Smart Production Line

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Abstract: *A production line is a set of sequential operations established in a factory whereby materials are put through a refining process to produce an end-product that is suitable for onward consumption; or components are assembled to make a finished article. A production line is a set of sequential operations established in a factory whereby materials are put through a refining process to produce an end-product that is suitable for onward consumption; or components are assembled to make a finished article. In this paper I modified the already existing normal production line into what I called smart production by giving the recognition capabilities to the normal production. This recognition capability was achieved by MATLAB, camera was installed on the normal production line which was taking pictures of the incoming products, identifying the incoming product from the picture taken and then the PLC was told by MATLAB did the recognition of the incoming product where to pack the three different incoming products without mixing them, each in its own pack tray.*

Keywords: matlab, plc, production line,s7 200 pc accesopcserver, ladder logic

1. Introduction

A. What is a Production Line

A production line is a set of sequential operations established in a factory whereby materials are put through a refining process to produce an end-product that is suitable for onward consumption; or components are assembled to make a finished article.

Typically, raw materials such as metal ores or agricultural products such as foodstuffs or textile source plants (cotton, flax) require a sequence of treatments to render them useful. For metal, the processes include crushing, smelting and further refining. For plants, the useful material has to be separated from husks or contaminants and then treated for onward sale.

B. Existing System

The current existing production line is just a normal one which deal/process one product at a time. The line might comprise of number of stations with different station performing a different task but still one product can be processed at a time. If another product has to be processed then another separate line has to be installed.

C. My Design

Smart production line is a production which involves MATLAB for identification of the coming product and the PLC for arranging the identified incoming product in its respective line. The interaction between PLC and MATLAB is achieved through the S7 200 PC access, which is an OPC server, the combination of PLC, MATLAB and the S7 200 PC ACCES SERVER resulted into high efficiency production line, which I decided to term it as *SMART PRODUCTION LINE.*

I. The main research

My project comprises of three parts, which are
 a) Automatic Production Line Driven by PLC
 b) MATLAB
 c) S7 200 PC ACCES
The role of each part is a explained below

a) Automatic Production Line Driven by PLC

The material being processed was three small different cylindrical work pieces, the white workpiece, black work piece and metal workpiece, as they can be seen below
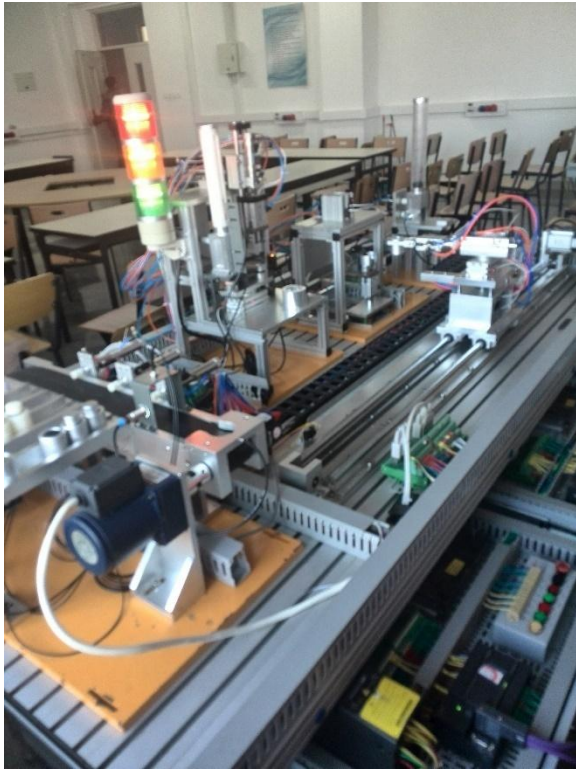

White work piece

Black work piece

Metal work piece

The automatic productions I used had five units, The feeding unit, the delivery (transfer unit), the processing unit, the assembly unit and the sorting unit

