Design of PLC–Visual Studio Communication using CX–Server Lite for Automation Tool's Crib

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Abstract—Role of tool's in enterprise is important, because a machine cannot assembled if one of tool's is not available. The problem that occured during transaction prosses of tools due to lack of information about the availability of tools, so the operator spend some time for searching the tools and the borrower is waiting for the operator. To solve this problem, a new system of tool's crib is requied for the tools storage. This system uses web as tools availability and uses PLC instead of operator. PLC is connected to PC using ethernet cable and programmed with Visual Studio as master. But in communication between PLC and HMI cannot communicate because PLC and HMI is a differend vendor, therefore requied an application to connected them. OPC is solution for of communication between PLC and Visual Studio because OPC is special to connected different hardware and software vendor. This OPC called CX – Server Lite from Omron. The previous system is changed to automatic and called Automation Tool's Crib and gives the fastest time than tools crib approximately 90 second with this communication.

Keywords—OPC, PLC, Visual Studio.

I. INTRODUCTION

PLC – Visual Studio communication design using CX – Server Lite for Automation Tool's crib has started from internship in PT.Astra Otoparts Division Winteq. In the internship process, internship placement in Rnd division which is research center of PT. Astra Otoparts Division Winteq.

The working on machine in ine production need a tools like cutting pliers to cut cables so wiring process can be done. Beside using cutting pliers, avometer is needed to troubleshooting process whether the cables is connected to a specified address that determined in manual book. That tools is available in tools crib which is the area to keep asset and tools that needed by employees so the employees do not need to bring a personal tools. But not all employees have a personal tools and must borrow from tools crib .But when doing the transaction of tools there is problem while long queuing up because to many employee are borrowing and less information about the available tools. The tool is available at the cribs tool which is a manufacturing operation for storing tools, where tools are available for machines at a factory [1].

The automation tools crib machine became the solution of the discussion so that a technopreneurship tool was created which was a miniature of the automation tool's crib. This miniature uses a small drawer with 3 shelves and an arduino controller with output, 3 buttons to open 3 racks, door lock and LCD as information about racks can be opened now. The door lock function as a lock when the drawer is closed so it cannot be opened before the button is pressed. After the miniature process was completed and discussed about this miniatur, it was agreed to make the tool crib machine and be named automation tool's crib.

In this research makes Automation Tool's Crib with automatic borrowing system using an ID card or Web login. This machine uses RFID as a tools scanner that is in the cabinet and as an ID card login. After login, the door lock will open and the employee can retrieve the items to be borrowed or will return the tools then cabinet closed and RFID scan the remaining tool's in the cabinet. the program will compare the number of items during the scan before the door is opened and when the scan after the door is closed to determine whether the employee is doing the loan or return transaction. The RFID signal is converted to digital data and entered into the database as a history of borrowing. The division of work scope is divided and discussed so as to realize the theme of the final task book entitled Design Of PLC - Visual Studio using CX-Server Lite for Automation Tool's Crib.

II. PROBLEM STATEMENT

Borrowing system in tools crib is use manual prosses, therefore need coin for transaction prosses. Employees coins are often lost because when working, the coin is fall down and lost unconsciously. Penalty are given for employees if the coin lost because it is company asset. Company gives nine coin for each employees and if one of that is lost, fifty thousand will be the penalty for employees. Transaction prosses also has a problem as though the queue is to lame and less information about tools that make assembled prosses delay.

Because of this problem, this paper will expalin about how to solve that. With new system of Tools Crib, the process run automaticlally and with no operator for take care of tools crib. The coin was replaced by RFID card for identity and login to the cabinet.

III. AUTOMATION TOOL'S CRIB SYSTEM

HMI and the controller cannot communicate directly, thus requiring third-party applications to connect HMI and

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controller. The PLC is used because it has a portion of Ethernet port on its CPU that is used as a PC communication with the PLC. For communication from HMI with PLC using OPC.

A. PLC uses

Programmable Logic Controller (PLC) is an electrical and electronic device that can be programmed to control various functions in sequence on machines or electrical systems [2]. This PLC is a modular type of PLC which means its I / O can be added according to the needs of the user and the components are separated apart. This device is separated into 4 parts is CJ1M CPU which is the part that serves as the CPU or Prossesor of this CJ Series PLC. CPU 13 has a memory capacity of 20Ksteps and has an I / O up to 640 points. For communications, this PLC uses RS-232 and Ethernet serials because there is a Peripheral Port port for Ethernet and RS-232 Port for serial. For the program use ladder program. The second part is the Power Supply for the CPU unit. The power supply has a voltage specification of 110 - 240 VAC and a total power of 14 watts and has Output for 5 VDC of 2.8 A and for 24 VDC of 0.4 VDC. This device has a range of 50 Hz - 60 Hz. The third part is input module which is is a digital input that does not have specifications for digital signals but can not be used for analog signals. The PLC has 16 inputs, a voltage of 24 VDC and a current of 7 mA. The fourth part is output module which only accepts outputs such as ON / OFF or 1/0 because this module is only used to control external devices only. This module consists of 16 outputs only and has a voltage of 12 -24 VDC and maximal current of 0.5 A per point and 5 A per Unit

