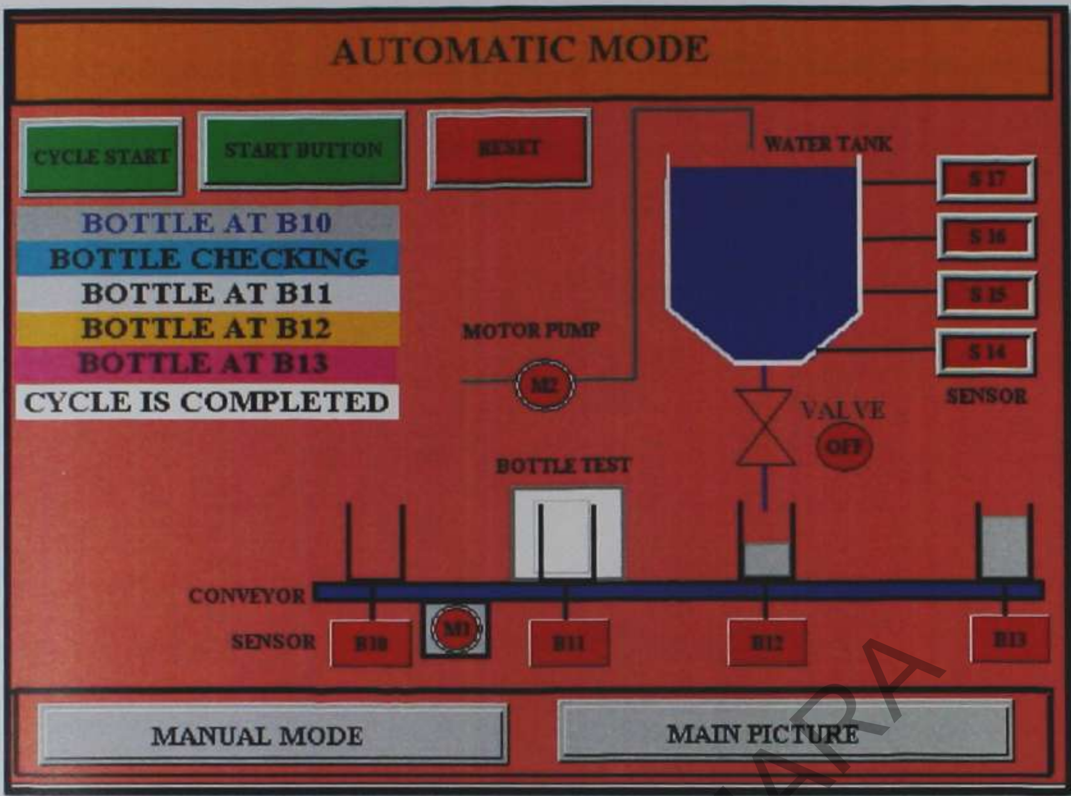

Figure 4.2: GUI of Virtual HMI Automatic Mode

If users selects automatic mode, the process is initiated by pressing the start button, followed by a cycle start. M1 motor will move the conveyor to the first stage B10 where the proximity sensor will detect the presence of the bottle. If there is a presence of the bottle, then a signal is sent to the PLC where the M1 will move the conveyor to the second stage. Proximity sensor in stage two B11 will examine the presence of the motor while the laser sensor is used to examine the body of the bottle, internal and external to detect level of dirt. Both condition required, the presence of the bottle and clean bottle needed to move the conveyor to the third stage. If there is dirt on the bottle, the M1 will not be activated and cause the system to halt until the operator removed the bottle and start the process again.

If the bottles passed the process of dirty level inspection, the conveyor over the bottle to third stage B12. In this stage, proximity sensed the presence of the bottle and sent signal to PLC to open the valve for refill the water. The process of filling water from the start till the end is controls by the PLC programming, The process successfully present in graphic mode that developed by using HMI.

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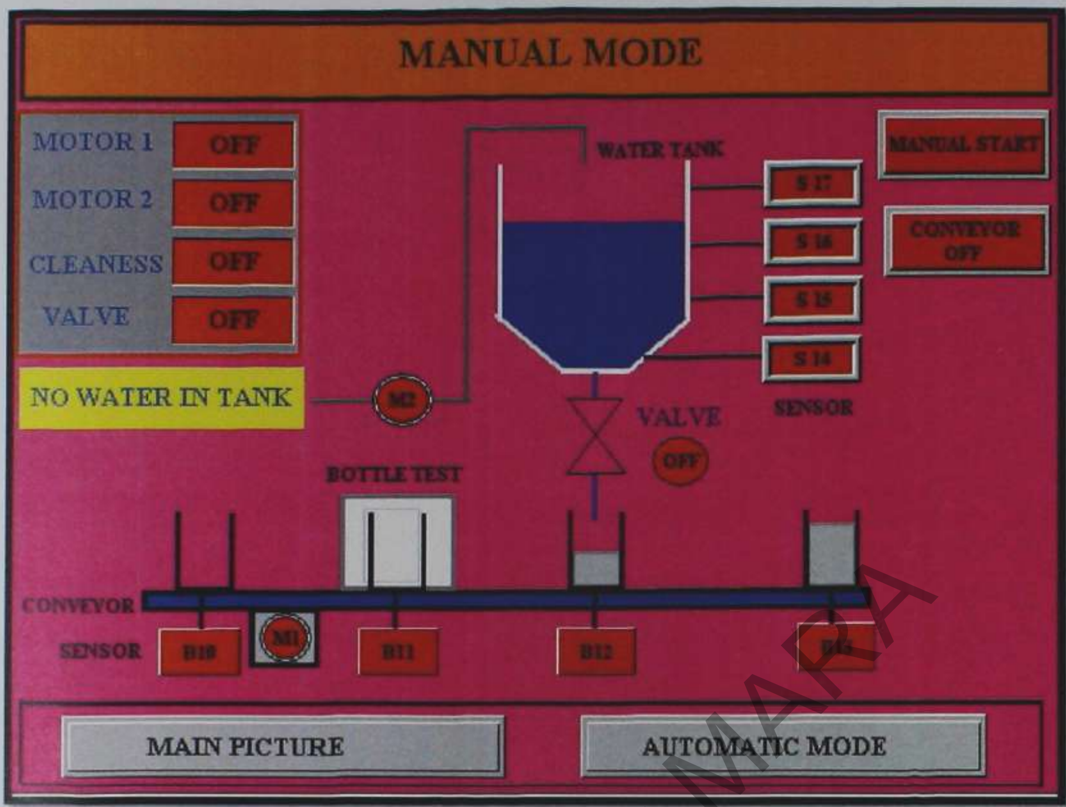

Figure 4.3: GUI of Virtual HMI Manual Mode

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If operators choose the manual mode, each process was done manually by pressing the button one by one. This process requires the operator's observation over a process period. To start the process, the operator/users will press the M1 button to move the conveyor to stage by stage. The process movement is similarly to automatic process except done by manually by pressing button. To ensure the storage tank full, the operator should press the M2 button to fill up the tank with the water. For third stage B12, the pushbutton must be pushed to open the valve in order to filling the bottle. Typically, the manual mode was used for the purpose of inspection, troubleshooting and repair the actuator or other devices. However, the whole process can be monitored through the built-screen which is much easier and systematic.

