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Literature Review

SCADA´S in The Automation of Agriculture in Mexico, A Overview

Jaime Cuauhtemoc Negrete*

Technical writer graduated in Antonio Narro Agrarian Autonomous University, Mexico

***Corresponding Author:** Jaime Cuauhtemoc Negrete, Technical writer graduated in Antonio Narro Agrarian Autonomous University Mexico.

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Abstract

Agriculture in Mexico is considered one of the most important economic activities since it generates a large number of jobs in the country. It is considered as the most important productive sector from an economic, social and environmental point of view, since it depends on the primary feeding of millions of people, the increase of the productive population and the preservation and care of the environment. Faced with this situation, the automation of small and large-scale agriculture is of colossal importance, Negrete [1], meanwhile applying mechatronic technologies to agriculture would help explode productivity in the Mexican countryside, an important role in this situation is the SCADA systems. The objective of this work is to know the current state of the applications of the SCADA systems in agriculture of the country. In Mexico the applications of SCADA'S systems in agriculture are nonexistent, despite their benefits for automation, being only used by large companies and government companies such as PEMEX (Mexicam Petroleum) and CFE (Federal electricity commission). In the review carried out of the applications of SCADA systems, irrigation systems in large extensions predominate in SCADA farmer shall have large projects they can monitor water flow rate of water soil humidity temperature also they can make control the irrigation remotely and choose irrigation area and control pumps, water tanks; for farmer the cost is the biggest barrier and they don't found any interest in this investment. Maybe for large scale project the idea is feasible. It was found that there are alternatives of alternative technologies such as Arduino to implement low cost SCADA systems, since this is the main limitation for its application in agriculture.

Keywords: Agriculture; Mexico; SCADA´S; Automatization

Introduction

Agriculture in Mexico is considered one of the most important economic activities since it generates a large number of jobs in the country; It is considered as the most important productive sector from an economic, social and environmental point of view, since it depends on the primary feeding of millions of people, the increase of the productive population and the preservation and care of the environment.

It is worth mentioning that agriculture is an important base for the development of the country, since it works as a tool that helps to promote food security; It is also a stimulus to enhance progress and productive growth that can significantly improve living conditions in large areas and boost the productive capacity of rural sectors. Anonimous [2]. Review the status of the automation in Mexican greenhouses and perspectives for the future and also suggests the use of mechatronics to automate and increase the productivity of agriculture, animal production and beekeeping [3-7].

Faced with this situation, the automation of small and large-scale agriculture is of colossal importance, Negrete [1], meanwhile applying mechatronic technologies to agriculture would help explode productivity in the Mexican countryside, an important role in this situation is the SCADA systems.

The objective of this work is to know the current state of the applications of the SCADA systems. in agriculture of the country.

Definitions

SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware modules. Widely used in industry for Supervisory Control and Data Acquisition of industrial processes, SCADA systems are now penetrating other domains as well. Today, SCADA technology offers key systems for various applications in agriculture, environmental control, irrigations, water management, disease control, insect control, and many others. Grigoras [8].

The concept of SCADA that comes from the acronym of "Supervisory Control and Data Acquisition", that is: data acquisition and supervision control. It is a software application specially designed to work on computers in production control, providing communication with field devices (autonomous controllers, programmable controllers, etc.) and controlling the process automatically from the computer screen. In addition, it provides all the information generated in the production process to various users, both at the same level as other supervisors within the company: quality control, supervision, maintenance, etc.

In this type of systems there is usually a computer, which performs tasks of supervision and alarm management, as well as data processing and process control. The communication is done through special buses or LAN networks, which will be addressed later for its specific study. All this is normally executed in real time and are designed to give the plant operator the possibility of supervising and controlling said processes. The necessary programs, and if necessary the additional hardware that is needed, is generally called SCADA system. Simon (2005).

Benefits

A SCADA package must be able to offer the following services

- Possibility of creating alarm panels, which require the presence of the operator to recognize a stop or alarm situation, with record of incidents.
- Generation of plant signal histories, which can be dumped for processing on a spreadsheet.
- Execution of programs that modify the control law, or even cancel or modify the tasks associated with the automaton, under certain conditions.
- Possibility of numerical programming, which allows high resolution arithmetic calculations on the computer CPU.

With them, you can develop applications for computers (PC type, for example), with data capture, signal analysis, on-screen presentations, sending results to disk and printer, etc.

