Automation of DMPS Manufacturing by Using LabView and PLC

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ABSTRACT

This Paper is to enable the Siemens (Programmable Logic Control) CPU 313-5A to communicate with the Lab VIEW and to control the process accuracy by image processing. The communication between CPU 313-5A and Lab VIEW is via OPC (OLE for Process Control). Process Accuracy is achieved with the use of Labview Image Processing and Gray Scale matching Pattern. Accuracy in the gray scale matching will purely depend on the calibration of the camera with respect to the corresponding image. The digital output from the labview is communicated to PLC via Ethernet Protocol for the industrial process control. With the use of Labview the dead time while using the normal image vision module in PLC can be minimized. Labview uses the gray scale matching technique which is more accurate than the normal image vision module used in PLC.

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1. INTRODUCTION

To mechanize the DMPS blending station for accomplishing better exactness in the process with the utilization of Labview Image Acquisition module and PLC. Machine vision is a wide term. Numerous scientific speculations, picture securing, picture handling and examination, and so on frame the entire machine vision world. In this manner, to characterize machine vision is a troublesome assignment, if these things are considered. Pages and pages could be composed on these distinctive subjects. Consequently, the principle centralization of this postulation archive was to build up a basic machine vision application utilizing programming promptly accessible in the market. The product utilized as a part of this proposal paper was Lab-VIEW. In any case, the essential necessities to comprehend a machine vision framework are talked about in the expected areas in the upcoming sections.

2. LITERATURE SURVEY

It is reported that mere physical examination and Laboratory shambling report is not helpful in the Process Accuracy. The reason behind it was the atmospheric conditions especially the temperature and the moister content may affect the Process accuracy.

Anjali Setal (2014) discussed about the various advantages on Labview-PLC based process control for a small statin with digital inputs via Modbus communication Protocol [1]. Forsyth et al (2009) contributed a method where measure of Image Color in gray scale pattern which is more accurate than Color matching Technique by Comparison with a reference image [2]. Papadopoulos, E et al (2008), described a novel approach to automation industrial process by the Image matching Technique with the use of separate image acquisition module [3]. Siemens Industrial Automation, (2008) explained the operation of the CPU 315- A Series type of Programmable controllers [4]. N. N. Barsoum, et al (2011) explains remote control applications over a wide area which is commonly used in industries these days. Ethernet module was used for achieving remote control [5]. Nargalkar Akshay, et al (2005) is to enable the Allen Bradly PLC (Programmable Logic Control) SLC-500 to communicate with the Lab VIEW. The communication between SLC-500 and LabVIEW is via OPC (OLE for Process Control). Development of OPC using RS Linux OPC Server. OPC is an industry standard provides real time plug-and-play software technology for process control and factory automation [6]. Fairchild, M. (2005) proposed a new feature of Color matching Technique by Comparison with a reference image [7]

3. DIMETHOXIC PROPONIC ACID

DMPS (Dimethoxic Proponic acid) is mixed gradually under controlled temperature with Edible Oil (Sunflower) for better quality. For this process 12 Ton of Edible Oil-Sunflower is taken for a batch, in its 12Kg of Sunflower oil concentrated with 120 Grams of DMPS solution is mixed gradually under controlled temperature. For the preparation of DMPS concentrated Sunflower oil 12kg of oil is taken in a vessel (small tank) and it was maintained at 650 C with the use of heater coils then DMPS Solution is dosed gradually to it with the use of dosing pump. During this process the colour of the sunflower oil in the tank gets changed due the concentration of DMPS. When the Colour of the DMPS Concentrated Sunflower Oil gets changed to Lime colour the camera will sense it and sends the signals to Lab view. The command from the lab view will be communicated to PLC-Simens CPU 315-A which governs the whole process with the use of ladder logic programmed in it.

For the preparation of DMPS concentrated Sunflower oil 12kg of oil is taken in a vessel (small tank) and it was maintained at 650 C with the use of heater coils then DMPS Solution is dosed gradually to it with the use of dosing pump the control of the dosing pump, Agitator and dosing pump is governed by the PLC Omron-Cpm2a.Temperature control of the vessel is controlled locally with the use of temperature controller with signals from temperature transmitter connected with RTD-PT100.The status signal of the temperature controller is given to the PLC Omron-Cpm2a for the control of the process. The Block diagram is shown in Figure 1

As the concentration of DMPS increases the color of the sunflower Oil changes to lime color which is sensed with the use of camera and the image is processed in labview and the status signal is shared to PLC for further action via OPC server of labview which is received by PLC via OPC client. The process is depicted on Figure 2.