B. Automation Tools Crib System Design

Tool's Crib is a store of tools assets of a company. Aside from being a storage area, tool 's crib has a function as a place to borrow a tools for the assembly process of the machine. The service system of the tool's crib uses coins for transaction. One coin is exchanged for one piece of tools only. For coin ownership, each employee is given approximately 10 coins. The difference with the automation tool's crib system, has a lending and return system using RFID cards that are scanned for login process. The process of transaction has also been recorded automatically and stored in the database that has been created. Automation Tool's Crib is able to replace the workforce of operator because the user is self serving while doing transaction processing. For safety components, this machine has a door lock solenoid as a cabinet lock so it can open the door automatically.

C. Visual Studio – PLC Design

PLC uses ladder program. This device has such a large specification has 640 points / 20 units and can be expansion up to one rack and has 20K steps. CPU also has ETN (Ethernet) that is RJ 45 or place of Ethernet cable in plugs and connected from PLC to PC / Laptop. Select Ethernet in Network Type section, because the communication uses an Ethernet cable. Creation of the file existence. Cdm is made with ladder diagram because this file adds a point whose contents in the form of Data Memory from PLC used so that Data Memory can be changed in Visual Studio program. visual studio can be used to create and carry out the development of many applications, it can be game applications, business jobs, windows applications or HMI [3]. To communitace Visual Studio – PLC is use OPC. OPC is is a low-level production system based on reliable traditional data acquisition technology [4]. This .cdm file specification matches with the CPU, if the CPU used by CPU with the specifications of 640 Point / 20 Unit in the .cdm file also has the same specifications. Point used can be selected and can be renamed according to the desire of the user.

Creating file with existence. Cdm on ladder software through New Project located on the left toolbar then right click and select properties. It appears and then create a new file with New File or use an existing file with select. Files that have been created will be stored in their respective user directories. This file will be imported to CX Server Lite in the Visual Studio form. Next step check the existing Memory Data in the PLC using ladder Program, by selecting the memory options on the Toolbar on the software. In .cdm file contains device and point. Device contains the name of the given PLC and the type of communication used by the PLC, when using serial communication toolbus will appear and for Ethernet will appear communication Ethernet. In the Functions Points menu make a new point. Then create a light indicator program. This program is used to send the programmed values in HMI to move red, green, and yellow light coils that exist on the Program. Light indicator program is used as an indicator when the machine experiences things that do not cool as forced opening on the door and do not close the door at the time after the transaction.

IV. TEST AND RESULT

A. OPC Testing

This test is done by making a simple program read value to retrieve the existing Data Memory values using Visual Studio. Data is taken using Button and displayed into Textbox in decimal form. It can be seen in the CX-Programmer Software after the data is entered into the Textbox and the data memory is taken in accordance with the one on the CX-programmer.

TABLE 1.
I/O PLC

No	DM	Input (value)	Output (Sensor)
1	D12	1	Yellow Lamp
2	D12	60	Red Lamp
3	D10	30	Green Lamp
4	D12	2	Solenoid Door Lock
5	D12	60	Buzzer
6	D12	21	Neon

Creating a write value program to change the value of data memory by entering the desired value into the textbox and

sending with write asynchronous commands in the program button. It can be seen in the Program after pressing the button and the value of the intended memory data changes or not.

B. PLC Testing On Login Form

In the table, there are 10 attempts on the Login Form to send values to the PLC and look when they enter the Login Form, the yellow light sensor lights up and the Limit Switch is in the Press condition. Door Lock is relase because it is still in login form so the door is still closed so that no transaction occurs when the user has not logged in with his RFID card.

TABLE 2.
FORM LOGIN INDICATORS

No	Sensor (Value)				
	Yellow Lamp (1)	Green Lamp (30)	Red Lamp (60)	Solenoid Door Lock (14)	Limit Switch (31)
1	On	Off	Off	Relase	Press
2	On	Off	Off	Relase	Press
3	On	Off	Off	Relase	Press
4	On	Off	Off	Relase	Press
5	On	Off	Off	Relase	Press
6	On	Off	Off	Relase	Press
7	On	Off	Off	Relase	Press
8	On	Off	Off	Relase	Press
9	On	Off	Off	Relase	Press
10	On	Off	Off	Relase	Press

C. PLC Testing on User Form (No Transaction)

In Table 3 there 10 experiments into the User Form to try to send value from Visual Studio to PLC. In the table above the door is still closed and has not made a transaction so the limit switch is still in the press or close and the door lock solenoid in the state of retrac so the door can be opened but only for 10 seconds so the solenoid is not overheat.