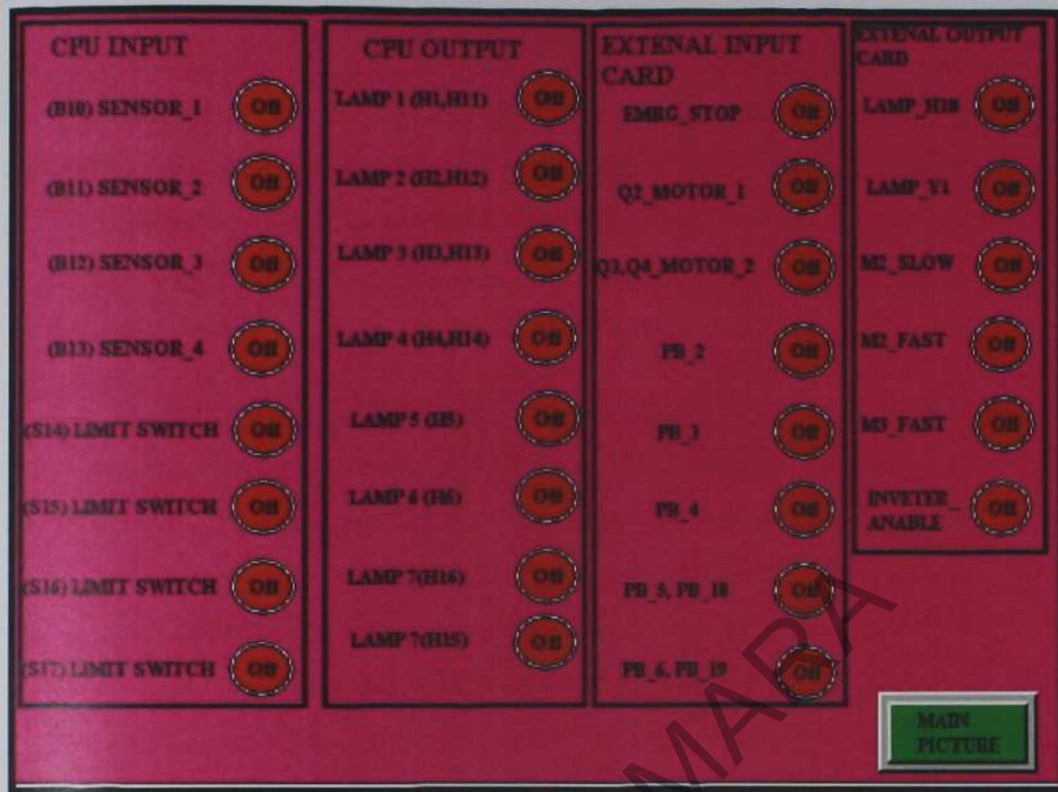

Figure 4.4: GUI of Virtual HMI Input and Output Screen

Input and Output screen (IO screen) displays four section: CPU input, CPU output, external card input and external card output. For the CPU input, it shows limit switch and sensor condition during process. The green lamp show which sensors works by that time. All these sensors input interface to HMI using PLC programming which is downloaded during the development process. While, the CPU output show the operation associated with the input. External card input show the mechanical button that controlled the overall operation, such as start, stop and emergency button. In addition, the button that used to move conveyor and water pump is also available in this screen. The last is involved in controlling the speed of the motor and also error lamp.

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4.2 Discussion

There are several problem faced when developing this project. The problems that must be addressed from the initiation through to final testing are associated with PLC programming, GUI development, the interfacing between the PLC and HMI, wiring and safety precaution. The problem, solutions and alternative decision taken to ensure the success of this projected are listed as below:

a) PLC programming taking long time to create in order to categorized and determined each input and output. The process of recognizing and determining the input and output is based on their need, application, power and control to the completed project. Each devices selected must synchronized and works as instructed in the program. To overcome the problem in instructing and programming using Keyence LV-1000, some manual that related to the study are reviewed and read. Program procedure need to be followed because of each PLC have their own command and instruction. Focus is given in to put all instruction about automatic controlling, manual controlling, motor for conveyor and tank controlling and output indicating in one long uninterrupted programming. Some subroutine built to ensure the project does not stop or stray from the instruction. The guideline used in writing the PLC program referring to objectives of the project; built a mini model for drinking plant which utilizing PLC as controller and graphic form monitoring screen developed by using HMI.

b) The second aspect that is emphasized is the development of Graphic User Interface (GUI) using Human Machine Interface (HMI). Each graphic drawn must be related to the instruction as direct in PLC programming. The direct virtual connection for each button and light are built to be compatible with the PLC type and programming. HMI with MyTek brand used for this purpose. Since it was first time applied, a few actions taken to encounter the problem exist such as the software, the power needs and safety procedure. In order to build graphic, the guidelines and manual are read and understood first before starting the project. Sketches for the whole completed GUI are

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sketched first. Four type of sketches are made; the main screen, the automatic mode, the manual mode and I/O screen. Each button and indicators are listed so as not miss. Names and function of each input and output s are also listed so that similar as in PLC programming. This process taken a long time and need a critical thinking. The biggest problem is to get a direct communication function which touch the screen will directly goes to PLC instruction. However, by referring to manual, surfing the internet sources, reading material and guiding by supervisor, it was successfully implemented.

c) To realize the project, one mini model station is made using steel frame. However, due to the limited abilities and difficulty in obtaining some of the components, the project different from the actual design plan. Among the most significant problem is that the conveyor does not exist on the real model. It is somewhat disappointing because of the difficulties getting a suitable size, placement into the model and high cost. Impact from that, the movement from one stage to other stage is made by taking the bottle manually. To recover the problem, one green lamp act as indicator is placed on the model to visualize the movement of the conveyor. The motor that used to pump the water into tank also visualize in GUI. The actual water tank is not provided in view of safety aspects and difficulties in place.

d) Wiring is made to cover all aspects of security because it involves with high voltage, 230 VDC. A switching power supply is used to step down the voltage into 24VDC as supply voltage to PLC. A lot of hard wiring are made and refer to the design circuit and should comply with safety aspect. The safety aspects are taken such as to insulate all exposed conductive wire and putting MCB as precautionary measure. Each cable is marked for easier the wiring and troubleshooting.

e) The sensitivity of the sensor is also difficult to be adjusted. Proximity sensor that attached to the stage needs very short distance to detect the presence of the bottle. The dust or any small particles also can activate this sensor to operate. Laser sensor used is the brand Keyence KV-300 is used to detect the level of dirtiness tested bottles. Laser is available in the form of a pair which

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consist receiver and transmitter. The transmitter will emit the barrier through the bottle and receive by the receiver. This level of barrier can be set-up using the amplifier that provide together with the laser sensor. In case of dirtiness is detected, the barrier receive by the receiver lower and will drop the voltage from the 4V to 2V. Thus, there is no signal sent to PLC and the conveyor circuit disconnected or deactivate by low voltage. The operator must remove the dirty bottle and reset the process again.

4.3 Potential Problem

When a station is built, some potential problems are identified for improvement or troubleshooting. Several issues identified for this project is the distance, type and size of sensor used. The reason is because of sensor should be appropriate within the specified distance and could provide a beneficial effect on the process. The failure of the sensor to operate may cause disruption to the movement of the system so that adverse impact on overall operation. For the purpose of maintenance cost savings, typically sensor that used to detect level of dirtiness on the bottle must be same height. If a shorter sensor used, the rotational and volatile movement will be needed in order check the whole body of the bottle. The potential problem with this case is rotary motor can stuck or misconduct which can cause greater cost.

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For each mechanical and electrical installation must comply with safety requirements and regulation by authority. Guard rails or a sign of the working area should be made to ensure the accident do not occurs during process, particularly electric shock or other accident. Electrical cable must be bound and arranged in a cable rack and each part should have cable marking to identify the connection. Terminal end should be covered so as not vulnerable to moisture and harmful to the operator.

For the stage rack, it to be design in flexible type so that can be adjusted according to the distance, high or size of the product. A sorting or ejector to the detected product during process can be added to avoid human interference. A manual should be prepared for the error detector, auto recovery and implementation process. HMI provides convenience to the operator in term of monitoring, application or troubleshooting. However, the touch screen type product which exposed to working environment and moisture should be covered with a transparent view of cover to ensure longer life.