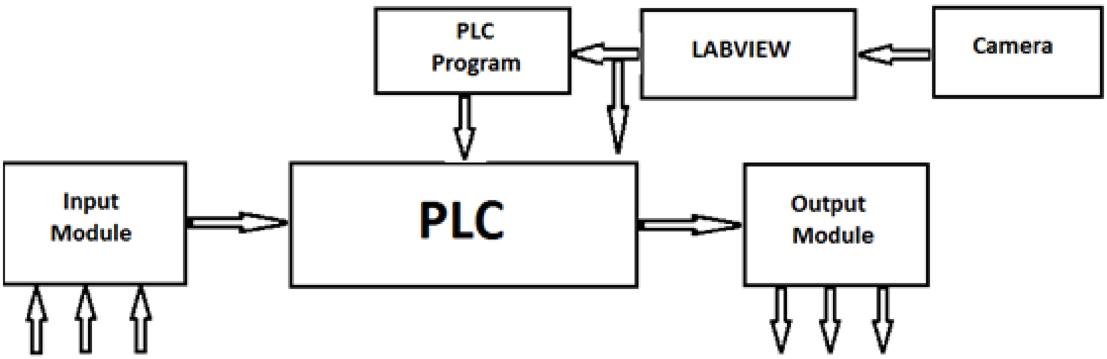

Figure 1. Block Diagram

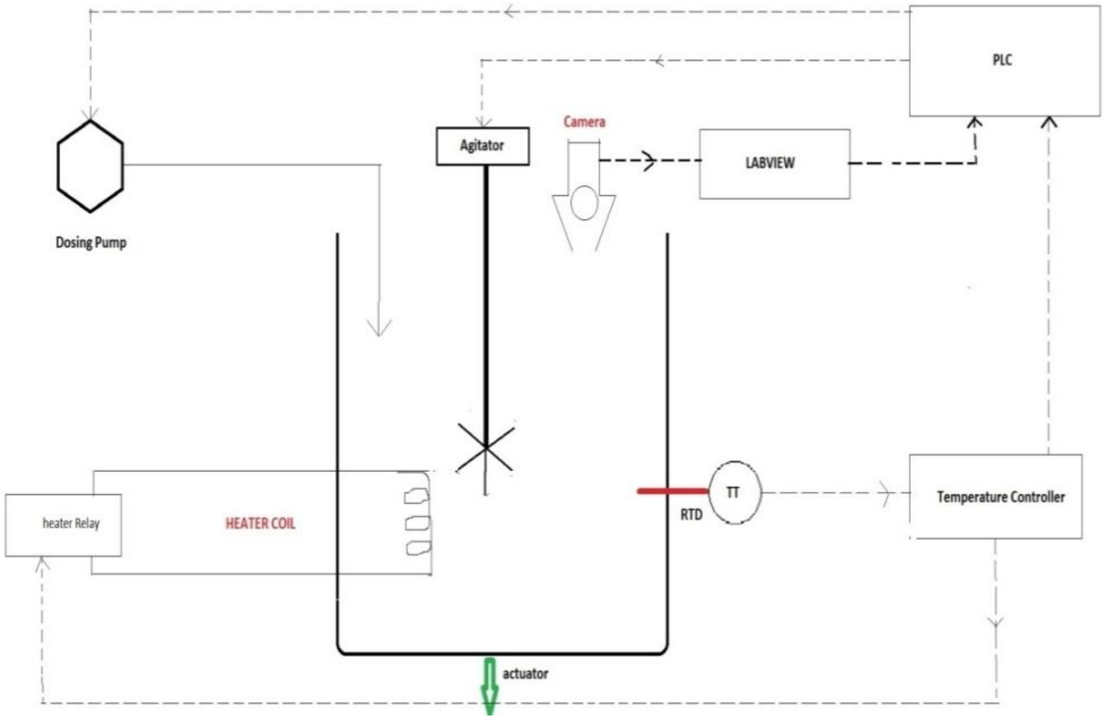

Figure 2. Process Diagram

3.1. Process Sequence

a. Push button ON-): Agitator, Dosing Pump and Heater gets powered heater uses separate temperature controller loop uses temperature Controller
b. Camera Starts sensing and when it reaches the required colour it passes the signal to plc via Lab view
c. When Image and temperature satisfies condition agitator and dosing pump stops and the outlet actuator starts dropping

3.2. Techniques Used

a. PLC –Siemens CPU 315-A uses Ladder Logic Programming with
b. Step-7 Logic LabView Uses Graphical programming
c. PLC-LabView Communication is with the use of LabView OPC Server and Omron CX-One Server

4. COMPONENTS OF MACHINE VISION SYSTEM

A machine vision system typically consists of machine vision software (machine vision tools) and a camera (image acquisition device). But many other things need to be considered for a machine vision system. Each of the components has its own significance. So none of the components can be isolated or segregated. The important components are discussed in brief in the following sub-sections.

4.1. Illumination

Illumination refers to the light sources that are available around the object being analyzed. It is significant that the object(s) under analysis be clearly visible to the image acquisition device. It ensures that much of the information is retained in the acquired image, and no much image processing needs to be done; thus making the machine vision application simpler to develop.

Illuminating object(s) does not mean availability of huge amount of light around the object; it refers the lights to be adjusted in a proper way. Proper illumination involves the right intensity and correct direction of light. It should be done in a way that shadow formation is checked and maximum contrasts can be achieved from the region of interest of the object(s). (Mo- vimed custom imaging solutions, 2007).