In addition, all these actions are carried out through a package of functions that includes programming zones in a general-purpose language (such as C, Pascal, or Basic), which gives a very high power and great versatility. Some SCADA offer function libraries for general-purpose languages that allow you to very broadly customize the application you want to perform with that SCADA. Simon (2005).

Requirements

A SCADA must meet several objectives so that its installation is perfectly exploited

- Must be open architecture systems, capable of growing or adapting according to the changing needs of the company.
- They must communicate with ease and in a transparent manner to the user with the plant equipment and with the rest of the company (local and management networks).
- They must be simple to install programs, without excessive hardware requirements, and easy to use, with user-friendly interfaces.

Simon (2005)

Modules of a SCADA.

The modules or software blocks that allow the acquisition, supervision and control activities are the following

- Configuration: allows the user to define the working environment of his SCADA, adapting it to the particular application that he wishes to develop.
- Operator graphic interface: provides the operator with control and supervision functions of the plant. The process is represented by graphic synoptics stored in the process computer and generated from the editor incorporated in the SCADA or imported from another application during the configuration of the package.
- Process module: executes preprogrammed control actions based on the current values of variables read.
- Management and data archiving: it is responsible for the storage and orderly processing of the data, so that another application or device can access them.
- Communications: responsible for the transfer of information between the plant and the hardware architecture that SCADA supports, and between it and the rest of the IT management elements. Simon (2005)

Materials and Methods

A systematic and thorough search was conducted for data collection in printed data bases, Internet, journals scientific, graduate and postgraduate university thesis, newspaper articles, etc.

Literature Review

Author and Year	Description	Country
Anonimous (2016)	Centralized control system for reuse of wastewater for agricultural use in the Balearic Islands (Spain) includes a SCADA supervision and control system with distributed architecture, 3G communications systems, GPRS, UMTS, HDPPA, ADSL, panel power system photovoltaic solar panels and standards such as the S88, which helps improve understanding of communications.	Spain
Venturini [9]	Implementation of a SCADA System applied to the Production of Tobacco, more precisely, in the processes of the Curing Tobacco Plant	Argentine
González [10]	Use of an economic communications module for the export of lysimetry data used in irrigation management to an external hosting	Spain
Kalaivani [11]	Controlling and monitoring of the grain storage area is fully automated using PLC and SCADA. The main objective of the proposed project is to control and maintain the temperature in storage area which prevents the formation of microorganisms and spoilage of grains	India
Monsalve [12]	Basic solution Neptune for irrigation consists of remote terminal units (UTR), SCADA and communications. SCADA system Neptuno communicates via SMS and email and allows users to access the Internet remotely.	Spain
Satish [13]	PLC is used for the fully automated control. Lastly, agriculture can be done just by one click system developed by us keeping the database required for farming at the back end and SCADA at the front end for a user-friendly interface.	India
Ruiz [14]	Automatic control of a water pumping system for irrigation, through the programming of two programmable automatas. Control of two pumping stations through PLC and SCADA	Spain
Gurban [15]	Proposes, as initial stage, a viable solution for SCADA telematics system for distributed applications including greenhouse environment control. The key point for this project is to develop a generic telematics system that is integrated in SCADA applications. This system contains the following elements: PIC18F4620microcontroller, GSM modem, Ethernet controller, RTC board, digital thermometer and a LCD.	Romania
Bugarski [16]	SCADA systems allow for acquisition, storing and analyzing signals from the field. Today such systems are increasingly present on the market. Special attention is given to examples of SCADA systems in agriculture.	Serbia
Grigoras [8]	Establish a proper management of the SCADA system implementation. A progressive management is described, along with the benefits a SCADA decision support system can offer in the field of sustainable agriculture development	Romania
Rijo [17]	Design, implementation and field tuning of the (SCADA) system of a Portuguese irrigation canal network upstream controlled by AMIL radial gates and equipped with other Neyrpic devices.	Portugal
Anastasiou [18]	Design of a digital control system SCADA with generalized functions for process control, configurable to meet greenhouse control requirements. Intelligence is shared among low level control loops in the controller and high-level decisions made at the central process computer.	Greece
Elaydi [19]	Computer-based control and monitoring system is designed and tested to automate drip irrigation. The model greenhouse can be used as a prototype where several sensors are connected to an acquisition and control system using a PC and a data acquisition card.	Palestine
Molina [20]	SCADA application that allows Controlled Deficit Irrigation (RDC) in almond, taking into account for it the edaphoclimatic data of the plot where they are located. This system is mainly constituted by a software application developed through the LabVIEW® graphic programming language and by a data acquisition card	Spain

