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LABVIEW SIMULATION FOR SPEED CONTROL OF INDUCTION MOTOR

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Abstract— Today's Industrial Control Applications are done by Remote Process only. Lab VIEW Software plays major role in Industrial Monitoring and control systems. In this paper i am going to discuss about Lab View based induction motor drive control system. It is One of the most common applications required in remote control and monitoring. Drive control system has various types of controller, in order to perform some actions such as control the speed, forward and reverse turning direction of the motor. This approach can be done by Lab VIEW programming, and with the rise of the technology, Ethernet module will be used in order to achieve the remote control system. Lab VIEW is a human machine interfaces design software that is user friendly. It can be easily communicate with different hardware.

Keywords: *Lab VIEW, Induction motor*

1. INTRODUCTION

The major problem occurs when Design an Engineering system with more Hardware Circuits then we need to go for more wiring connections. It is not possible to design distance control of the system as more hardware's and wirings were needed. If in addition, if engineers wish to improve the design, all the irrelevant hardware's need to be replaced away, which is not sustainable.

Due to the rise of the technology, Lab VIEW have eased the engineering design and lesser the materials required, it is because the entire design is implemented in software programming paradigm. Lab VIEW had been commonly used in the industry, including controlling induction motor inverter fed variable drive system. Thus Designing distance control machinery is now possible, even by using Ethernet as the communication device between the computer and the Induction motor[1]

The engineers can use LabVIEW [2], which has various types of industrial applications which are in virtual instrument (VI) instead of the real and heavy instrument, to control the Induction motor.

2. PROJECT DESIGN CONFIGURATION & PREPARATION

2.1. Lab VIEW

Lab VIEW is the acronym for Laboratory Virtual Instru- mentation Engineering Workbench and is a graphical development environment for generating flexible and scalable design, control, and test applications rapidly at minimal cost. With Lab VIEW, engineers and scientists are able to interface with real-world signals, analyse data for meaningful information, and share results through intuitive

displays, reports, and the Web. Regardless of programming experience, Lab VIEW makes development fast and easy for all users [3]. The programming style used in Lab VIEW is G programming, which is abbreviation for graphical pro- gramming. It is also known as dataflow programming as it is depending on the structure of the graphical block diagram to execute the user-designed program. Compared to text-based programming, Lab VIEW is user friendly as the user can design the program by simply arrange and wiring the relevant icons together [3]. Lab VIEW programs are named as virtual instruments, or VI, because their appearance and operation mimic the physical instruments, such as oscilloscope and multi- meters [4]. Similar to other conventional programming, Lab VIEW has standard features such as looping structures, data structures, event-handling, object-oriented programming. Lab VIEW also has an extensive library of math functions similar to MATLAB libraries and also formula nodes that allow text-based programming for certain sections of the code that require complex logical structures. Lab VIEW has front-end interface applications that allow user to design and then use for controlling systems. In general Lab VIEW has three main elements: the front panel, the block diagram and the connector panel. The front panel allows the user to build the controls and indicators. The controls are including Cons, push buttons, dials, and other input mechanism. Indicators are graphs, LEDs, and other output displays. Meanwhile, the block diagram let user to add code using VIs and structures to control the front panel objects. The connector panel allows user to represent a single VI as a sub VI icon that can be called in another VI. The elements are illustrated in **Figure 1**.

