

Design and Test the Supervision and Control System (SCADA) Of Tobacco Cigarette Manufacturing Machine

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ABSTRACT

This research discusses the improvement of the production process of the tobacco cigarette industry by developing manual control systems to a mechanism based using Programmable Logic Controller (PLC) and design of the Supervisory Control and Data Acquisition (SCADA) The productivity of the machine and the reduction of labor, and adding the possibility of following-up work and giving orders by the manager or engineers supervisors remotely via the Internet.

The SIMATIC STEP7 program was used to design the programmable control system and write software for the programmable controller, the SIMATIC WinCC program for the design of human machine interfaces and the construction of the traditional SCADA system within the factory. The Internet-based monitoring and monitoring system was designed using the Eclipse software including the Siemens S7 Java Beans and Java Swing library And then load the control and control pages of the machine (HTML and JAR files) on the CP 343-1 IT card via FTP, where CP343-IT works as a server.

Simulation and testing demonstrated satisfactory results in terms of system's ability to control and monitor, response speed and error detection, and the efficient use of the Internet for its features for supervisors and large laboratory owners distributed in remote geographical areas.

Keywords — SCADA By Internet, S7 Java Beans, the tobacco cigarette machine, CP 343-IT.

I. INTRODUCTION

Control technology was based on the manual control in which the human operator had the primary role in following up the process, making decisions and executing operations manually. However, with the development and expansion of industrial applications, the need to measure and control a large number of factors and variables and the geographical area of industrial establishments became difficult for the Human beings worker to perform these tasks efficiently. More sophisticated and precise control systems have to be in place to control industrial processes and equipment and operate them without the need for the human factor, thus replacing them with monitoring and controlling variables that interact with all Industrial processes ,leading to accomplish the functions that it was constructed to perform .

To keep up with the development of information technology, especially in manufacturing companies, the concept of the automation network has been developed under the name of TIA, which through TIA is able to see or control all levels of the factory from the level of process control to the operators. (SCADA), a common process control application that collects data from sensors on the factory floor or at remote locations and sends them to a central computer for control and management.

The SCADA system includes input / output (PLC) equipment - an interface between the machine and the human

factor (HMI) - networks - communications - database and software.

Due to the high quality of the Internet service and its speed that it make it possible to work in real time. It has become possible to use the Internet in automated industrial zones, especially for companies that have divisions in many countries around the world.

II. RESEARCH PROBLEM

Depending on the human factor in the process of loading tobacco to the machine and the process of monitoring all variables related to the operation and control and detection of error causing the machine stopped, led to a decrease in the production of tobacco cigarettes within the specified working hours per day, hence the need to develop some of the manual techniques in our existing system in our research to A control system that supports the monitoring and control by PLC devices and the designing of SCADA-based control interfaces ,so we are able to quickly detect and identify faults and process them to increase productivity. This system help in the reduction of workers number.

The use of the Internet in the industrial zones and automation gave advantages to owners of factories located in different regions of the world, like providing information on the production process of each factories and the coordination of factories according to the markets size of demand and the ability to give some decisions regardless of the actual presence in the factories.

III. THE IMPORTANCE OF RESEARCH AND ITS OBJECTIVES

The aim of this research is to design two systems for the tobacco cigarette industry after conducting an analytical study of its working system and developing some manual processes to increase the production process:

1-SCADA integrated with programmable logical controllers for in-machine control and real-time monitoring, troubleshooting, alarms, automatic report generation, event and process documentation.

2- Internet based SCADA. The factories and the specialized engineers are able to follow the work of the machine and give some commands remotely through the Internet from anywhere in the world.

IV. RESEARCH METHODS AND MATERIALS

The development of the existing system in the industry of the tobacco cigarettes from manual control to automatic control system has been achieved through the use of modern PLC control technology equipped with the Siemens SIMATIC S7-300 CPU which was programmed using Siemens SIMATIC STEP7 software, and (SCADA) using the SIMATIC WinCC software from Siemens (Germany), as well as the design of a built-in HTML interface that is linked to the PLC by providing the programmable controller With the Siemens CP 343-IT network card, the network card must be configured and the S7-300 unit programmed in a district The manager can call and give some machine control commands over the Internet.