Table 4.1: Level of dirt in the bottle

DIRT LEVEL (MM)	VOLTAGE (V)
3	3.557
6	3.025
9	2.752
12	2.519
15	2.422
18	2.071
21	2.034
24	1.742
27	1.559
30	1.077

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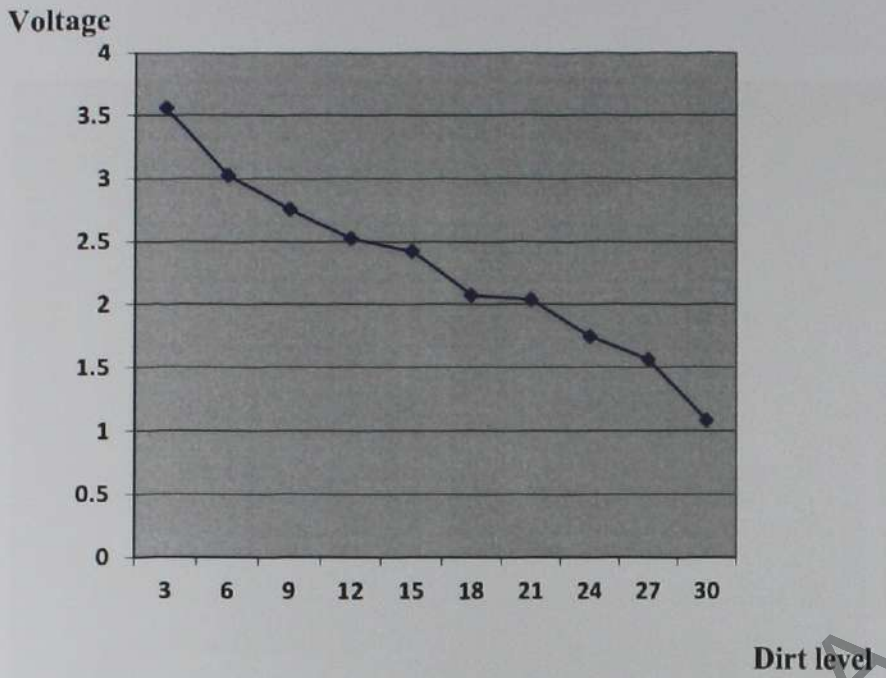

Figure 4.5: Voltage and Dirt Level profile for bottle using LV-300 laser sensor

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Figure 4.5: Completed project from front view

Figure 4.6: Completed project from top view

Figure 4.7: Completed project from side view

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CHAPTER 5

CONCLUSION

5.1. Conclusion

To work with the system user have to be able to control the system and assess the state of the system. PLC is well-adapted to a range of automation tasks. The PLC Keyence KV 1000 can successfully interface with HMI MyTek. A Human Machine Interface (HMI) is employed for this purpose. HMI is a modification of the original term MMI (man-machine interface). HMI is also user friendly, simple and easy to interface with PLC. In present PIC and PID cannot interface with HMI system. The developed system has successfully implement detection task using HMI, complete with PLC system. Results obtained from the study indicated chapter 4. The mini simulation model of Automatic Detection Using Human Machine Interface will help operators increase their productivity thus help produce more goods in less time. It will also facilitate in minimizing human error through a hassle-free simulation system. It is also very suitable as teaching aids to enable students to view, understand, apply and make troubleshooting before venturing into real work.

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5.2 Future development

The developed system can be further enhanced for large application. Incorporation of (supervisory control and data acquisition) SCADA system can be the future scope of research. SCADA usually refers to centralized systems which monitor and control entire sites, or complexes of systems spread out over large areas (anything between an industrial plant and a country). Most control actions are performed automatically by Remote Terminal Units ("RTUs") or by Programmable Logic Controllers ("PLCs"). The advantages of SCADA system may allow operators to change the set points for the flow, and enable alarm conditions, such as loss of flow and high temperature, to be displayed and recorded.

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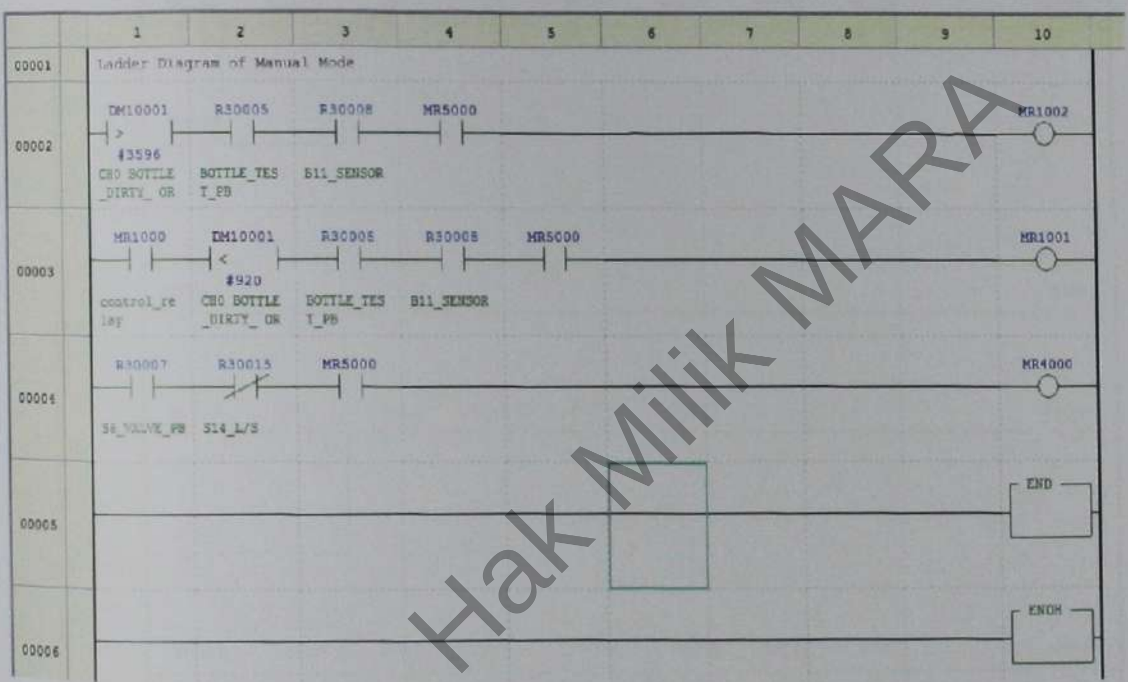
APPENDICES I

