GRIAS: GUI-Based Real-Time Industrial Automation Software

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Abstract: Industry has a great importance in the development of a country. These days a country cannot progress and prosper without industrial development. Industrial revolution has changed the fortune of many western countries. In the fast moving world of today, the industrial plants have become very complicated and many new technologies have been introduced in the market to overcome these complications by automating the industrial plants. This work proposes an industrial automation software called GRIAS (GUI-Based Real-Time Industrial Automation Software) that can be used for any industrial plant in which OPC (OLE (Object Linked Embedding) for Process Control) compliant hardware devices are used. This generic software has the ability to interact with an OPC server which is responsible to retrieve runtime data from the hardware device. The data provided by the server can be used by the software to monitor the running industrial plant. It can also be used in critical industrial units where it is very difficult to manually control the machinery. The industry has been looking for such software which can meet up their requirements, thus, this new industrial automation software will surely be able to realize their dreams into reality. The purpose of this automation software is not only to eliminate the perils and hazards involved in industries but also to speedup the process of manufacturing and production in such a way that it is no more error prone. [Journal of American Science. 2010;6(12):96-101]. (ISSN: 1545-1003).

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1. Introduction and Problem Statement

The sole super power of the world is basically an industrial power. Industry has the importance of a backbone in the economy of a country. In the fast moving world of today, the industrial plants have become very complicated and also very dangerous to the environment and the human life. A single industrial unit which is not functioning properly can prove to be a source of great peril to all human population in the nearby area.

The industrial trends have changed at a very fast pace and these days due to the presence of internet trends are changing on a day to day basis. The industrial trends are in a transition from traditional based business to business transactions, to web based and e-commerce. The most important parameters in the industrial manufacturing are the consumer interaction, product characteristics, rapidity, costs, strategic assets and productions.

The automation software has totally changed the industry trends. These days no industry can think of increase in productivity and competing in the market without the automation software. The automation software provides the competitive edge to the company using it, because it increases both efficiency and the productivity. Traditionally, without the presence of automation softwares, the speed of placing an order was too much. It took weeks to place an order and even months to receive the confirmation.

There are a large number of industrial automation technologies which are widely used in the market to automate an industrial plant/unit. These technologies cannot work in isolation and usually a blend of technologies is used to prepare an automation solution. Some of these are physical interface, data acquisition, databases, GUI/visualization etc. The various vendors have developed various tools which based on any one of these technologies. These tools provide an integrated development environment (IDE) which helps to develop a software solution in a very efficient way. The various software technologies are the SCADA (Supervisory Control and Data Acquisition) (Daneels et al., 1999), Human Machine Interface (HMI) (Hagenmeyer, 2005), OPC (OLE for Process Control) (DeltaV, 2007) and so on.

1.1. Overview of OPC

OPC is an industry standard for hardware devices used in critical industrial units. All OPC devices follow certain specifications which are laid down in the OPC standards papers (Draft-3, 1998; OPC; Zheng et al., 2002). These specifications force all the devices to use the same technology so that any software written for one OPC compliant device should be able to work with another. OPC is based on

OLE technologies. It characterizes standard objects, schemes and functions for real-time information servers (such as historian, PLCs (Baresi et al., 2000), DCS and other software applications). The end users by utilizing the OPC specifications may select the client application which best fulfills their demands. Prior to OPC an end user used particular client software that offered an interface for a specific control device only, but by means of OPC, any client application which is OPC compliant can interface to a control device with an OPC compliant server, thus, the end user finds the best way out for a specific assignment.

In this context, this work also proposes new automation software (i.e., GRIAS) to automate any OPC (OLE for Process Control) compliant device. The GRIAS automation software actually interacts with an OPC server which is responsible to retrieve runtime data from the hardware device. This data provided by the server is used by the software to monitor the running industrial plant. This data may be the temperature in a certain boiler or the pressure at a certain valve etc. The software is also able to generate commands to the hardware device through the OPC server in order to keep the industrial unit under control. These commands may result in lowering the pressure or temperature to a certain degree or the opening of a valve etc.

The GRIAS has two types of users; a higher level user (or the administrator) is able to configure the software for a particular industrial unit. The administrator can also perform certain administrative tasks like creating or deleting the operators and setting their privileges and logins. The second type of user is the operator who is assigned the task of monitoring the runtime data coming from the industrial unit. An operator may also issue the commands if required.

It also includes a manual to provide a systematic and right approach for making and maintaining automation software. The various design steps are explained with the help of market standard UML diagrams. The various use-case, sequence and collaboration diagrams are also included to give a clear view of the functionalities and the sequence in which various actions are taken by the software.