This research includes a detailed explanation of the work of the machine for the manufacture of tobacco rolls. The machine engine algorithms were developed in detail and the SCADA system is designed to integrate with programmable logic controllers for machine control and real-time monitoring, troubleshooting, warnings and reports creation. Automatic and documenting events, processes and many other tasks. In this research, a built-in interface is designed within an HTML page that gives the factory manager and maintenance experts the power to monitor and give remote commands to the machine.

The SCADA design concept is used in combination with programmable logic controllers for machine control and provides connection to the electronic control units used to control the machine. And the HMI interface in the factory to allow the operator to control the machine and provide its work information and warnings.

The use of the Internet with the SCADA system enabled managers and engineers at the company, regardless of where they were, to obtain important information about the factory's performance. This information helped them make the right decisions at the right time.

V. SYSTEM DESCRIPTION

The research follows an analytical and applied methodology. First, we conducted the field study of the tobacco cigarette industry to develop the system and determine all the requirements. We have described a general outline of the stages of cigarette production, as shown in Figure (1).

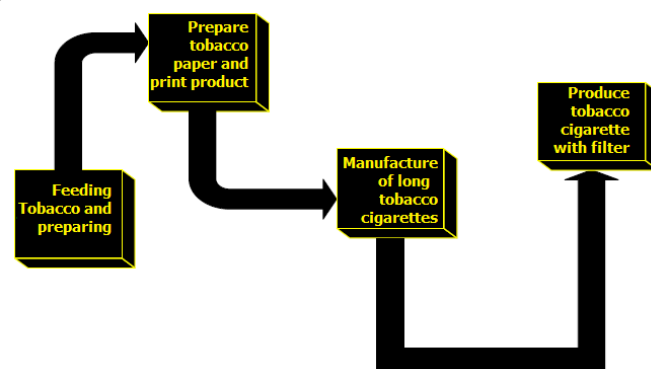


Figure 1 Stages of tobacco cigarette industry

The PLC is the key element in achieving the proposed development. The SIMATIC CPU S7-300 has been connected after being programmed and configured using the Step7 v5.6 software package with a traditional SCADA system in the factory using the WinCC Flexible software package, Factory monitoring using a program written in Java at the Eclipse package to access the factory remotely using the Internet via a cp343-IT and an industrial networking switch from Siemens SCALANCE-X108 through industrial Ethernet, through router and a computer connected to the Internet using standard Web browser supports the Java Applet As shown in the figure (2).

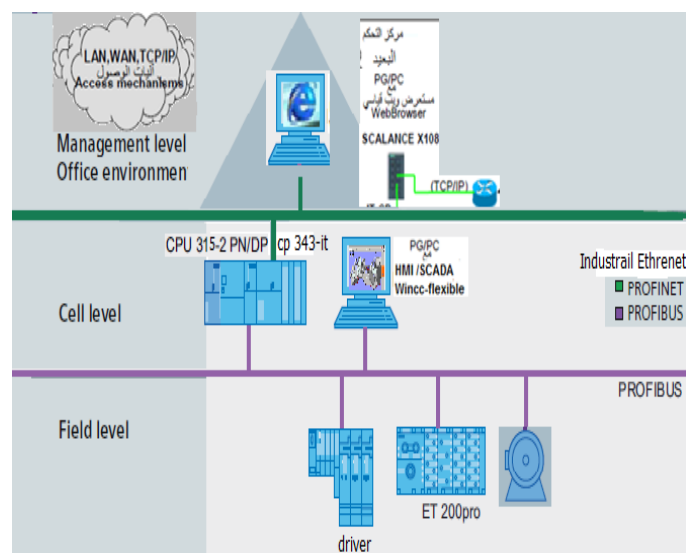


Figure 2 Proposed design of the system

Table (1) the following table outlines roughly which main function is contained in which hardware component.