Ladder Diagram Manual Mode Using PLC Keyence KV – 1000



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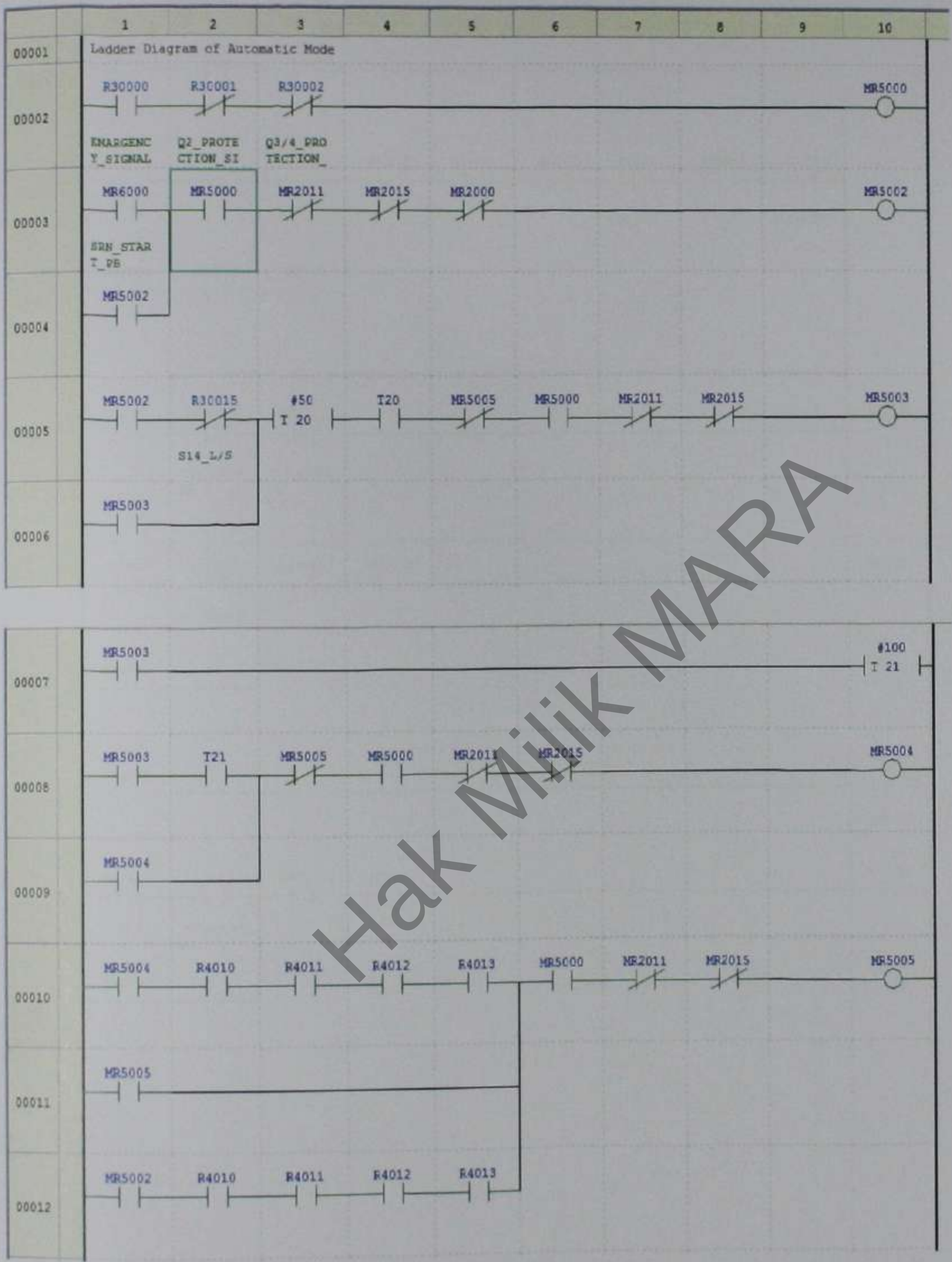
Ladder Diagram of Automatic Mode Using PLC Keyence KV-1000



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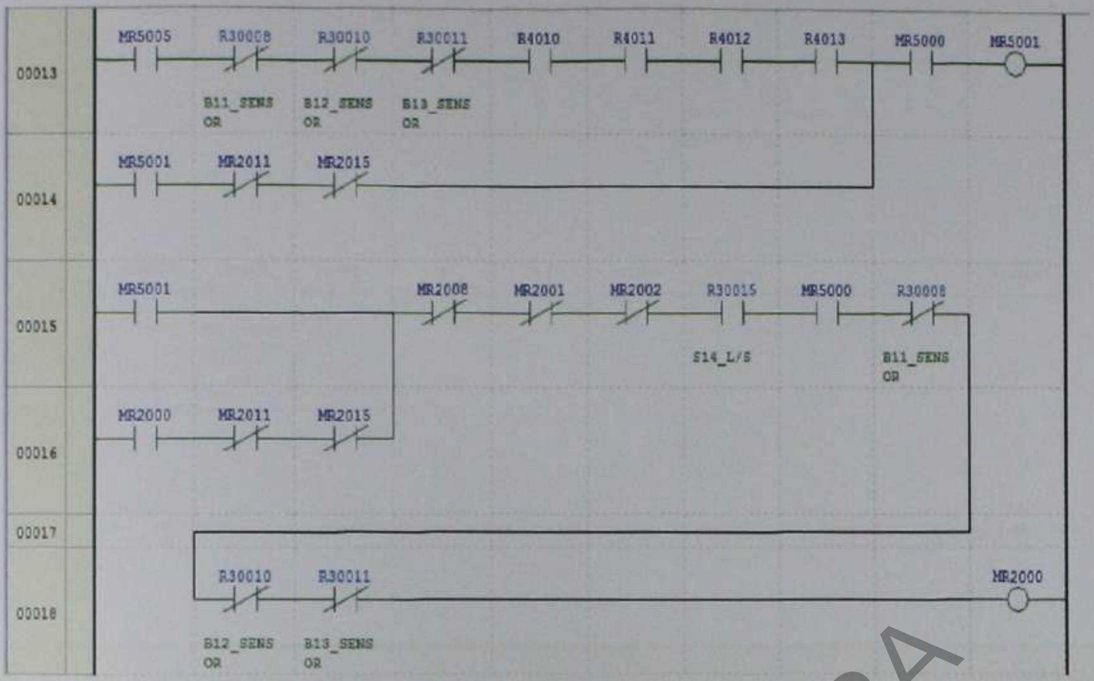

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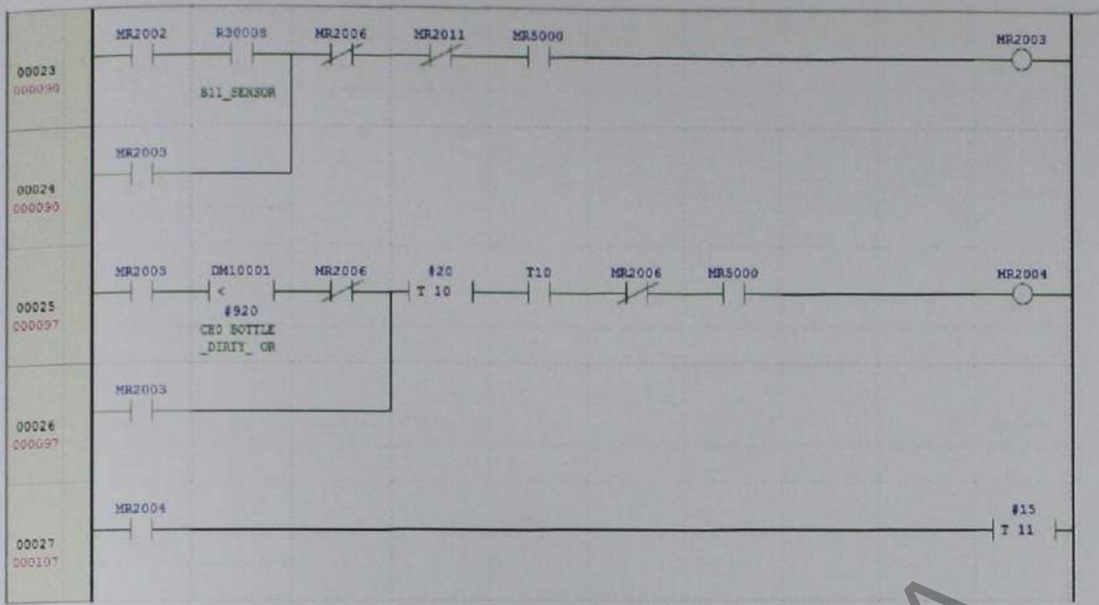