The most important feature of this work is that it throws light on the different development phases of software engineering which are necessary for developing quality software.

Thus, this research work proposes such GUI-Based Real-Time Industrial Automation Software that will be able to control an industrial plant which uses an OPC complaint hardware device. It will be used to monitor the industrial units and issue the required commands on time. This will make the overall process of industrial manufacturing and production very efficient and will certainly reduce the cost of business. Its implications will also include the safety of human lives as everything will be controlled by the software and no human interaction with the industrial plants will be needed.

1.2. Assumptions and Dependencies

In the initial software it will be assumed that the PLC (Programmable Logic Controller) (Baresi et al., 2000) device is available and the OPC server is also available. Since a PLC device is very expensive and a group of students without any funding cannot purchase it, thus it will be assumed that a PLC device is present and working. A simulator will be used instead of a PLC device; the simulator will help to generate the data for the software just like a PLC device produces. The data produced by the simulator will be used by the application and it will appear as if data is really coming from the hardware device that is the PLC.

2. Software Analysis and Design

In this section, data flow diagrams (DFD) are used to represent the flow of data in the system. The zero level DFD in Figure 1 shows the top level view of the proposed system. The first level DFD in Figure 2 then shows the various processes hidden in a zero level diagram and demonstrates the interaction of various external entities with these processes. The next level DFD in Figure 3 represents the processing of data at different levels and interaction of various processes with the data stores.