HW component	Main function
CPU 315-2 DP	<ul style="list-style-type: none"> • Simulation of the process values and supplying the visualization interface with process values
CP 343-1 Advanced	<ul style="list-style-type: none"> • Web server for the access of the stations to the HTML pages disposed in the IT-CP • Storage location for the HMI HTML pages for displaying the control & monitoring used in the Java applets • Java applets for downloading
PG/PC	<ul style="list-style-type: none"> • Configuration computer • Operating the example via a standard Web Browser
SCALANCE X108	<ul style="list-style-type: none"> • Ethernet network component

VI. TRADITIONAL SCADA

SCADA is an industrial measurement and control system consisting of a central or central host (usually called a main terminal or MTU), one or more data collection and control units (usually remote terminal units or RTU units) and a range of communication technologies which connects different units. Communication is the backbone of SCADA technology there are two common types of communication modes: wired (cable or fiber optic cable) and wireless communication (radio frequency).

The traditional SCADA system performs data acquisition functions by scanning field inputs into RTU units, or connecting them to an MTU transmission unit via public or dedicated connection links, and then processing these inputs into the MTU. The traditional SCADA system also performs automatic control. Manual control is initiated by the operator, by sending command signals to RTU units via the same connection links. The human device interface (HMI) is usually made to the operator as GUI that represent the factory or equipment under control. Live data can be viewed as dynamic graphical shapes on a static background. Data in the field also changes, either as numeric states (open or closed valve) or analogue values such as numbers, bands, or diagrams, and controls are displayed as buttons or values [2].

When using traditional SCADA systems, real interoperability between different equipment cannot be achieved without the use of special drivers and interfaces.

VII. INTERNET-BASED SCADA

The Internet-based SCADA term has been loosely used in the industry to describe the SCADA system that applies one or more Internet technologies, including communication techniques, software programming techniques, and web browser technologies.

The main objective of SCADA's Internet-based application is to use internationally accepted standards and techniques to

achieve the control and control functions of the traditional SCADA system, but at a lower cost. This will usually lead to better interoperability between the various components of the system, ease of dissemination of information on different applications and external systems, and standardization of the human interface (HMI) through the standard web browser.

Interoperability or the ability of system components to interact with each other successfully is achieved when communicating in a specific way, using a set of common protocols and standards. The Internet-based SCADA system typically relies on one of the common network standards such as Ethernet, Token Ring, ATM (which is compatible with Layer 1 and 2 in the OSI network model), as well as a set of Internet protocols that include IP, TCP, and User Datagram Protocol (UDP) (Layers OSI 3 and 4).

Deployment of process information is also achieved through the factory or organization using a set of common applications and open interfaces. The web-based SCADA system typically uses web technologies, where the web server stores information and the web browser reads or writes information. Data is typically displayed using Hypertext Mark-up Language (HTML). However, HTML is limited in terms of functionality, and thus the XML was created to overcome the limitations of HTML and use it to send data between the server and the browser (or between two different servers). XML in industrial automation replaces many of the protocols used.

The Internet-based SCADA system may also include built-in smart devices (such as drives, drives, servers, drives, scales, pumps, and flow meters) built into built-in web servers that can transfer data from the factory floor to corporate web browsers. Allows remote control, diagnostics, asset management and supply chain management. The web browser also acts as an HMI that combines the graphical user interface and data collection.