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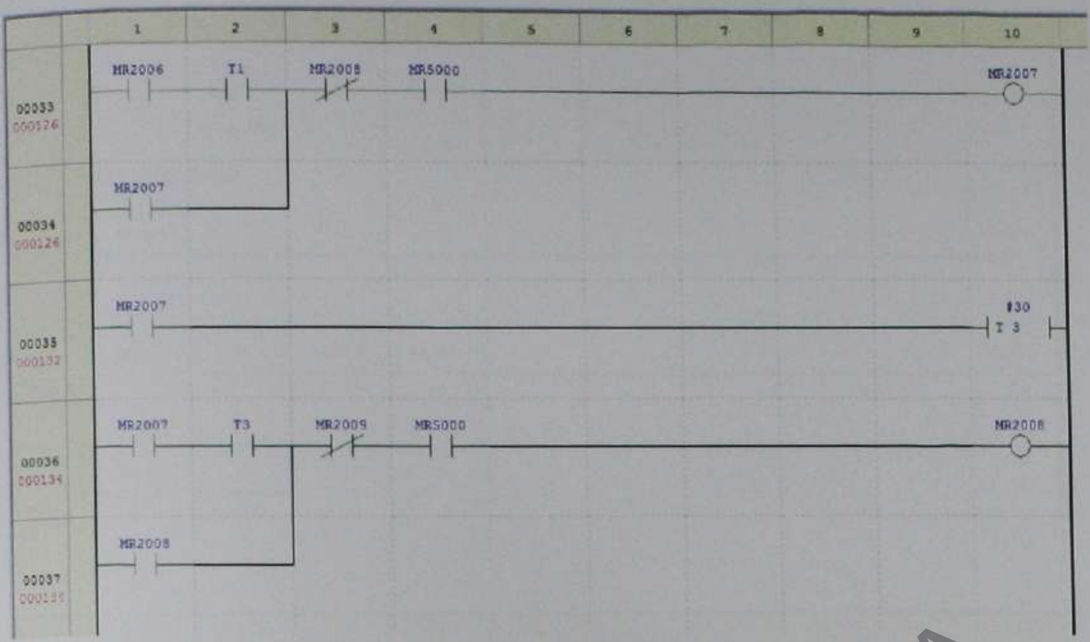

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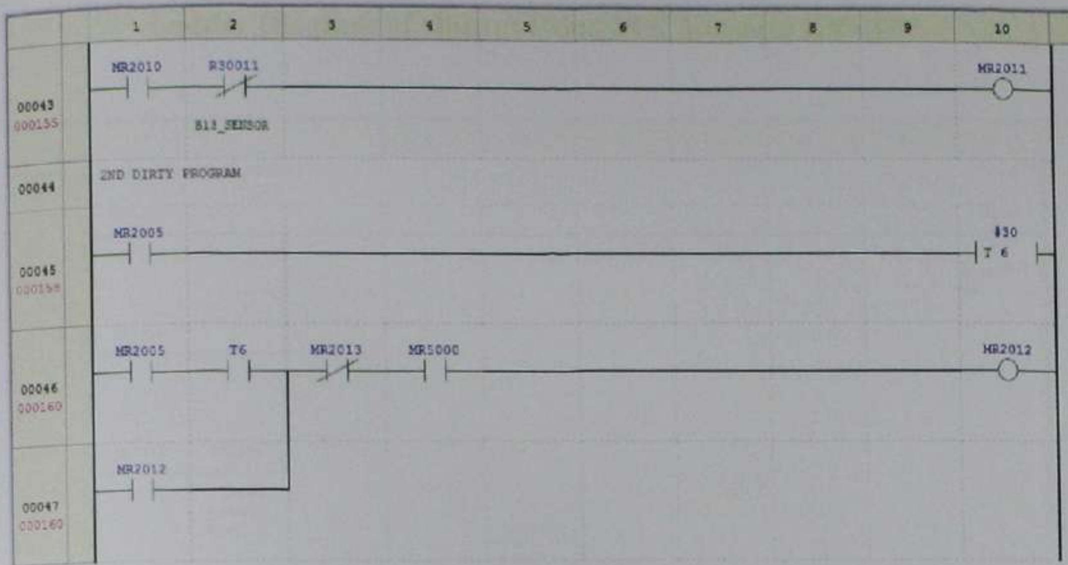
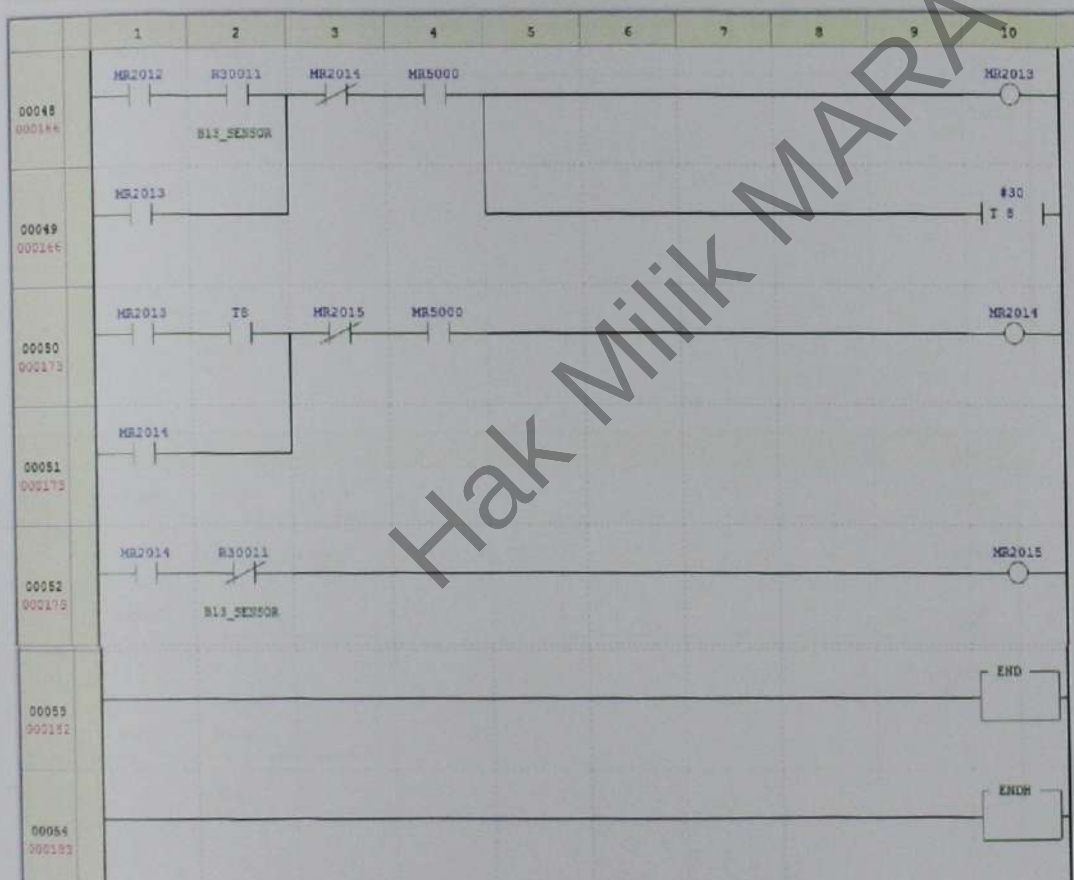
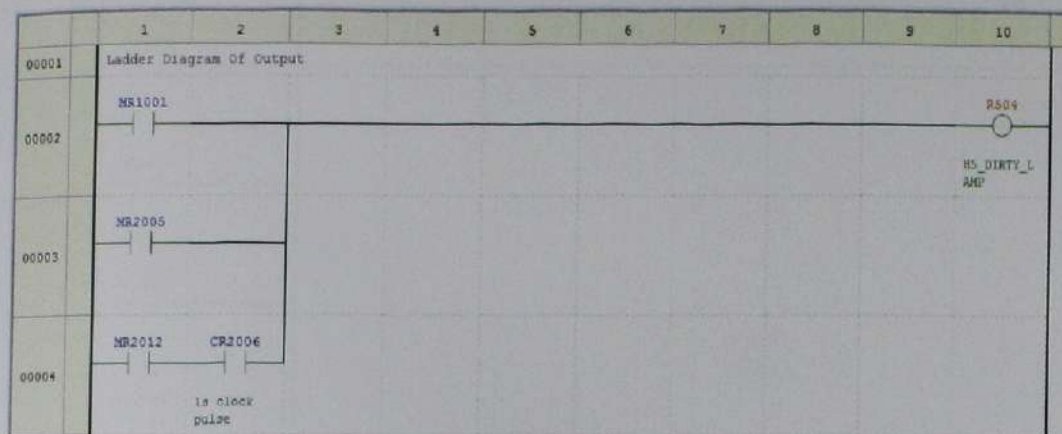
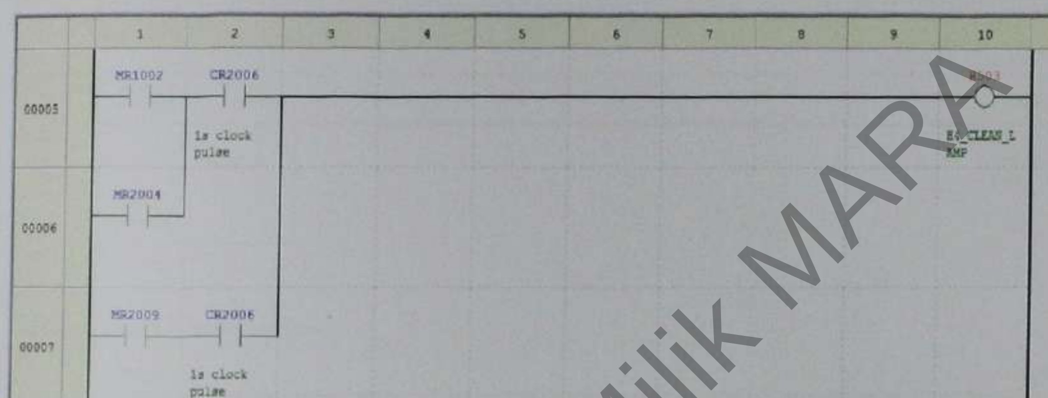