The light sources may be fluorescent lights or LED lights or halogen lights, etc. LED lights are more preferred over the other types of light sources, because of their long life and less energy consumption. Depending upon the arrangement of lights, illumination can be direct or indirect.

4.2. Image acquisition

Image acquisition is the most important part in a machine vision system. It involves capturing an image of the object to be analyzed with the help of camera. Different types of cameras can be used for image acquisition; they can include an ordinary mobile camera, a typical digital camera, or even a webcam. But cameras that are tailored specially for industrial use are also available. Depending on the sensor technology used, different cameras can be classified into two categories as follows:

- CMOS cameras
- CCD cameras

“The sensors could be matrix sensors or line sensors. An image sensor converts an optical image into an electronic signal.” Choosing a machine vision camera can be a difficult task. However, resolution, sensitivity, and type of camera-monochrome or color, should be considered when buying one. (ALLIED Vision Technologies GMBH, 2006). Also, the interface the camera uses for communication should be considered. The available interfaces include USB, Ethernet, Firewire, etc.

4.3. CCD cameras

A CCD (Charge-coupled Device) camera uses the CCD sensor technology. The main features of these sensors (and hence cameras) are listed as follows (Vision Systems Oy, 2012). The most common camera sensors In-coming charges are stored Equivalent to films of traditional film cameras. Consist of pixels with a typical size of 10µm x 10µm.

a. These are both color and monochrome.
b. These are light-sensitive diode sensors.
c. Each pixel has a micro-lens for focusing the light into the sensor surface.
d. Disadvantage of these sensors is the possibility of over exposure

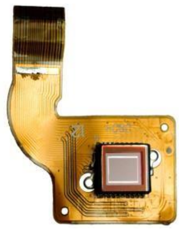

Figure 3. CCD Camera

4.4. Depth of field

Depth of Field (DOF) is the measure of the distance between the nearest and the farthest objects in a scene that can be captured by the camera and be acceptably sharp in the image.

4.5. Construction of the station

The system consists of cylinders, sensors, a motor as the physical components. As the PLC used in the station requires additional signal modules for the I/O (inputs and outputs) devices, signal modules from Beckhoff (www.beckhoff.com) was used.

4.6. System communication

The PLC was interfaced to the computer using S7 MPI adapter. The bus coupler, LC3100 was networked with the PLC using PROFIBUS cable. Also OPC communication was done using the same S7 MPI adapter. A diagrammatic representation of communication among the system components is shown in Figure 4.

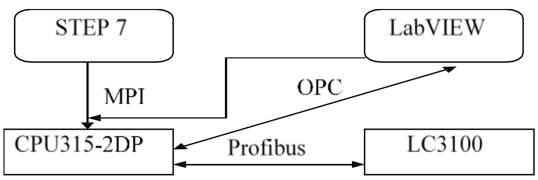

Figure 4. Communications among STEP 7, LabVIEW and CPU315-2DP and LC3100

4.7. STEP 7professional

STEP 7 PROFESSIONAL (STEP 7 in short) is automation software from Siemens Industry (www.siemens.com). It is used for programming simatic PLC stations. Figure 5 shows the system manger window of simatic STEP 7, where a created paper with some blocks is also shown.

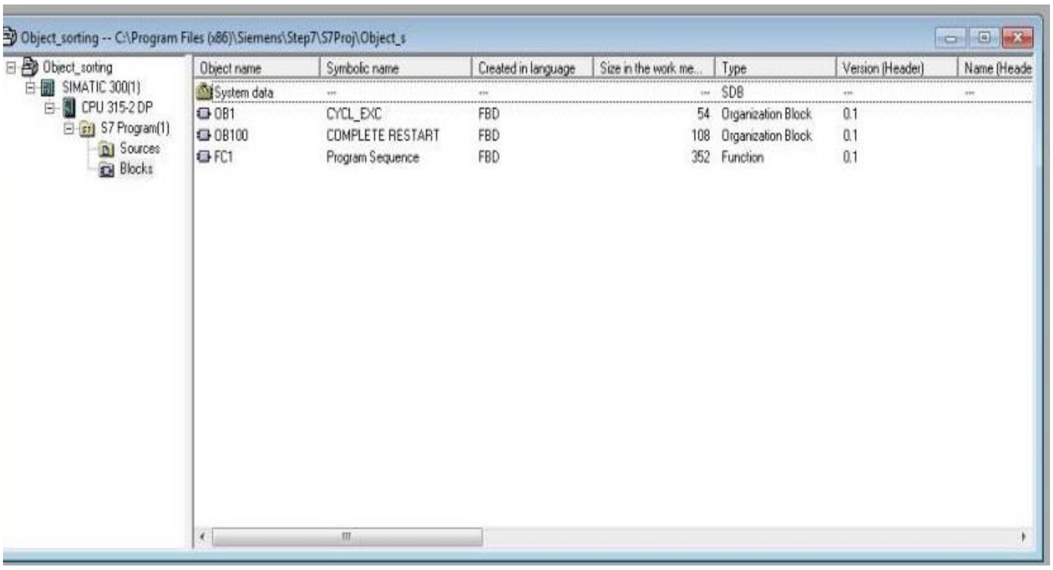

Figure 5. Screenshot of simatic manager (STEP 7)

STEP7 provides provision to code the program using seven different languages. Some of them are FBD (Function Block Diagram), LD (Ladder Diagram), and SCL (Statement List), etc.The user can freely choose the language. A STEP7 automation program may contain functions (FCs), function blocks (FBs), organization blocks (OBs), sequence functional charts (SFCs), etc. But, every STEP7 program must have OB1, because it is the main function. Details about the STEP7 programs are not covered in this thesis. The language used for the automation of the system described in this work was FBD.