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My research focused more on the sorting unit, the sorting unit had three different rails for sorting the incoming products, and since we had three different products I wanted each incoming product (the three workpiece) to be arranged in separate line without being mixed, this is where the interface between MATLAB and PLC was done
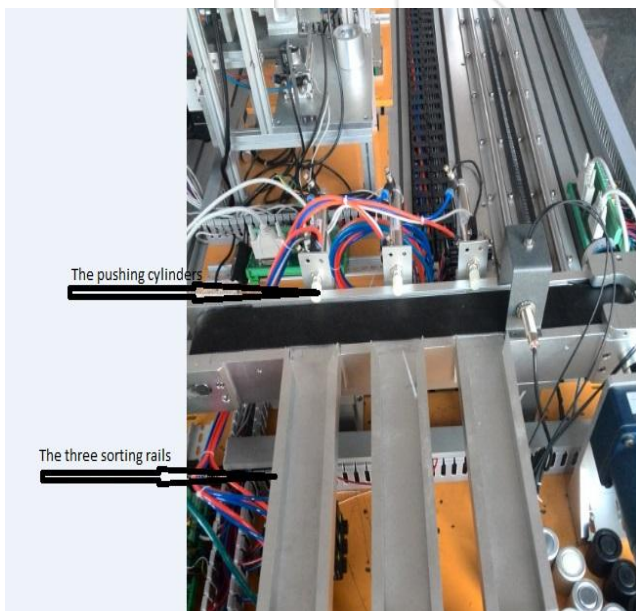
PLC

PLC or **programmable logic controller** is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. PLCs are designed for multiple analogue and digital 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-up or non-volatile memory. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

Before the PLC, control, sequencing, and safety interlock logic for manufacturing automobiles was mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers. Since these could number in the hundreds or even thousands, the process for updating such facilities for the yearly model change-over was very time consuming and expensive, as electricians needed to individually rewire the relays to change their operational characteristics.

PLC PROGRAMMING

Early PLCs, up to the mid-1990s, were programmed using proprietary programming panels or special-purpose programming terminals, which often had dedicated function keys representing the various logical elements of PLC programs. Some proprietary programming terminals displayed the elements of PLC programs as graphic symbols, but plain ASCII character representations of contacts, coils, and wires were common. Programs were stored on cassette tape cartridges. Facilities for printing and documentation were minimal due to lack of memory capacity. The very oldest PLCs used non-volatile magnetic core memory.

More recently, PLCs are programmed using application software on personal computers, which now represent the logic in graphic form instead of character symbols. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM. In my project I used s7 micro/win software to program the plc in ladder logics, I also used data blocks(DB) for temporary storage of data because I was sending data from MATLAB after the incoming product was identified to activate logic gate. To trigger the cylinder controlled by the PLC.

b) MATLAB
MATLAB (**mat**rix **lab**oratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran and Python

In MATLAB you can write data evaluation programs in other programming languages such as Visual Basic, C++, or Java, but Matlab is a language designed especially for processing, evaluating and graphical displaying of numerical data. A particular advantage of Matlab is that, contrary to most other languages, it can be used as an «interpreter»: you can enter single commands and have them executed immediately; in this way, you can quickly test how the syntax of the command has to be to yield the desired result. The thus verified commands can then transferred by «copy-and-paste» to your program files. And to execute a program, you do not need to pre-process (compile) it beforehand. MATLAB has high capacity in signal processing.

In my project I used MATLAB to process the image of the products, I wanted my production line to process three different products at a time, and arrange them in separate lines without mixing them. The identification of the products was done by taking the picture of the incoming product, then the picture was imported into MATLAB for identification and after the identification process the results was sent to PLC to activate a certain output port of the PLC.