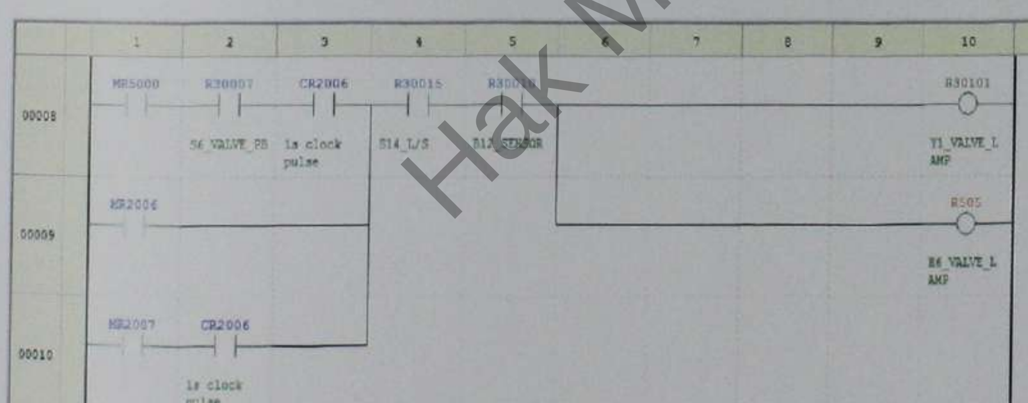


Hak Milik MARA

Ladder Diagram of Output Using PLC Keyence KV-1000







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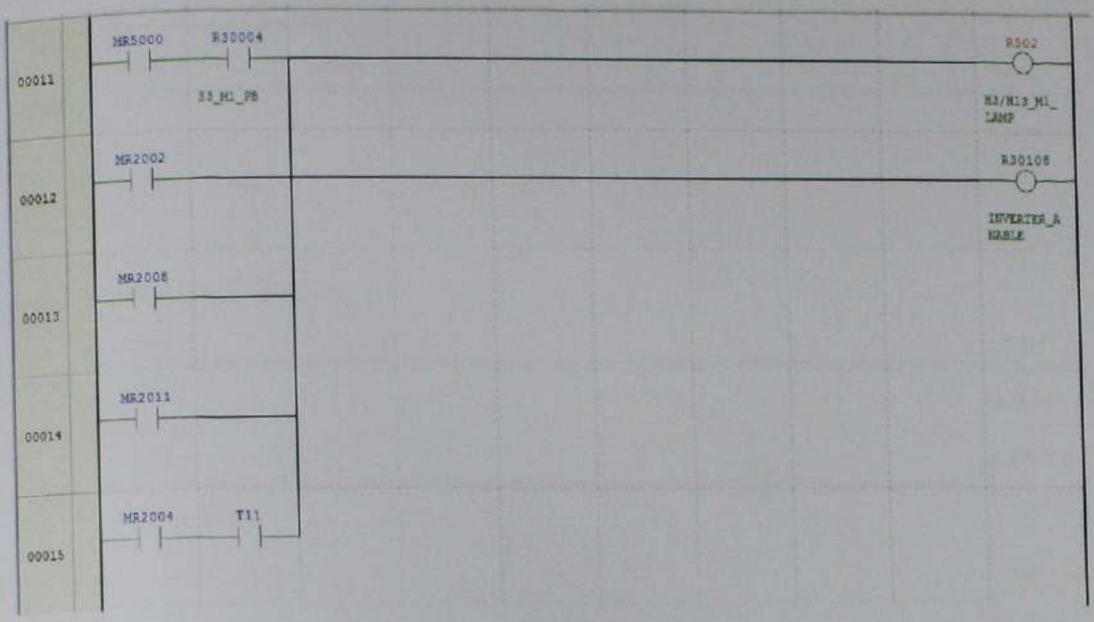