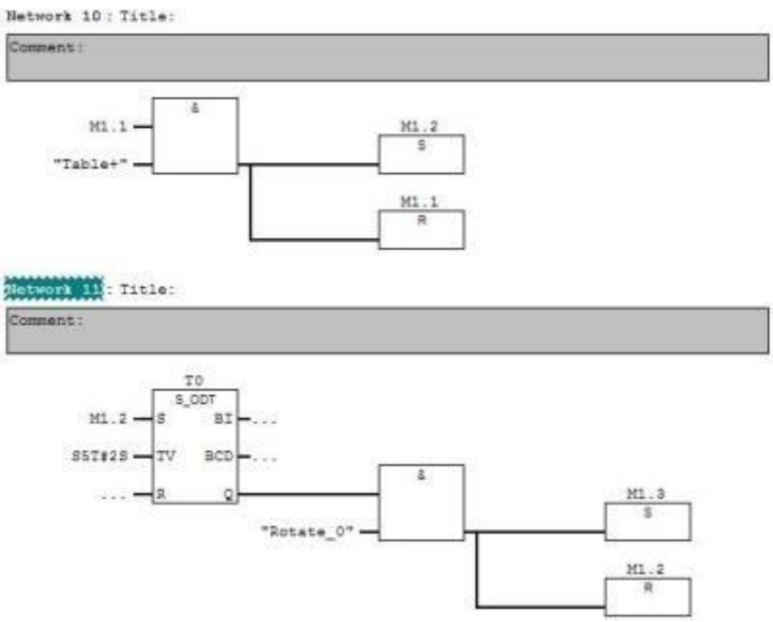

Figure 6. FBD codes in STEP 7

4.8. CPU315-2DP

CPU315-2DP belongs to Simatic300 group of PLC controllers. It consists of different indicators, a program manipulation key, and a memory card slot. It has 2 serial-connection ports; one of them is for interfacing between STEP7 and the PLC whereas the other is for connecting to a distributed module. Figure 7 shows CPU315- 2DP.

Figure 7. CPU315-2DP

4.9. Hardware configuration

Hardware configuration (HW) needs to be done before any program can be downloaded into the PLC. In the hardware configuration, the type of power supply, the CPU model (such as CPU315-2DP), the signal modules and (or) other distributed modules being used need to be specified so that the software and the hardware can inter-connect. Figure 8 shows the hardware configuration done for this paper.