Molina [21]	SCADA system for irrigation programming and educational use in Agriculture. This system is made up a SCADA application developed with LabVIEW® and a DAQ-card used for data collecting of transducers and the activation of actuators of an irrigation system	Spain
Leon [22]	Design of a monitoring and control system of the pH of mineral nutrients for a prototype of recirculating hydroponic culture using PLC and Scada software. With the control of the pH the quality of the product is optimized since the mineral nutrients necessary for its growth are delivered to the plant	Peru
Merchant [23]	Design of an automatic irrigation system, using SCADA software and wireless sensor network. Design was made with drip irrigation system method and, the communication between the field and the supervisor system was established using ZigBee devices connected in mesh topology.	Colombia
Vasquez [24]	Design and development of a controlled aquarium through a SCADA, with the option to carry out remotely through the web	Spain
Smith [25]	In northeastern Colorado, an appropriate technology to consider is a Supervisory Control and Data Acquisition System (SCADA), which can provide for both monitoring and control of canal operations from a centralized location.	USA
Freeman [26]	Overview of experience implementing SCADA systems. By investing in advanced communications and electronics technologies in agricultural water districts	USA
Cárdenas [27]	In order to optimize irrigation, a SCADA system has been designed to manage a network of weighing lysimeters and an agroclimatic station for the efficient control of irrigation and the calculation of the water needs of the crops.	
Soto [28]	Proposes the incorporation of information and communication technologies in irrigation management; these technologies are; Decision Support Systems (SSD), Geographic Information Systems (GIS), Supervision and Data Acquisition Systems (SCADA), WEB Applications, Applications for Mobile Telephony.	Spain
Mestre [29]	Ubiquitous computing and communications concepts are well suited for modern SCADA (supervisory control and data acquisition) systems for agricultural applications, not only to the higher levels, but also to the field level.	Canada
Molina [30]	Programmable multifunction system for use in agriculture. The system allows, with respect to the rest of the irrigation programmers of the market, thathrough a software of control and data acquisition (SCADA) incorporated in a PC.	Spain
Abu Mteer [31]	One of the most important problems facing the agricultural sector, irrigation is indiscriminate and others regularly, causing wastage of large quantities of water and we will work in this project to solve this problem using the SCADA system, which provides command and control and collect data on irrigation to rationalize and streamline the process of irrigation.	Gaza
Bonaiti [32]	SCADA rapidly spread in the irrigation and dreinage district in Italy in the past 10 years.2011 District was merged to other two, within a Regional Effort to rationalize water agencies. This was possible also because of the more efficient and standardized management of the distribution network using SCADA, which has been implemented in most district in the Venetto Region.	Italy
Fernández-Pacheco [33]	present a new SCADA platform for the regulated deficit irrigation management of almond trees. This new platform implements a wireless architecture that ensures error-free communication among the irrigation system components with no need to maintain cables.	Spain
Molina [34]	Educational platform for the design of SCADA applications for irrigation programming combined with a scale model of a trickle irrigation system	Spain
García [35]	a SCADA System was implemented using LabVIEW as the application development platform; The system has sensors installed in the field coupled on a Wireless Sensor Network (WSN) using ZigBee technology for the monitoring and evaluation of moisture in the cultivated soil. Based on this, a programmable automaton performs the management of resources under its control. automatic irrigation of plantations	Ecuador