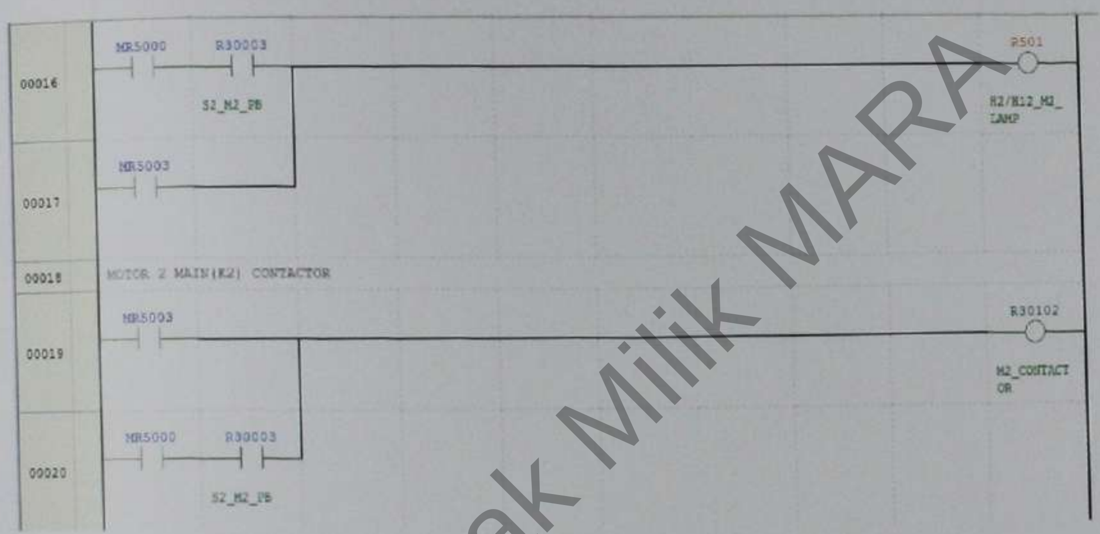

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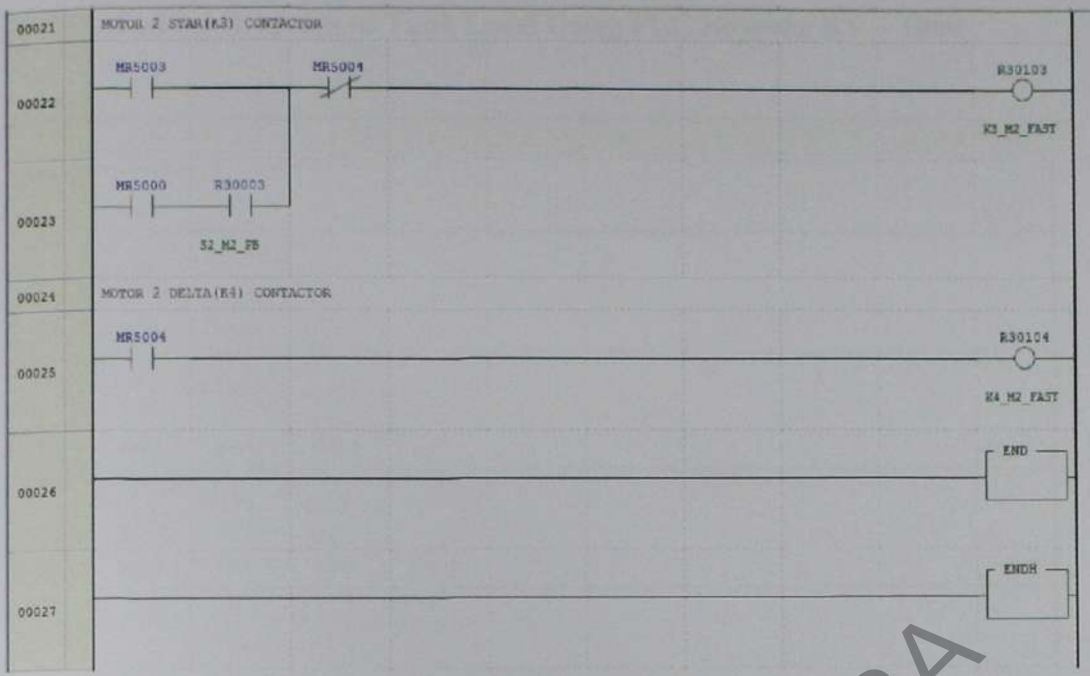

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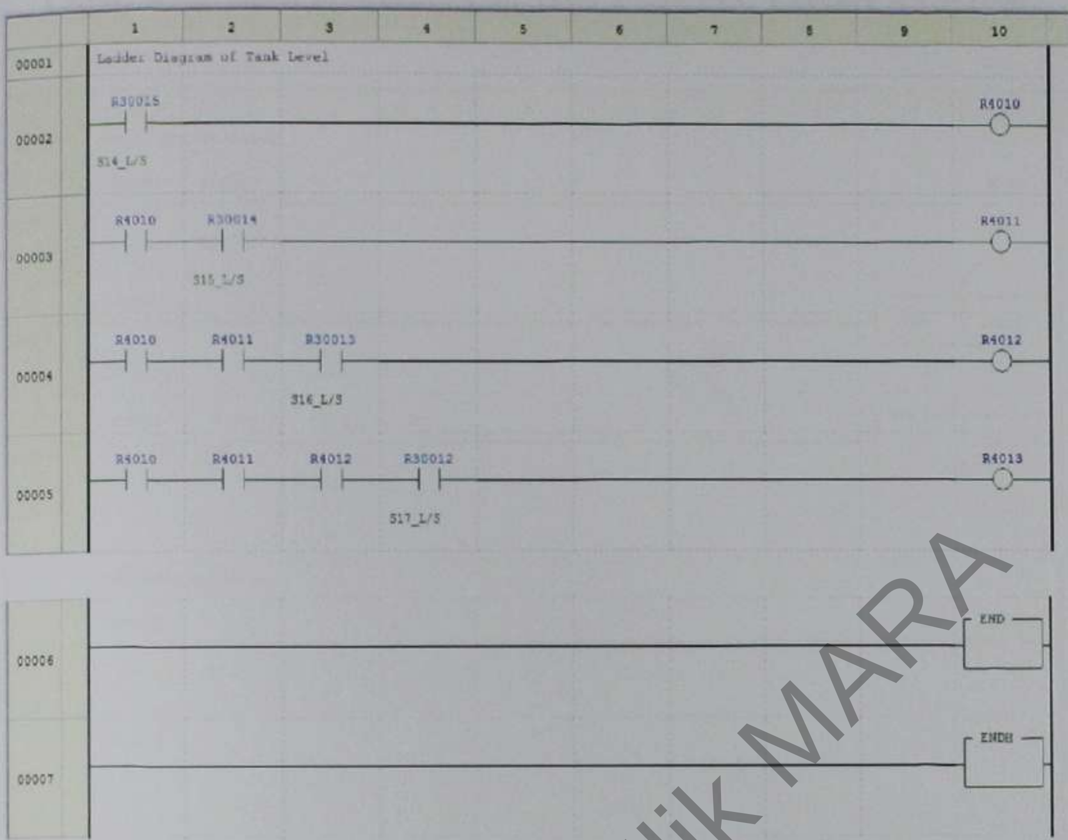
Ladder Diagram of Tank Level Using PLC Keyence KV – 1000



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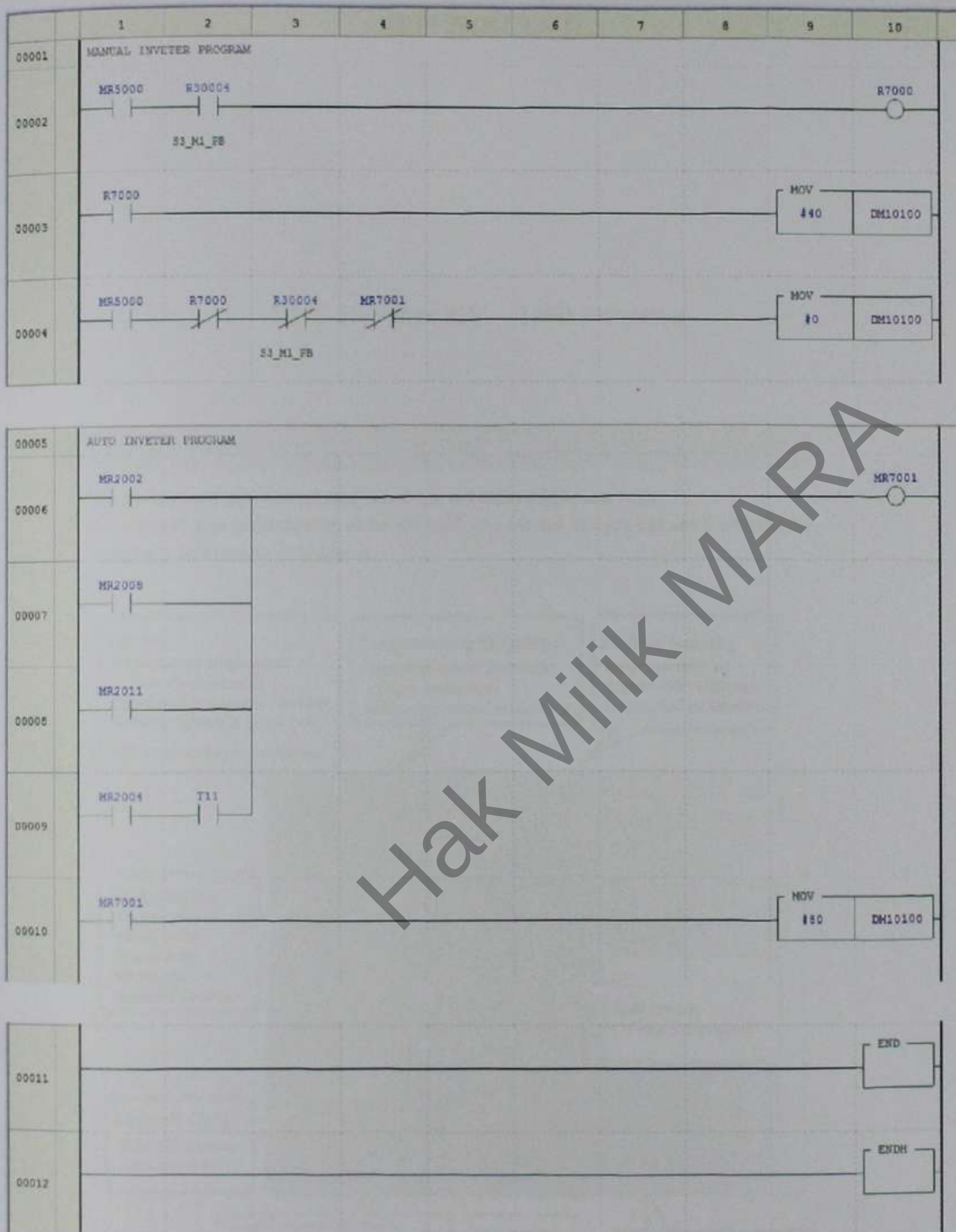
Ladder Diagram of Frequency Converter Using PLC Keyence KV – 1000