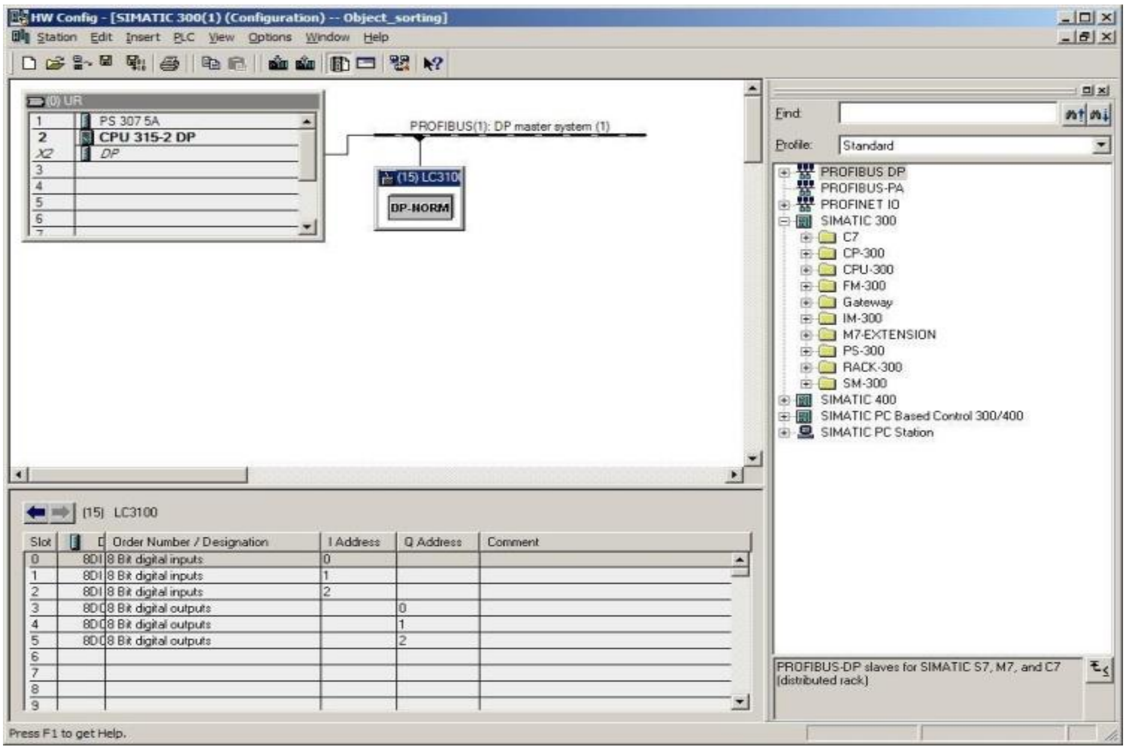

Figure 8. An example Hardware configuration for simatic PLC

5. RESULTS AND DISCUSSION

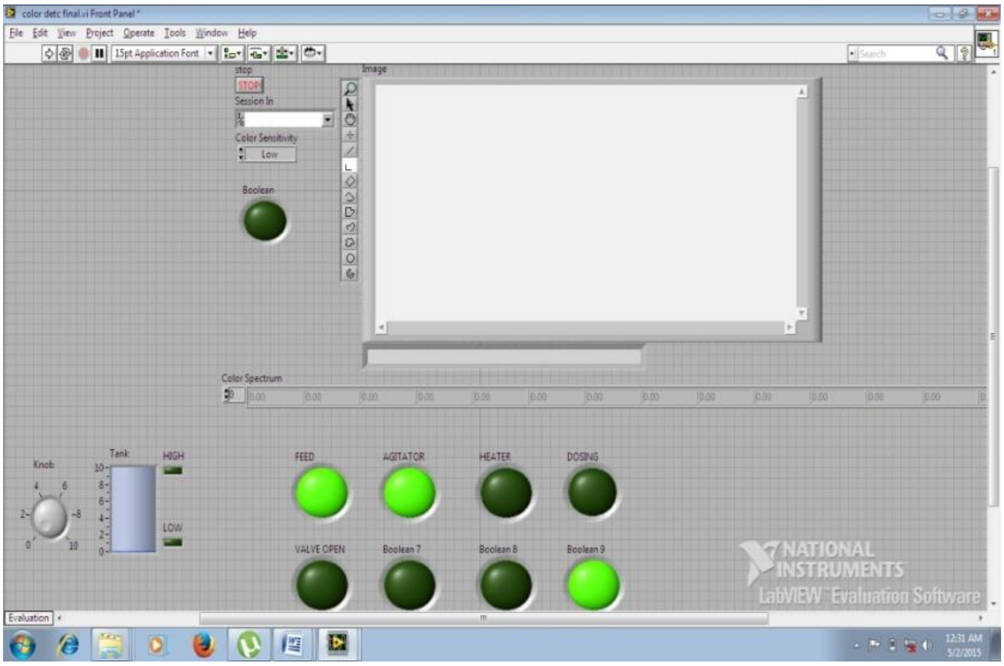

Figure 9. LABVIEW font panel

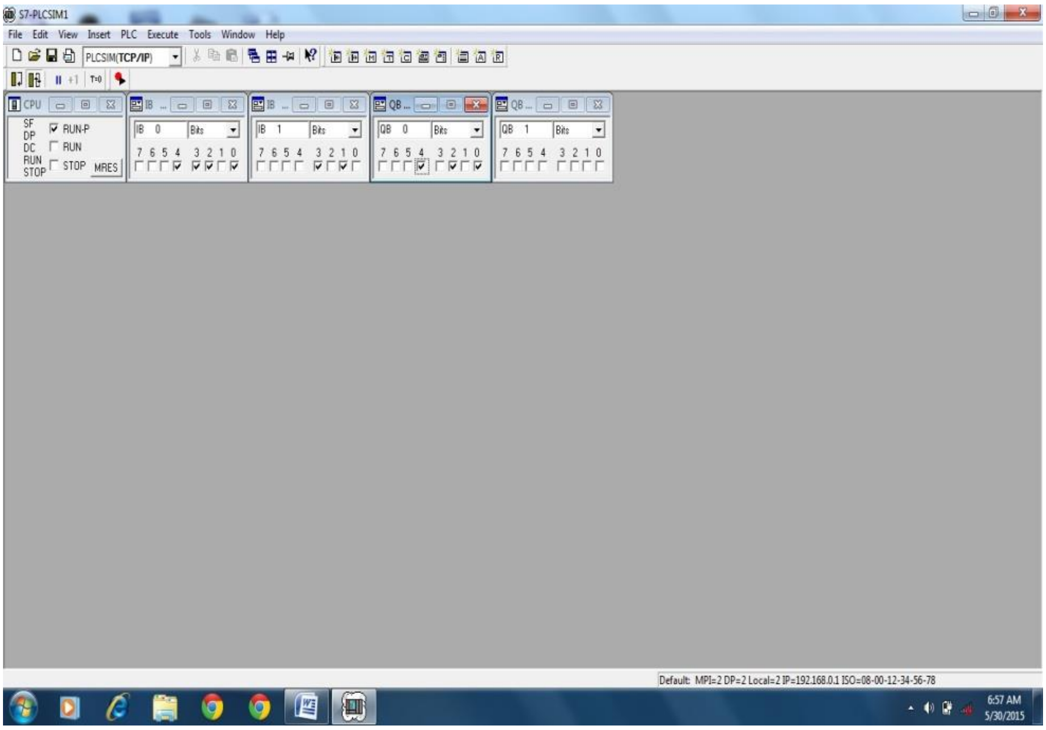

Figure 10. Step 7 Ladder and Simulation Module

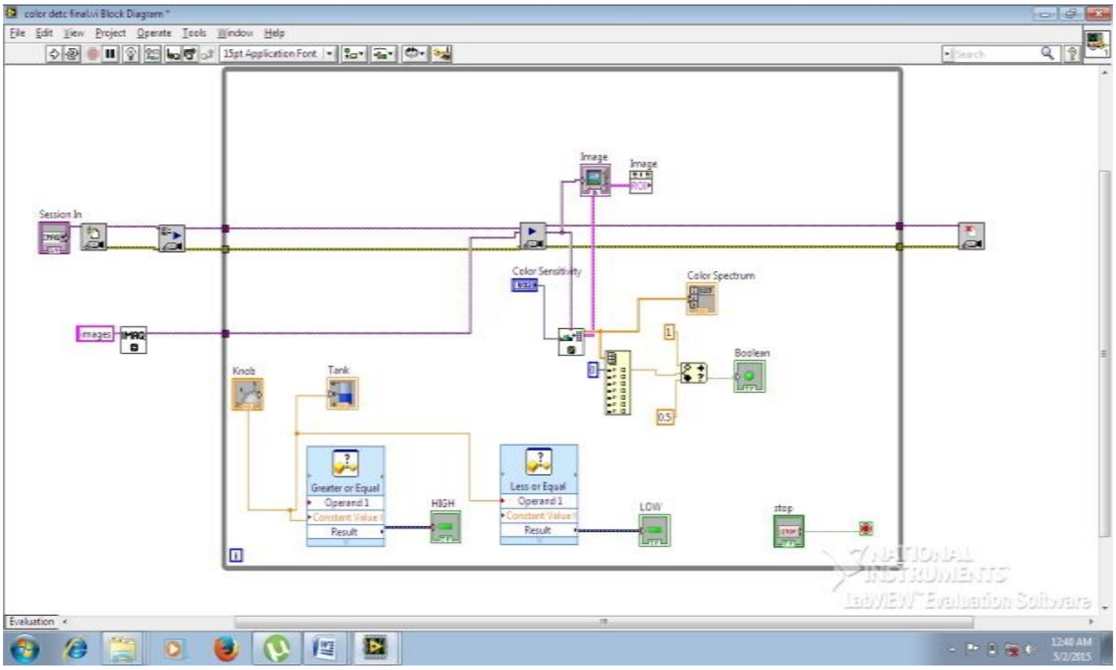

Figure 11. Selecting bounding box to create a bounding box

The output terminal from the Unbundle by Name VI was once again wired to Array-to- Cluster VI, whose output terminal was also once again wired to another Unbundle by Name VI.This time it was enlarged to get 4 output terminals. The first output terminal was assigned to 'Bounding Box [0]>x'; the second to 'Bounding Box [1]>y'; the third to'Bounding Box [2]>x'; and the fourth to'Bounding Box [3]>y' as shown in Figure 11.