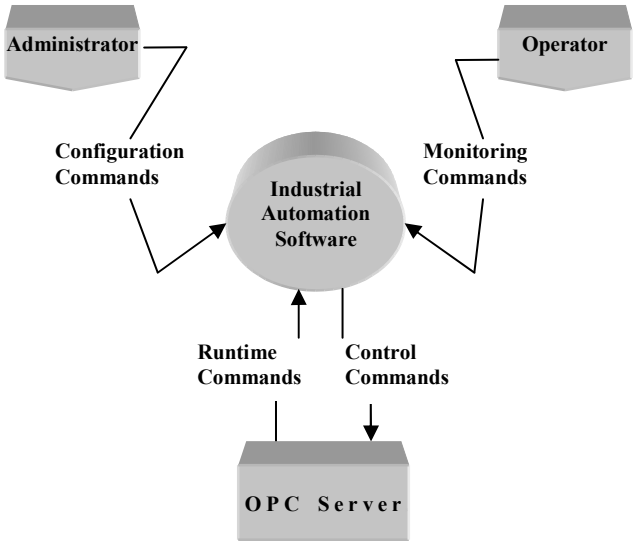

Figure 1. A top level view of the proposed system

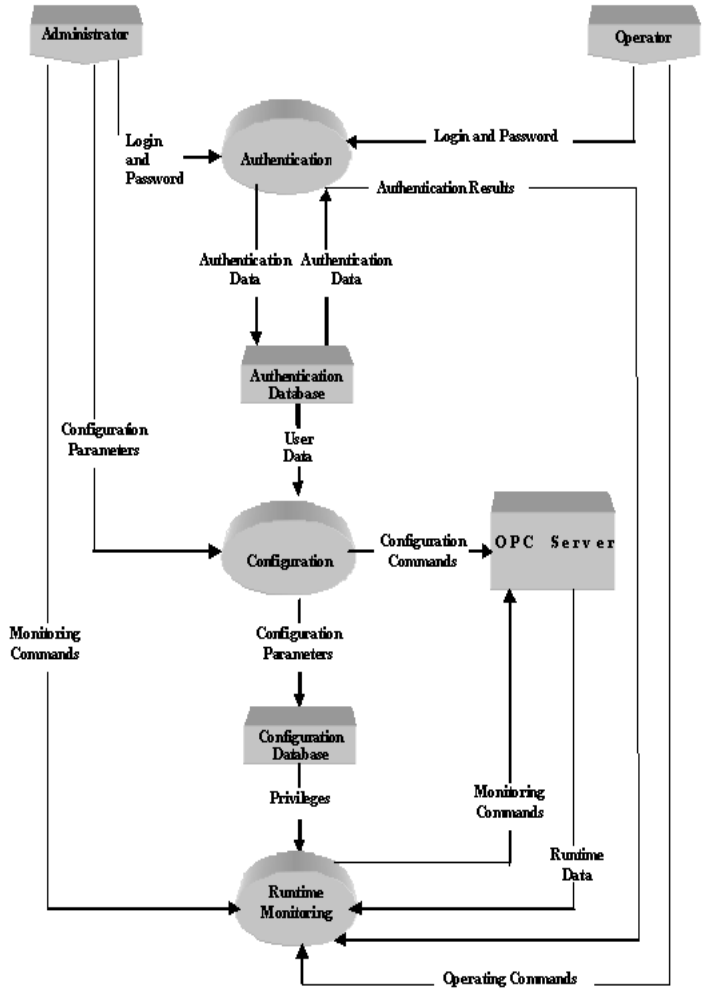

Figure 2. First level DFD of the system

3. Proposed Software's Features

3.1. Object-Oriented Architecture

This software involves some basic steps to build a process. Initially choose the object's type that the developer wants to make from software's big library having display, driver, control & data handling objects. Next, you organize the objects through software's advanced features and lastly you attach these objects. A developer is able to make remote/complex connection, or direct connection which perform calculation or check logical conditions. After creating the objects selected from software's extensive library, all the driver objects are now arranged to write and read from the field hardware attached to your system. You are even able to create a basic process also within an aggregate object to reuse with other processes that save your time.

3.2. Event-Driven Performance

Events drive the industrial automation software, meaning that whenever a change happens, it is instantly reported. As compared to loop-based softwares it responds to events more rapidly.

3.3. Online Configuration Features

A developer can build, modify and stop a process while its application is in progress. With the help of online configuration feature you can perform the maintenance without having any gap in your application data, event, alarm and records.

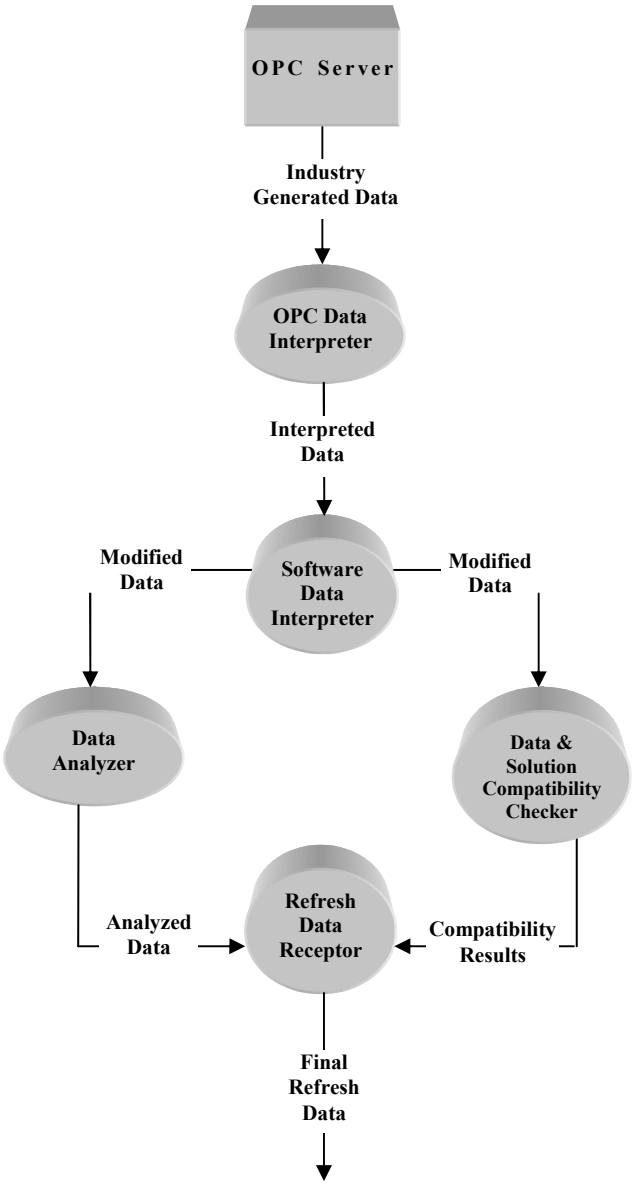

Figure 3. Second level DFD of the system

3.4. Redundancy Capabilities

GRIAS provides enhanced objects which can simply be used to produce urgent backing system to work at the time when the system breakdowns. A developer can apply objects as well to build and sprint several processes as of a single process model–all made the simple Industrial Automation Software way.

3.5. Web Capabilities

It also supports the web-connectivity and by the means of this feature; a developer is able to examine and supervise automation software's process by any workstation connecting to the Internet. You can rapidly construct a basic webpage by means of an easy export module and then via Internet Explorer the client process can be accessed. Also you can generate the HTML reports pages simply for observing.