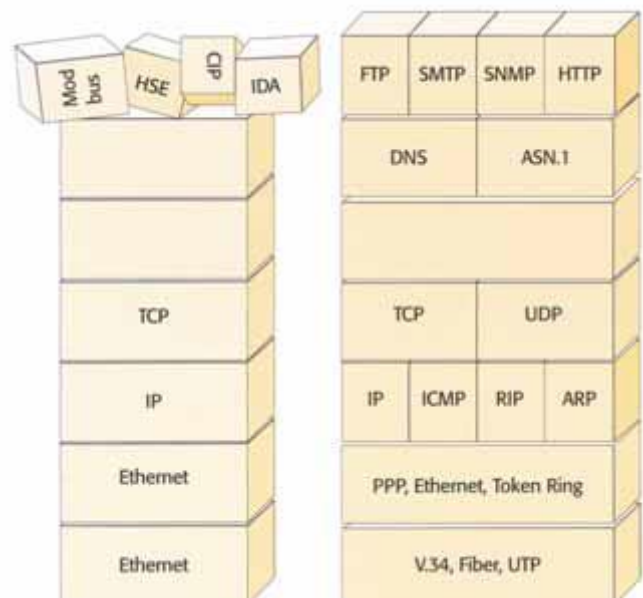


Figure 3 Typical industrial networks compared to the internet.

VIII. BASIC INFORMATION ON JAVA APPLETS

Java applets are small user programs which are executed in the web browser. Applets are embedded in HTML pages and together with these they are loaded from the server (here: IT-CP) into the client (Web Browser).

The solution is based on the employment of Java applets which are executed when loading an HTML page, thus depicting process values of the machine. In this case, the Java applet is always located on the IT-CP of the station itself. Therefore it is not necessary for the client to have specific information about the system.

IX. BASIC INFORMATION ON THE S7 BEANS

Java beans are Java components which have encapsulated functions and can be controlled by using known methods. The delivery scope of the ITCP contains a number of S7 beans regulating the communication with the CP or the CPU. All the S7 components (visual and non-visual) are contained in " Jar" Archive files:

- s7api.jar -> all the device classes of the S7 beans API
- s7gui.jar -> all visual components
- s7util.jar -> auxiliary classes for converting data types
- s7applet.jar -> contains preprogramed Java applets




The S7 beans can be imported into the palette of components of a Java development environment like, for example, the Borland Jbuilder where they can be used and configured by the programmer using Drag-and-Drop. The following table (2) shows the components after the import in a development environment.

Table (2) Components in a development environment

Library	IDE components
s7api.jar	AWT s7api s7gui s7misc s7util Fuelstand MyBr
s7gui.jar	AWT s7api s7gui s7misc s7util Fuelstand MyBean Swing Swing-Com
s7util.jar	AWT s7api s7gui s7misc s7util Fuelstand MyBean Swir

The following diagram compares the functionality and the functional chain of the S7 Java beans with the real SIMATIC components.

Table (3) Direct comparison HW <-> S7 beans

Components in the SIMATIC	S7-bean representative	Comment
	S7CP	The S7 bean S7CP is the Representative of the IT-CP. The entire protocol Communication to the system is performed via this bean.
	S7Device	The S7 device represents the S7-CPU on the system.
	S7Variable	The S7 item represents the value of an S7 address

Each S7 bean in the table (3) encapsulates the features of its real representative on the SIMATIC hardware/software level. The S7 beans on the client side are to be connected in the same way as, e.g., the S7 CPU via the backplane bus and the S7 communication mechanisms are connected with each other. This is performed via the methods of the individual S7 bean classes.

X. RESULTS AND DISCUSSION

We have tested two scenarios :

- Scenario 1: "traditional SCADA system"
Scenario 2: "internet-based SCADA"

In scenario 1, we test the traditional SCADA system As shown in the figure (4)., test the controls of each stage and all the business requirements we have identified, including monitoring the speed of the engines, monitoring the tobacco application, opening the valve to feed the machine and shutting it down, and the ability to change the machine's operating system. Among the controls we tested was to increase the heat of the main engine of the first stage and to open the doors of the protection of the machine through the simulation program and some of the other risks that were studied, the result was that the machine stopped working in addition to giving a coloured alert message on the screen which is the risk management strategy that we have designed.