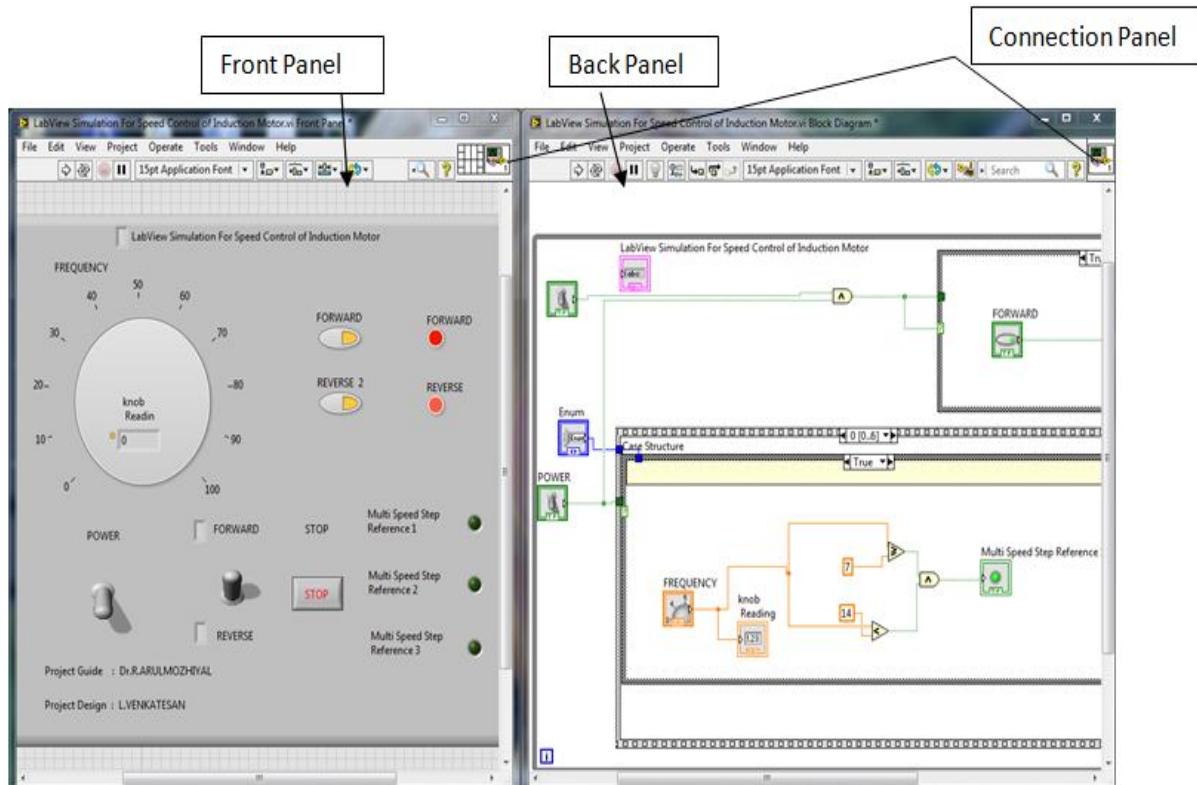


Figure 1. Three main elements of LabVIEW software.

Shared variable is a library function variable that allows sharing of data between applications or different data sources across a network. There are many existing data sharing methods in LabVIEW, such as UDP/TCP, LabVIEW queues, and Real-Time FIFO. Compared to Datasocket Communication, using shared variables is user-friendly as the configuration can be done by simple setup in the library instead of writing URLs and performing more wiring in Datasocket Communication [3,5].

3. IMPLEMENTATION

3.1. Implementation Process

The Ethernet control systems presented in this paper are to control squirrel cage three-phase induction motor. In order to achieve the objectives, the establishment of the communication between PLC and LabVIEW is crucial as LabVIEW is 3rd party software instead of using the software implemented in the PLC itself. Thus, the implementation used LabVIEW to perform the start and stop operation of the motor, either in forward or reverse direction, and varying the speed by changing the frequency of the motor. However, this system is not a supervisory control and data acquisition (SCADA) since there is no practical data measurement acquired from the actual output of the motor.

The system has three-layer network architecture

illustrated in Figure 2.

3.2. Implementation of VI Design

The objective of the VI program in this paper is to allow the user to make the decision of the start and stop operation of the motor, either in forward or reverse direction, and varying the speed by changing the frequency of the motor, by performing two simple steps. Firstly, select the turning direction by pressing the push button in the VI Front Panel, which is either forward or reverse. Secondly, vary the speed by turning the Frequency knob to the value of the frequency that the user desires. Figure 6 illustrates the VI Front Panel.

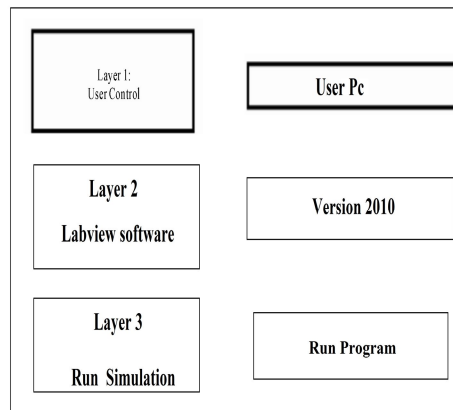


Figure 2 Three-Layer Network Architecture

Before running the VI, make sure all the hardware's have been switched on and configured correctly, and launch the NI OPC Quick Client so that the OPC tags can be browsed by the shared variables in this VI.

There are 5 OPC tags was created and used in the implementation, and the details of the tags have been tabulated in **Table 1**.

By referring to **Figure 3**, the Green push button is the switch to determine the motor is turning in forward direction. Meanwhile, the Orange push button is the switch to determine the motor is turning in reverse direction. Both Green and Orange light indicators at the right hand side show whether the push buttons have been switched ON. The knob labelled as "Frequency" is the key program to control the frequency as well as the speed of the motor. The push button labelled as "Stop" function to stop the program execution.