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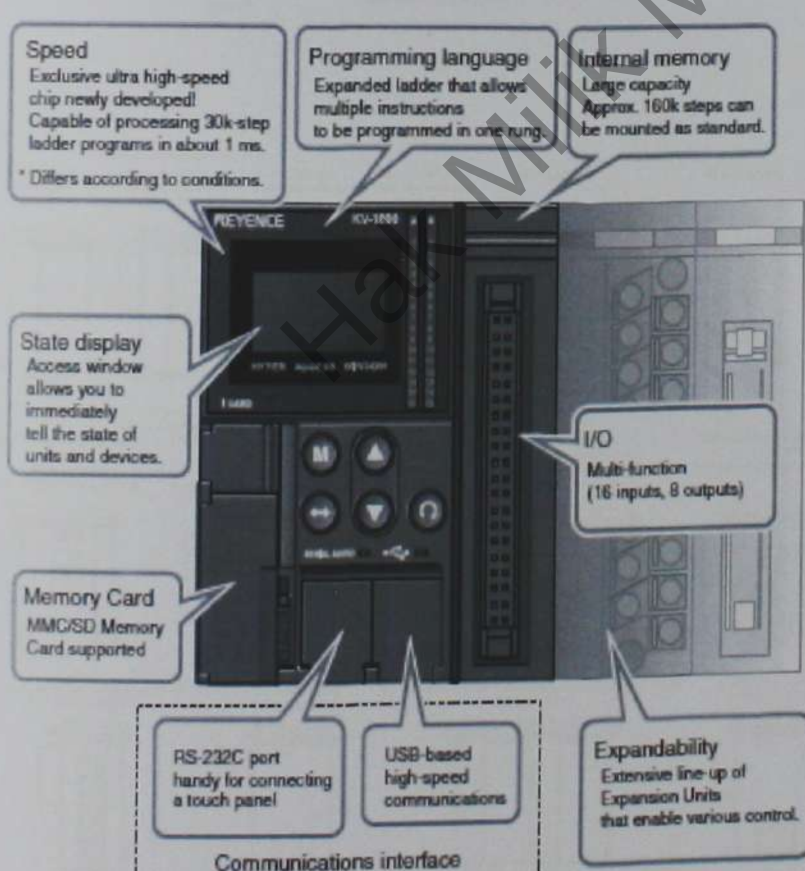
APPENDICES II

PLC Keyence KV – 1000 Function

KV-1000 Functions

The KV-1000 is a high-performance, advanced and highly expandable PLC.
If you further your understanding of the KV-1000, you will find that you can use it efficiently for control in a wide number of situations.



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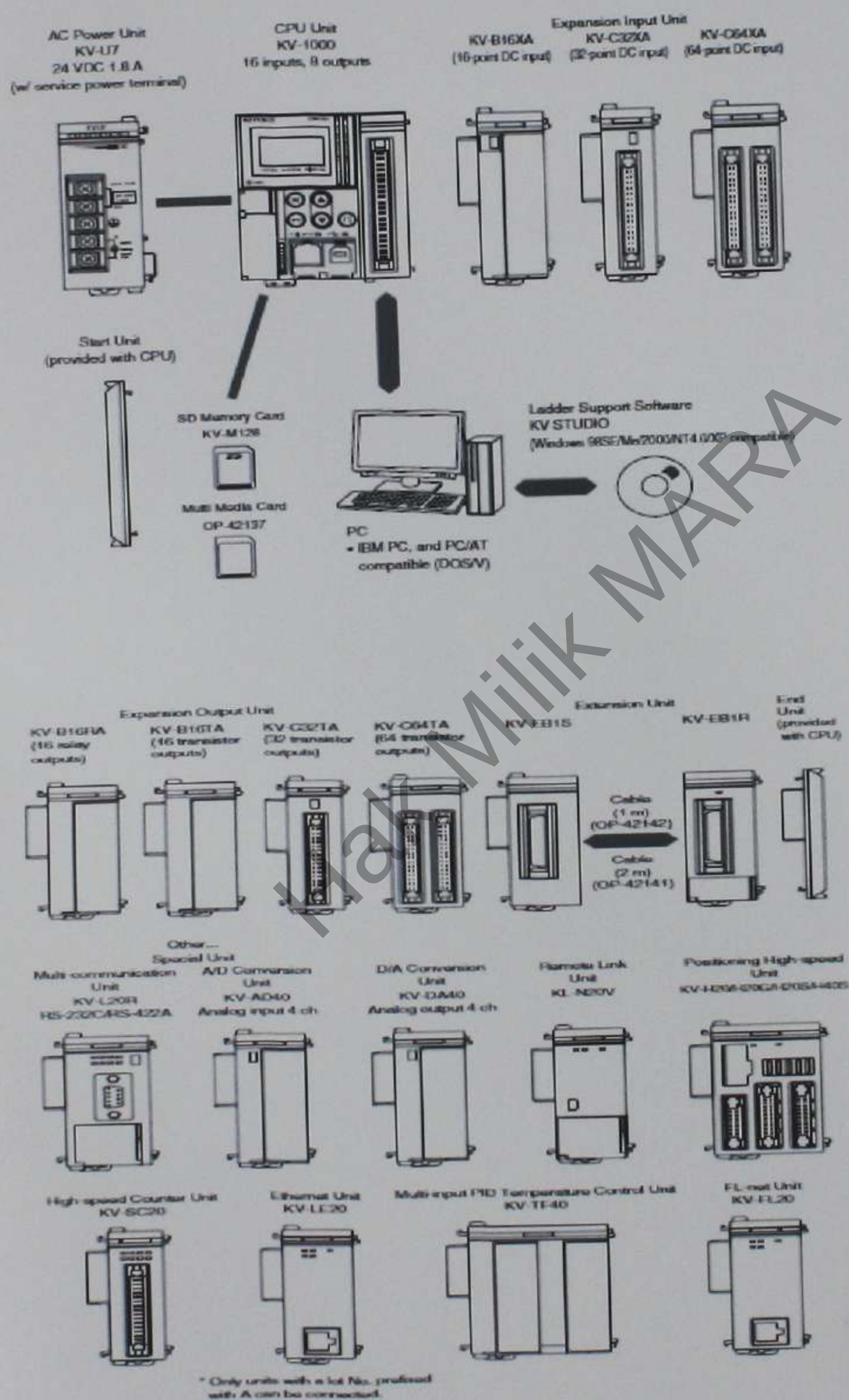
Basic System Configuration of PLC Keyence

System Configuration

The KV-1000 Series basic system is configured as follows.



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