TABLE 3.
FORM USER TESTING (1)

No	Sensor (Value)			
	Green Lamp (30)	Yellow Lamp (1)	Door Lock (2)	Limit Switch (31)
1	On	Off	Retrac	Press
2	On	Off	Retrac	Press
3	On	Off	Retrac	Press
4	On	Off	Retrac	Press
5	On	Off	Retrac	Press
6	On	Off	Retrac	Press
7	On	Off	Retrac	Press
8	On	Off	Retrac	Press
9	On	Off	Retrac	Press
10	On	Off	Retrac	Press

D. PLC Testing on User Form (With Transaction)

The table describes the experiment carried out 10 times for the loan process and returned. The difference with table 3 is the solenoid door lock and limit switch, table 3 shows that the solenoid retracts or closes with value 2 and the limit switch is still press with value 31. Table 4 door lock is closed because the door has been opened and the limit is switch in Relase state. When the limit switch is relase, RFID will stop

scanning because there are conditions in the program if the value that reads 35 then RFID will stop scanning, so that when borrowing or returning the created listview can compare the number of objects in the cabinet before the door is opened and after the door is closed. After the limit switch is pressed because the door is closed then the yellow light will light up and back.

TABLE 4.
FORM USER TESTING (2)

No	Sensor (Value)			
	Green Lamp (30)	Yellow Lamp (1)	Door Lock (14)	Limit Switch (35)
1	On	Off	Relase	Relase
2	On	Off	Relase	Relase
3	On	Off	Relase	Relase
4	On	Off	Relase	Relase
5	On	Off	Relase	Relase
6	On	Off	Relase	Relase
7	On	Off	Relase	Relase
8	On	Off	Relase	Relase
9	On	Off	Relase	Relase
10	On	Off	Relase	Relase

E. PLC Testing When Key Is Rotated

In the Table 5 explain when the key is rotated, seen in the yellow light column blinks because the Key Switch men triger the yellow light to blink. in CX programmer - Programmer in setting P_0_1 every second the contact will Close and Open again for one second continuously. These two indicators can light up at the same time because when the Key Switch is playing, Visual Studio sends two values.

TABLE 5.
TESTING WHEN KEY IS ROTATED

No	Sensor (Value)			
	Lampu Hijau (30)	Lampu Kuning (1)	Door Lock (14)	Key Switch ()
1	On	Blink	Relase	Rotated
2	On	Blink	Relase	Rotated
3	On	Blink	Relase	Rotated
4	On	Blink	Relase	Rotated
5	On	Blink	Relase	Rotated
6	On	Blink	Relase	Rotated
7	On	Blink	Relase	Rotated
8	On	Blink	Relase	Rotated
9	On	Blink	Relase	Rotated
10	On	Blink	Relase	Rotated

F. Comparison of Loan Speed Between Tools Crib and Automation Tools Crib

TABLE 6.
COMPARISON BETWEEN TOOLS CRIB AND AUTOMATION TOOLS CRIB (1)

No	Loan Time (second)	Return Time(second)
1	61	51
2	90	50
3	95	55
4	121	51
5	60	60
6	61	65
7	62	52
8	124	86
9	70	50
10	103	53

In Table 6, experimenting with time data retrieval on conventional tool 's crib and obtaining data when borrowing time is around 84 seconds due to the operator having to find a tool that the employees wants to borrow. For data retrieval when back time is around 52 seconds because the operator just put the device according to the borrowed tool rack.

The Table 7 shows the time data retrieval experiments on the automation tool's crib machine. The time to borrow is around 29 seconds, because the user must choose the goods to be borrowed. The retrieval of the time data is available for around 19 seconds, the borrower simply puts the borrowed device and closes the cabinet door.

TABLE 7.
COMPARISON BETWEEN TOOLS CRIB AND AUTOMATION TOOLS CRIB (2)

No	Loan time (second)	Return Time (second)
1	30	19
2	23	20
3	22	20
4	34	17
5	31	22
6	31	23
7	36	16
8	31	18
9	27	21
10	31	19

V. CONCLUSIONS AND SUGGESTIONS

With this Final Project, the concluded and suggestion is that PLC can communicate with PC using OPC CX - Server Lite so that HMI can monitor sensor and company does not need operators in the process of borrowing or returning, the operator only do the bookkeeping done automatically. Automation Tool's Crib takes a much faster time In the process compared to the conventional Tool's Crib which is around 90 seconds. For advice, the placement of Automation Tool's Crib is placed in a room and RFID is placed at the entrance and exit so that the scanning process is done when exiting and entering the room. This placement also aims to place other cabinets that will be made so that all tool's existing in the tool's Crib can fit in the Cabinet.

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