Figure 4 illustrate the VI Block Diagram, which the programming part of the VI. By referring to the **Figure 4**, the Red colour square boxes with dotted lines are the VI components that are visible in both Front Panel and Block Diagram. For Example the push buttons, knob, light indicator. Meanwhile, the Red colour square boxes without dotted lines are the VI component that is visible in Block Diagram but they are not visible in Front Panel, which are essential VI to structure the program. For example, shared variables, formula node, number to Boolean converter (consist of number to Boolean array and index array) and the While loop. The While loop, which is similar concept with the While loop in C Programming, is used in this VI to

ensure the program execute continuously until the stop button is triggered.

The VI block diagram consists of two parts of the program. First part of the program is to allow user to switch on either Forward or Reverse direction of the squirrel cage induction motor. The second part of the program is to vary the frequency of the motor by changing the knob value.

Table 1. The details of OPC tags and its connection to inverter.

<i>BIT 6</i>			<i>Input5 (Multispeed reference 2)</i>
<i>OUTPUT BIT 7</i>	<i>CIO0001.07</i>	<i>S7</i>	<i>Multi Function Input5 (Multispeed reference 3)</i>

By referring to **Figure 5**, if the user has switched on the Forward button, the signal will be transmitted to the "outputbit1" shared variable, which is in write mode, i.e. the signal will be written into the PLC. Then once the signal has been successfully written to the PLC, the light indicator of the output address 1.01 of the PLC, and the "Forward" direction indicator in the LabVIEW's Front Panel will light. This process identical to the reverse direction as well.

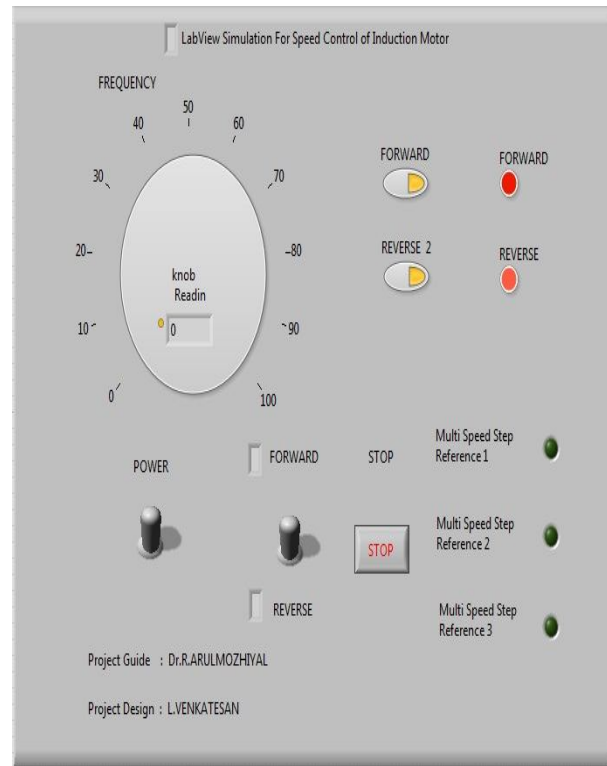


Figure 3. VI front panel of the project.

OPC TAG NAME	PLC ADDRESS	3GMV INVERTER	
		CONNECTED TERMINAL	TERMINAL NAME
<i>OUTPUT BIT 1</i>	<i>CIO0001.01</i>	<i>S1</i>	<i>Multi Function input1 (Forward/Stop)</i>
<i>OUTPUT BIT 2</i>	<i>CIO0001.02</i>	<i>S2</i>	<i>Multi Function Input2 (Reverse/Stop)</i>
<i>OUTPUT BIT 5</i>	<i>CIO0001.05</i>	<i>S5</i>	<i>Multi Function Input5 (Multispeed reference 1)</i>
<i>OUTPUT</i>	<i>CIO0001.06</i>	<i>S6</i>	<i>Multi Function</i>

By referring to the **Figure 4**, the square boxes indicate the Frequency calculations. After the user set the value of the frequency by turning the "Frequency Variable" knob, the value will be sent to the Logics used, where it is denoted as "a". The output of the formula node has been divided into Multispeed Reference 1, 2, and 3, in which the number is either 0 or 1.

Table 2 below describes the relationship between the multi-step speed references 1 through 3 and frequency references 1 through 8. The value of each frequency reference can be set in the function parameters of the variable frequency drive. In this paper, the value of each frequency reference has

been tabulated in **Table 3**.