3.6. Graphics and Visualization

GRIAS offers a simple visual interface for controlling and monitoring industrial applications. It allows the developers to apply graphics to visually illustrate their processes at control panels. This software contains a wide graphics library which includes not only animated figures but static pictures as well that can improve your process via graphically presenting your system and the variations that take place, as shown in Figure 4. Also your own graphics (for example auto-cad documents or photographs) for added customizing can be imported. This automation software also supports .wmf and .bmp files. The graphics and visualization add to the look and feel of the entire application that makes it more attractive.

3.7. Multi-Client/Multi-Server Networking

A developer can attach several computers, which are connected through Industrial Automation Software's server and client processes, as shown in Figure 6. The TCP/IP (Stevens, 1996) networking protocol integrated into Industrial Automation Software to interconnect networks in a simple-way like to drag a data-point on a control-panel view or typing into a URL.

3.8. Security

Automation software allows you to set different levels of security, with varying levels of write/read access derived from these levels of security.

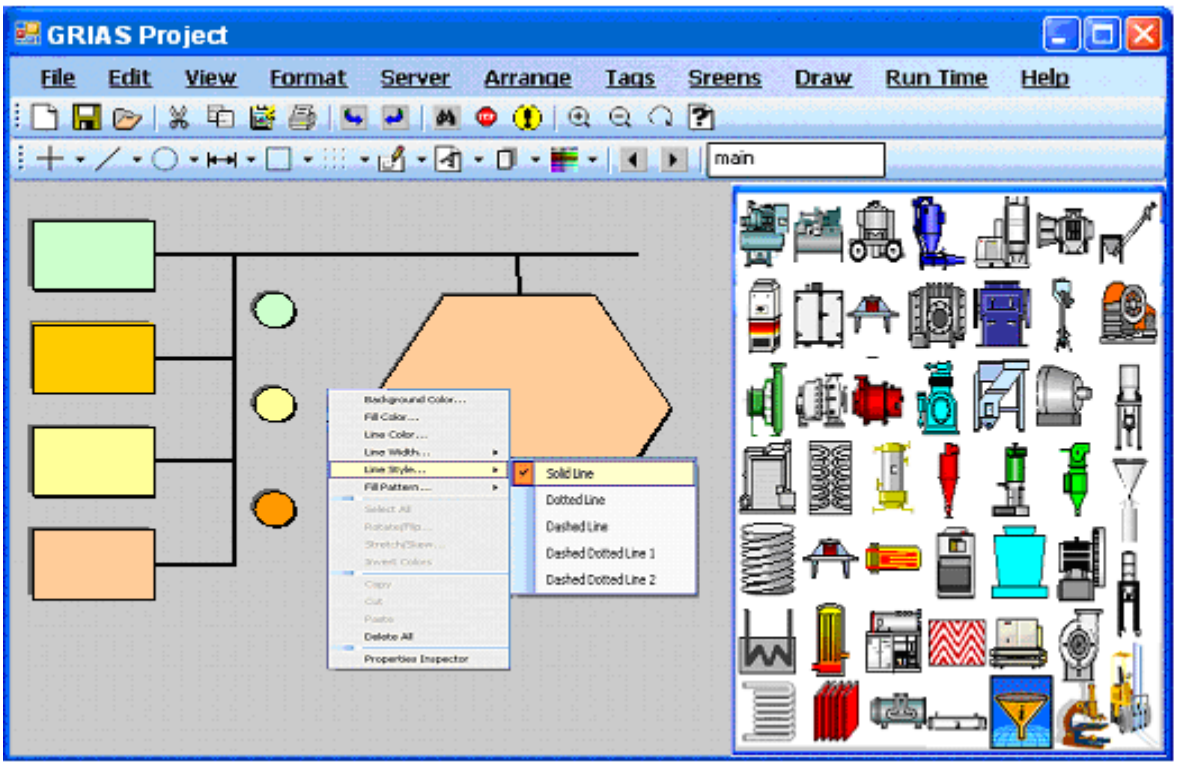

Figure 4. Screen shots of the GRIAS software

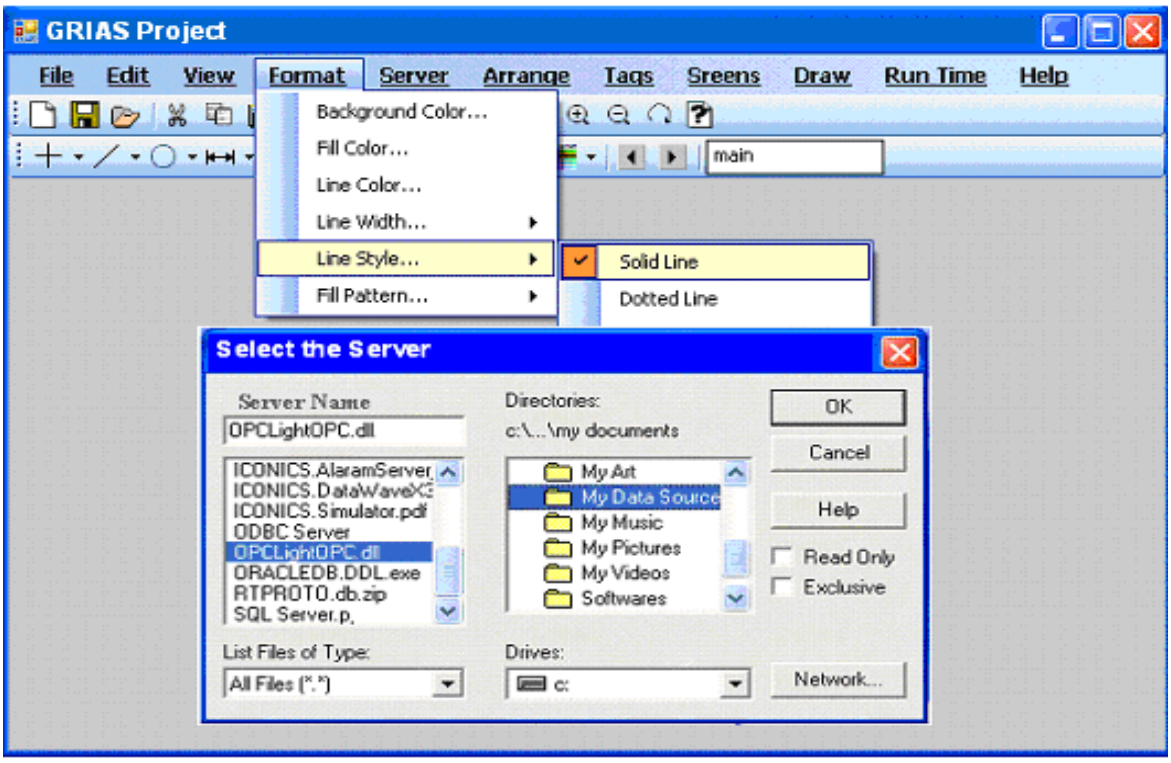

Figure 5. Screen shots for selecting a server

You are able to apply the security options restricting panel to retrieve and view, particular object handling or whether closing or minimizing the Automation Software. You can apply the limit over users and groups accessibility, including permission to a particular folder and individual object. Even you have the authority to impose accessing limit by means of IP-addresses.

In addition, Automation Software includes the following other capabilities:

Distributed Data-Logs- the GRIAS logs event, alarm and data to the software's personal data-base.