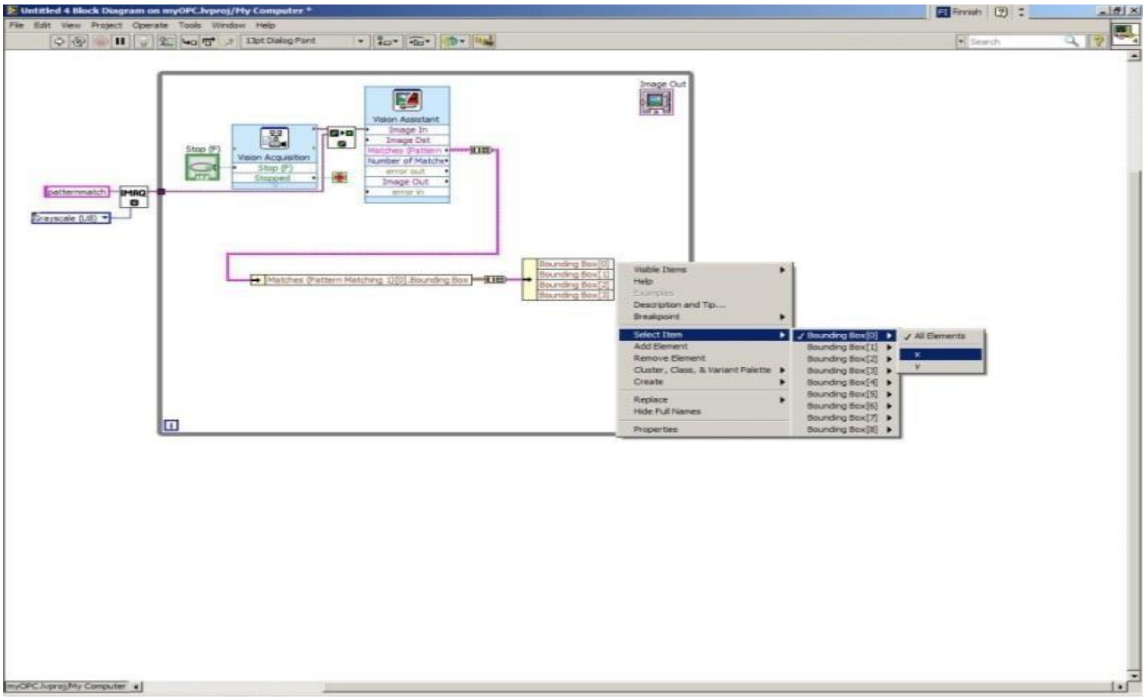

Figure 12. Assigning x- and y- axes to the bounding box

Each of the outputs was then connected to the input terminals of a 'Build Array' VI. The output terminal of this VI was also wired to an- other Array-to-Cluster VI; one thing to be noted is that all the clusters' size needs to be changed to 4; it can be done by right-clicking the Array-to-Cluster VI and selecting 'Cluster Size' from the context menu as shown in Figure 12.