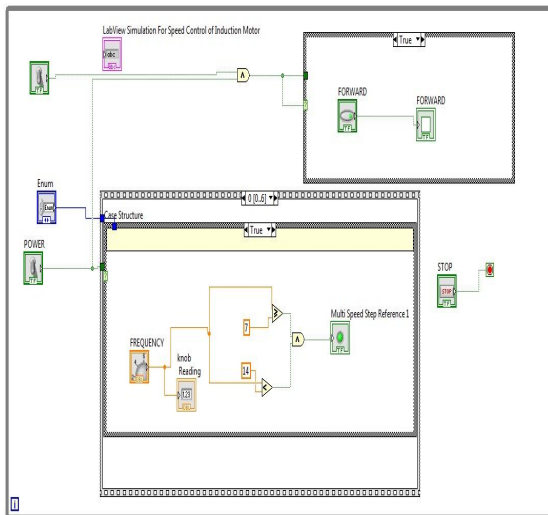


Figure 4. VI Block Diagram of the project.

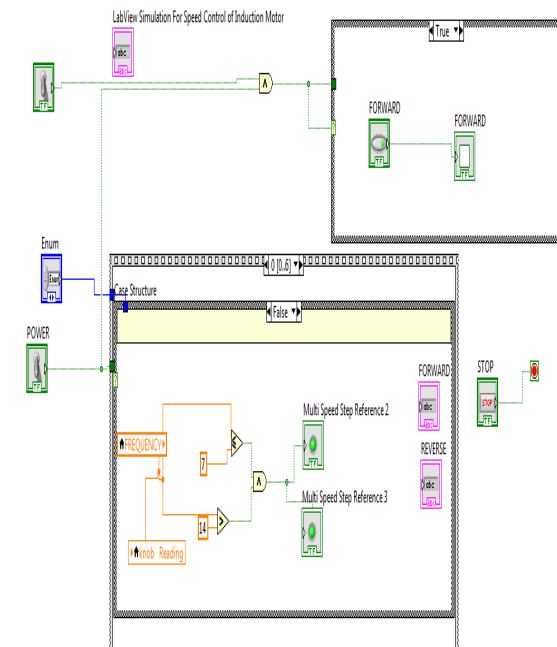


Figure 5. VI block diagram program (motor orientation switching part).

By referring to **Table 3**, as long as the user has set the input frequency according to any of the condition, the number will be converting into Boolean in which it will arrange according to the relevant Multi-step speed reference. Then this Boolean number will trigger the variable frequency drive and determine the frequency and as well as the speed of the squirrel cage induction motor according to the output condition listed in **Table 3**.

For example, if the user set the input as 8 Hz, in which the input range of this value is within $7 \leq x \leq 14$. Therefore, the Boolean number of Multi-step speed reference 1 is 1, and the rest are 0. Then, this signal triggers the variable frequency drive to deliver the frequency of 7 Hz.

Table 2. Relationship between multi-step speed references and frequency reference [6].

Frequency reference	Multi-step speed reference 1 (Set value: 6)	Multi-step speed reference 2 (Set value: 7)	Multi-step speed reference 3 (Set value: 8)
Frequency ref.1	OFF	OFF	OFF
Frequency ref.2	ON	OFF	OFF
Frequency ref.3	OFF	ON	OFF
Frequency ref.4	ON	ON	OFF
Frequency ref.5	OFF	OFF	ON
Frequency ref.6	ON	OFF	ON
Frequency ref.7	OFF	ON	ON
Frequency ref.8	ON	ON	ON

Table 3. Conditions of input frequency in LabVIEW for varying frequency reference

Frequency reference	Multi-step speed reference 1 (output bit 5)	Multi-step speed reference 2 (output bit 6)	Multi-step speed reference 3 (output bit 7)	Output frequency of squirrel cage induction motor (Hz)
$x < 7$	0	0	0	0
$7 \leq x < 14$	1	0	0	7
$14 \leq x < 21$	0	1	0	14
$21 \leq x < 28$	1	1	0	21
$28 \leq x < 35$	0	0	1	28
$35 \leq x < 42$	1	0	1	35
$42 \leq x < 48$	0	1	1	42
$x > 48$	1	1	1	49

4. TESTING AND VERIFICATION

After the Simulation program is implementation, test is performed in order to verify that the system is working smoothly.

5. CONCLUSIONS

In conclusion, the objective, scope and fundamental requirements of the project had been achieved. But there are some defects in this project. Firstly, there is a delay of time during the execution, which every decision made by the user through LabVIEW Simulation. The delay mainly caused by the poor specification of the Laptop used for implementation, that leads the LabVIEW to take long time to execute the program and generate the Reference output data. Therefore user cannot make too many actions and changes at the same time as it will crash the program. Secondly, there is limitation in the speed control as there are only 3 multi-step references in the VFD. The frequency changes in this project cannot perform in smaller steps unless there are additional multi-step references provided.

In overall, choosing LabVIEW as the human machine interface for the implementation is a proper decision as it has various types of applications and functions that are easy to understand and use. Additionally, this approach is more economical as the objectives of the system implementation have been achieved with only basic functionality of the LabVIEW toolkits used.

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