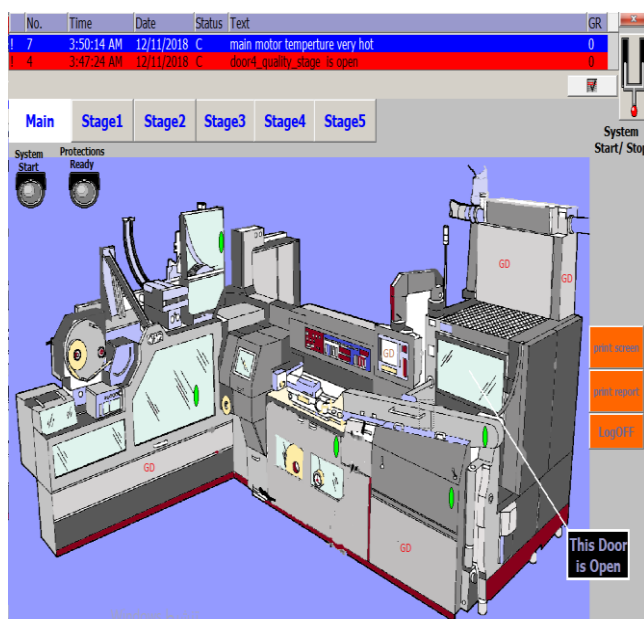


Figure 4 traditional SCADA system

In scenario 2, we have tested the internet-based SCADA system after our SIMATIC controller and the TCP / IP protocol for CP343-IT are configured and the controller has the required program, and exporting the JAVA program as a current file, splitting the work pages we created and images and including the Applet as pages (HTML), and then we transfer these files to the cp343-IT via the FTP protocol, so we used the UltraFTP software to secure communication with the same computer (FTP server), after these steps the browser is running and entering the [Http: // 192.168.0.1 /user/index.htm](http://192.168.0.1/user/index.htm), which represent the installed application that load the S7-Beans libraries from IT-CP, and the applet is running through JVM. This takes several seconds. According to the level of authorization configured, then login using your name and password and enter the name hmi_user and password hmi_user.

User interfaces have the option to switch between On and Off modes. Each interface contains a field for setting up updates, which can be selected between manual and periodic updates. Clicking the Special button enables the change between the control interface, the motors interface, the warning interface for the interfaces used, or the buttons that are designed in the main HTML page described As shown in table (4).

Table (4) test internet-based SCADA interfaces

Interface	Description
	Http: // 192.168.0.1 /user /index.htm

	Control Block with operating methods
	Motor speed any“ Controls to PLC
	Alarms mask Messages from Buffer

After testing the two scenarios we obtained the following results:

- The traditional control and control system within the factory provided local or central control using clear, concise, scalable pages, adding controls to these interfaces to perform one or several functions, the ability to detect early faults, show text or graphical messages, With him rather quickly depending on the factor of each stage, giving periodic reports on the production process.

- For the Internet-based control and supervision system, the following results are presented:

a) For multiple plant owners located in different countries:

- ✓ Reducing the burden and ability to know the quantity of production per plant, raw materials and the actual number of working hours of the machine.
- ✓ Ability to change the mode of operation of the machine to coordinate the production between factories in proportion to the market and the quantity of demand

b) For engineers (expert supervisors):

- ✓ Follow up errors and warnings (risks) that led to the shutdown of the machine.
- ✓ Ability to identify the exact error by virtue of their experience through the archive of errors that caused the failure and communication with the technician to resolve the errors without waiting for their arrival.

XI. CONCLUSIONS AND RECOMMENDATIONS

Even though this project meets the requirements, and ready to deploy it in real environment there has to be some improvements. They can be categorized in three groups; first two groups are software related, and the last one is a hardware related one.

- Improvement in Java programming
- Improvement in S7 control program
- Improvement in hardware

Test program modules can be used to find out the reason behind slowdown in HMI, which is written in Java. There are few things can be investigated; number of the S7Variables, program structure, and time intervals of the timers.

If number of S7Variables is the problem then a Step7 program can be developed to take most of load from Java program. For example instead of separate DI and S7Variables one can combine the entire DIs in to one S7Variable, let S7 program do the work.

Second improvement can be done to improve error handling. Since Java programming in Eclipse is done manually it is important to test the program for every scenario and fix the bugs.

Third improvement can be done by using newer versions of hardware. For example instead of using SIMATIC S7-300 one can try S7-400

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