Trends & Charts- it facilitates the user to represent the graphics-data from several different sources at once in parallel.

Report Generation- it provides the facility to generate custom reports using your favorite spreadsheet package.

Telemetry- it supports the various protocols to utilize the single serial-port.

Hardware Connectivity- it provides notable integration for National Instruments (NI) hardware, for example, Field-Point & Data Acquisition (DAQ) (Hayles, 2006) equipments.

Technical Support- the software not only performs the automation but also helps in management purposes (e.g., it helps in maintaining session information).

Operating Systems Used- it supports different operating systems according to the requirements of an industry.

4. Conclusions

In this research work, we have proposed the GUI-Based Real-Time Industrial Automation Software to control and maintain an industrial plant which uses an OPC complaint hardware device. We have described the proposed system in terms of its interface to the process hardware and structural design, and presented its functionalities/facilities it provides for application development.

In some developing countries like Pakistan, there are still hundreds of small or medium size industries that are neither automated nor computerized, because they cannot afford to buy such costly automation software currently available in the market. Thus, through the proposed GRIAS software, the small or medium size industry of Pakistan that is running its system manually will be encouraged to use and maintain its system at the least possible cost. That tolerates significant progress in the competitive

development of a country via the use of real-time (and even web-enabled) automation software.

This research work will also be helpful for the researchers or whether you are an IT supervisor in an industrial unit or a novice who is interested in automating his industrial plants to give a boost to his productions.

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