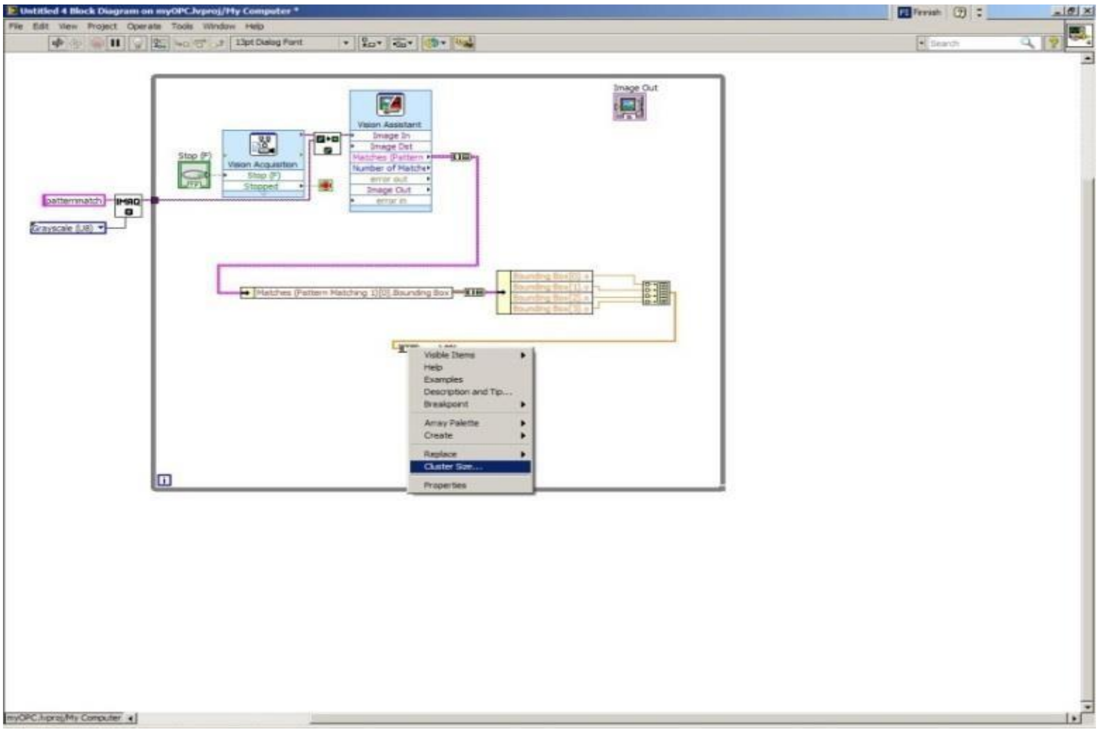

Figure 13. Changing the cluster size

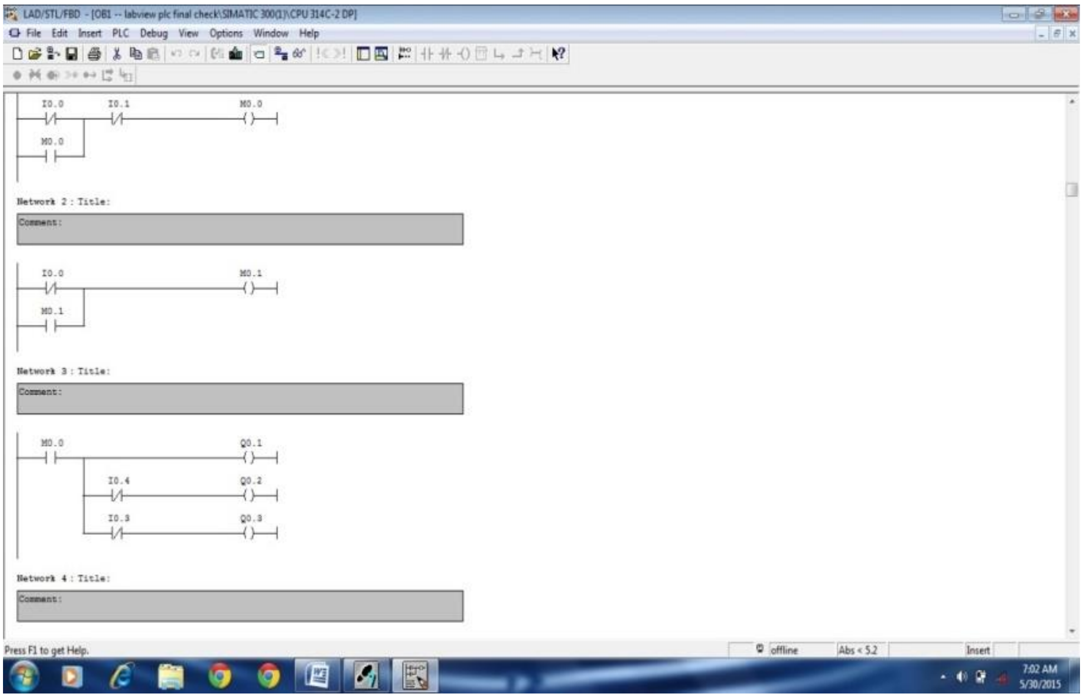

Figure 14. PLC Ladder & Simulation Module

The output terminal from that final Array-to-Cluster VI was connected to the 'Rectangle' input terminal of the 'IMAQ Overlay Rectangle 'VI. Also, the input terminal 'Image' of this VI was wired to the

‘Image out’ output terminal of the vision assistant. Finally, the output terminal from the Overlay Rectangle VI was wired to the input terminal of the ‘Image Display’ VI.

5.1. Method of Interfacing

5.1.1. Configuring PLC Driver

Here we choose RS-232 DF1 devices and click on Add New. Next we name the PLC and then start the configuration in Configure RS-232 DF1 devices.

5.1.2. Creating New OPC Topic

Create a new OPC Topic and save it for further use. All the inputs and outputs that are available in the PLC will be available under topic which we have created

6. CONCLUSION

From the paper performed, it was obvious that machine vision technology and NI Vision tools together can be used for sorting objects in a factory production line. It was confirmed that out of many machine vision tools, the pattern-matching algorithm could be applied for the object sorting purpose. Also, it was clear that a simple webcam could be used for performing machine visions tasks. Because, a webcam was used for pattern matching, it is not for sure that it can be used for different machine vision applications. But, if the application is independent of different image processing tasks, it might be possible to use webcams instead of other industrial cameras.

The pattern matching was done at different times of the day; every time the score generated by the vision assistant needed adjustment for the correct pattern matching. This shows that pattern matching is based on direct correlation matrix algorithm. The score generated for the image template was 900. If the score was increased over 900, none of the objects matched the pattern; below 900 patterns matched, but if the score was below certain score (for example 850), the objects which tend to be of the same pattern also matched. In that case, the aim of pattern matching failed.

Although pattern matching is not affected by lighting, it was seen that shadow formation of some other objects over the analyzed object hindered to match the pattern stored in the pattern template. So, to say that pattern matching is independent of lighting might be somewhat unrealistic. It might be said that pattern matching not affected by lighting directly, but there might be some other indirect cause relating to light that affects pat- tern matching.

It was also confirmed that PLC could be integrated with LabVIEW using OPC communication protocol; communication was enabled using NI OPC Servers in this thesis. The integration of simatic PLC was illustrated in this thesis but almost all the PLCs can be integrated with LabVIEW using NI OPC servers; provided there is an OPC driver for the PLC.

In this thesis document it was possible to present only a simple pattern recognition technique for the object sorting. Although the objective of sorting object using machine vision tool was met, it was realized that geometric matching tool would be more robust for sorting objects. The objects used in the paper were all similar; defining only one parameter could be enough in such condition to get the result. But the case would not be the same always. The objects may have different shapes and sizes; in such cases, it is not enough to match only the pattern of the object. Measuring distances between two points, measuring diameters, etc. could be added to the application to make it more powerful and error-free.

The main idea was to interface LabVIEW and PLC for more effective and efficient process control. This paper of interfacing two most powerful technologies ruling the industries lead to many new features like acquiring data at faster rate, controlling the process accurately, providing Multi-Tasking operations, Remote controlling and several other features. Used correctly, multi threading offers numerous benefits including more efficient CPU use, better system reliability, and improved performance on multiprocessor computers. Using LabVIEW, we can start today to maximize performance on multi threaded operating systems and multiprocessor computers without increasing either your development time or the complexity of your application. Because the multi threading technology of LabVIEW is implemented transparently, no extra programming is required to take full advantage of multi threading technologies.

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