The identification process was done by extracting features from the picture of the incoming product, then comparing those features with the image of the preserved images of the products, after the match was found then MATLAB will tell the PLC which cylinder to activate so to push the product to a specific rail. I extracted SURF features from the image taken of the incoming product, then finding the match in the pre-saved images of the three products, For example when a metal work piece was coming, the picture was taken by the camera, features was extracted and compared and then when it was confirmed cylinder no 1 was activated to push the workpiece in the rail one and arranged in one, white for cylinder number two and arranged in rail two and black for cylinder number three and arranged in rail three.

c.s7 200 pc access
S7 200 pc access is an OPC SERVER,**OLE for Process Control** (OPC), which stands for Object Linking and Embedding (OLE) for Process Control, is the original name for a standards specification developed in 1996 by an industrial automation industry task force. The standard specifies the communication of real-time plant data between control devices from different manufacturers.

As of November 2011, the OPC Foundation has officially renamed the acronym to mean "Open Platform Communications" although they also use the tagline "Open Productivity & Connectivity" on their website. The change in name reflects the applications of OPC technology for applications in Process Control, discrete manufacturing, building automation, and many others. OPC has also grown beyond its original OLE (Object Linking and Embedding) implementation to include other data transportation technologies including XML, Microsoft's .NET Framework, and even the OPC Foundation's binary-encoded TCP format.

After the initial release in 1996, the OPC Foundation was created to maintain the standard. Since then, standards have been added and names have been changed. As of June, 2006,

"OPC is a series of standards specifications". (Seven current standards and two emerging standards.) "The first standard (originally called simply the **OPC Specification**"), is "now called the Data Access Specification", or (later on the same page) "**OPC Data Access**", or OPC Data Access Specification.

There are number of OPC SERVERS such as MATRIKON OPC SERVER.KEPWARE OPC SERVER, RSLIX OPC SERVER and so on. In my research I used S7 200 PC ACCES OPC SERVER, developed by Siemens

Its Role

OPC was designed to provide a common bridge for Windows based software applications and process control hardware. Standards define consistent methods of accessing field data from plant floor devices. This method remains the same regardless of the type and source of data. An OPC Server for one hardware device provides the same methods for an OPC Client to access its data as any and every other OPC Server for that same and any other hardware device. The aim was to reduce the amount of duplicated effort required from hardware manufacturers and their software partners, and from the SCADA and other HMI producers in order to interface the two. Once a hardware manufacturer had developed their OPC Server for the new hardware device their work was done to allow any 'top end' to access their device, and once the SCADA producer had developed their OPC Client their work was done to allow access to any hardware, existing or yet to be created, with an OPC compliant server.

OPC servers provide a method for many different software packages (so long as it is an OPC Client) to access data from a process control device, such as a PLC or DCS. Traditionally, any time a package needed access to data from a device, a custom interface, or driver, had to be written. The purpose of OPC is to define a common interface that is written once and then reused by any business, SCADA, HMI, or custom software packages.

There is nothing in the OPC specifications to restrict the server to providing access to a process control device. OPC Servers can be written for anything from getting the internal temperature of a microprocessor to the current temperature in Monument Valley.

Once an OPC Server is written for a particular device, it can be reused by any application that is able to act as an OPC client. OPC servers use Microsoft's OLE technology (also known as the Component Object Model, or COM) to communicate with clients. COM technology permits a standard for real-time information exchange between software applications and process hardware to be defined.

MATLAB is equipped with OPC toolbox which makes it capable of communicating with OPC SERVERS, so here MATLAB is a client to the S7 200 PC ACCES OPC SERVER, the OPC SERVER's role is to make a link between MATLAB and PLC, when the product was coming MATLAB had duty to identify it and sent(write) the

information to the PLC to know which cylinder to activate and push the incoming product, MATLAB was commanding the PLC by activating the gates in the ladder program in which was running in the plc.

2. Drawbacks on the System

The only drawback I faced in my developed system the identification process of the incoming product was to slow.

3. Conclusion

I can conclude by saying after a long time, with a lot of obstacles finally made my idea into practice and the system was working fine

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