Pfitscher [36]	Presents a complete solution for the automated irrigation of rice crops using water level sensors, remote supervision system (SCADA) and wireless communication (GPRS). The proposed system is tested in four irrigation areas of small scale (10m x 20m). Ultrasonic sensors are used to measure the water level in the field. The control of the crop conditions is done by a dedicated controller, which eliminates the need for a computer on site	Brazil
Duran-Ros [37]	A supervisory control and data acquisition (SCADA) system has been developed to monitor and control microirrigation system performance. The microirrigation system had four types of filtration units and, placed after each one of them, twenty-four irrigation laterals using urban effluents. The SCADA system activated the irrigation system and the backwashing filter procedure.	
Cifuentes [38]	Example of the relationship between agricultural engineering, algorithm and programming, based on SCADA software in irrigation systems, relationship originated by the different needs presented by the community of Elche (Spain), where new models and algorithms were used in a system of decision support DSS (decision support system), to determine the water irrigation schedule	Colombia
Anonimous [39]	The system includes also a supervision level which is based on a SCADA application which can be accessed remotely by any web browser for supervision and control purposes of the process the protocol used for communication in the wireless sensor network is Zigbee The micro-controller is based on the open-source electronics prototyping platform Arduino The SCADA application is programmed in HTML and PHP languages and all the information of the system is stored and accessed from a MySQL relational database.	
Bhutada [40]	Automation of a free-standing greenhouse using supervisory control & data acquisition (SCADA) system. The end product is expected to give the farmer or enduser a kiosk type approach. Entire greenhouse operation will be governed and monitored through this kiosk.	USA
Gensler [41]	The SCADA system and related improvements in operational practices have reduced The Middle Rio Grande Conservancy District (MRGCD) river diversions from 7.4_108 m3/year a decade ago to an average of 4.3172_108 m3/year over the last 3 years.	USA
León [42]	Evaluated the sprinkling irrigation system type Pivots in sugarcane, which has recently been implemented in the Olmos irrigation project Likewise, a SCADA system was implemented that allowed much easier operation and maintenance, giving the possibility of irrigating large areas, being feasible the application of fertilizers and chemicals with irrigation water, obtaining a better and profitable production	Peru
Rabbani [43]	Implementation of an algorithm for real-time irrigation operations using a supervision, control and data acquisition (SCADA) system with automatic centralized controller.	France
Sigrimis [44]	A Virtual Greenhouse: A SCADA system, including its own special PLC with a class of generic control functions, signal processing math library, special built-in functions for event driven control loop and an embedded fuzzy inference was built to control and manage complex process. With recent additions for IP connectivity and remote camera support it has become a virtual laboratory system for training but also for remote management	
Sharma [45]	Develop and design a SCADA (Supervisory Control & Data Acquisition) System for Temperature and Humidity control using PLC (Programmable Logic Controller) and Eclipse SCADA Software for GUI (Graphical User Interface) in vertical farming. SCADA system integrates information coming from the analog humidity and temperature sensors present in vertical farm.	India
Aillón [46]	Design a SCADA system for automatic control of temperature and humidity for worm humus production beds in the company BIOAGROTECSA CÍA. LTDA	Ecuador
Herrera [47]	Step by step development of a wireless SCADA system with Arduino and Xbee, configuration of the Arduino hardware platform as a replacement for a National Instruments data acquisition card. Achieving complete compatibility with Labview, which reduces the assembly costs of the system. The XBEE module is attached to the Arduino to perform remote measurements of sensors and make decisions according to these.	Colombia
García [48]	Automation of a Laboratory of Agricultural Safety Level 3 (NSB3A), using a SCADA system (Supervisory Control and Data Acquisition).	Colombia
Contreras [49]	Project developed to design and implement a SCADA system (Supervisory Control and Data Acquisition) applied to the process of pasteurization of juices. Design steps were followed, starting with the preparation of schematic Layout, PLC programming, communication drivers and SCADA software design for a plant juices.	Colombia

Table 1: Applications of SCADA Systems in World Agriculture.

SCADA en México

In Mexican agriculture there was no evidence of the use of SCADA systems, despite their benefits for automation, being only used by large companies and government companies such as PEMEX (Petroleos Mexicanos) and CFE (Comision Federal de Electricidad). which also carry out research to implement and design these systems. Millan [50]., Sanchez [51], Likewise some universities [52-55].

Conclusion

In the review carried out of the applications of SCADA systems, irrigation systems in large extensions predominate in SCADA farmer shall have large projects they can monitor water flow rate of water soil humidity temperature also they can make control the irrigation remotely and choose irrigation area and control pumps, water tanks for farmer the cost is the biggest barrier and they don't found any interest in this investment. Maybe for large scale project the idea is feasible. Hifnawy (2015).

SCADA systems are very expensive to acquire, for this reason this article of search for solutions for this situation, to find alternatives to reduce such costs as presented by Herrera [56] that shows the step by step development of a wireless SCADA system with Arduino and Xbee, where the process of configuring the Arduino hardware platform as a replacement for a National Instruments data acquisition card is detailed. Achieving complete compatibility with Labview, which reduces the assembly costs of the system. The XBEE module is attached to the Arduino to perform remote measurements of sensors and make decisions according to these. Also, Vasquez [24] also recommends designing Scada's with Arduino and Visual Basic. Faced with this situation, the institutions dedicated to the automation of agriculture in Mexico, such as the Universidad Autónoma Agraria Antonio Narro, the Autonomous University of Ciudad Juarez, the University of Guanajuato, the Autonomous University of Querétaro, should place more emphasis on research on this theme [57].

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