CHAPTER 1

INTRODUCTION

1.1 OVERVIEW OF INDUSTRIAL AUTOMATION

Today’s watch word industrial automation is a combination of control systems and information technology. This is an era of information technology and it has influenced every realm of society and dramatically impacted on the traditional industry.

The present industrial automation systems are categorised into three different levels i) monitoring, ii) monitoring and control, and iii) added features to web-based monitoring and fault diagnosis both for the management level as well as the controller level. Internet has played a vital role over the past decade interfacing people and systems. The existing industrial automation field combines the features of Internet and gives feasible network solutions in terms of wired or wireless network.

The Internet and the World Wide Web (WWW) have created a revolution in the way information is archived, accessed and processed. Furthermore, these systems have brought changes in communication modalities that have been no less profound. Business, commercial and societal interactions have all changed irrevocably as stated by Yang (2011). The web enabled monitoring and control platform has many advantages for the engineering community as well for the business community. Monitoring of the process and the operational performance of the entire system away from
plant is possible. Expert support for performance optimization is also quite possible and the most important issue of downtime between failures on the system controller level or process level failure can be minimized between the plant engineers and service providing vendors over web-enabled platform.

The web-based remote monitoring, control and fault diagnosis is a multi domain feature where the plant engineers and service providers are bridged together to perform better plant operation, maintenance and safety from time to time. The recent research attempts made in web-based platforms for the different levels of applications were demonstrated in the areas of educational laboratory studies of experiments, chemical – refinery and steel plant etc., where the operations are required to be continuously monitored, controlled and fault diagnosed away from plant locations.

In the past years, before the Personal Computer (PC) was widely incorporated into industrial automation systems, all the faults that occurred in industrial process were checked and dealt with by trained and experienced engineers. In order to deal with abnormal conditions and handle it in real time it is necessary to automate the measurement operations as well as to improve the operating efficiency.

In recent decades, this scenario has been dramatically changed due to the wide adaptation of industrial automation applications. A typical industrial automation system as illustrated in Figure 1.1 is usually made up of a physical system, transducer, device drivers and data I/O, host computer, network server and remote computer. Information technologies have rapidly developed in recent years, and they have provided sufficient technical support for building modern industrial automation system with more open architecture with respect to the previous ones. It turns out that the computerised real-time monitoring analysis and automated technologies can realize the full automation of an industrial measurement system.
The combination of emerging information technologies with traditional condition monitoring systems allow for the continuous running status monitoring for essential equipment as well as comprehensive data processing and centralised resource management.

Web-based remote monitoring is classified into different categories based on the research directions. Major research, monitoring the process / operations with the web-enabled platform, process monitoring with control features over the web platform and the next level monitoring, control as well as fault diagnosis features are the present focus on the recent research issues in industrial automation.

1.2 DEVELOPMENTAL TRENDS IN INDUSTRIAL AUTOMATION

In an information rich world, the integration of various disciplines is the trend in today’s industrial automation systems. The trend is the convergence of communication, networking, computing and control technologies. Figure 1.2 illustrates a new control system platform that combines the recent advances in information technology and industrial automation. In the future industrial automation will involve more interaction among system components as well as with the physical environment. The
application oriented architecture for automation with networked, Internet based control system is an area of focus in recent research and development. Another direction is to develop continuous, on-line, real-time measurement and control systems. The functions of such systems are more comprehensive as compared to the handheld-instrument-based measurement and control. They are generally more suitable for monitoring the key of individual plants’ control equipment. The advantages provided by internet can be fully exploited by building networked industrial automation systems.

![Industrial automation development trends](image)

**Figure 1.2 Industrial automation development trends**

### 1.3 FUNCTIONALITY OF INDUSTRIAL AUTOMATION

Present industrial automation systems are capable of performing real-time online data acquisition and manipulation, centralised system resource management and networked data sharing. But they also must have
flexible configuration capability and facilitate the setting up of general Local Area Network (LAN) and Wide Area Network (WAN) to meet specific industrial automation solutions. Further they must also allow the building up of various comprehensive monitoring network integrating functions such as data collection, condition monitoring, fault diagnosis, resource management and decision making. Industrial automation system should be suitable for operation and management at different levels with reference to the automation hierarchy. Instrumentation, Systems, and Automation Society (ISA) has proposed a hierarchy model for the levels and domains of control in manufacturing industries as shown in Figure 1.3.

![Industrial Automation Hierarchy](image)

**Figure 1.3  Industrial Automation Hierarchy**

In Figure 1.3, level 4 represents functions of the enterprise domain, covered by Enterprise Resource Planning (ERP) or Supply Chain Management (SCM) systems. The lower levels deal with the domain of control. Levels 2, 1 and 0 define the cell or line supervision functions, operations functions and process control functions.
A standard reference model for batch control processes has been proposed by ISA. The activities of the batch control reference model can to some extent also be applied for continuous process. These control activities include:

- Process control
- Unit supervision
- Process management
- Production planning and scheduling
- Production information management

The activities of the control level and the Manufacturing Execution System (MES) clearly overlap, as do the activities of levels 3 and 4 in the ISA model. The standards assume that all activities are not explicitly defined at each level.

The automation of an entire process plant can be thought of as a process beginning with field equipment and ending with plant information systems. At the top of the pyramid, the time scale for activities can range from days to months. Moving down the pyramid, the number of functions and time-criticalness increase. At the bottom, the time scale ranges from milliseconds to hours. Moving up, the information is refined and reduced.

1.4 APPLICATIONS OF INDUSTRIAL AUTOMATION

The applications of industrial automation system can be classified into the following categories:

- Industrial measurement and control system
- Remote measurement, communication and control
• Monitoring and alarm of industrial process parameters

• Industrial parameters acquisition, processing, presentation search and networking

In order to implement the above mentioned applications, dedicated industrial automation software platforms are required. From the application perspectives following areas are focused recently:

• Measurement and control of process parameters in industrial automation

• Integrated management system for intelligent buildings such as building equipment monitoring and security management

• Power management and protection

• Environmental monitoring and protection

• Condition monitoring for large machinery

• Product quality testing and analysis.

• Supervision of assembly line manufacturing

• Safety and critical aerospace applications

A wide range of software platforms have been developed for better industrial automations solutions. Therefore, it is believed that developing networked applications and architecture orientated solutions are very essential as it can help can help the industry operate cost effectively and safely.

1.5 WEB-BASED INDUSTRIAL AUTOMATION

There is a great deal of benefits for industry in adopting the Internet based industrial automation. Over the years, there has been a constant increase in the development of industrial automation that makes it possible to supervise and control industrial processes over the Internet.
In the recent days, Internet has been playing a very vital role not only in our daily life and work, but also in real-time industrial automation, scheduling and management. During the last decade, considerable research has been carried out to develop new technologies, called Internet-based control systems in our research, that make it possible to supervise and control industrial processes over the Internet.

Internet-based industrial automation solution is a new concept which has been receiving much attention in the recent years. However, little work has so far been done, aimed at developing systematic design methods for the design of such Internet-based industrial automation system. In the last decade, the most successful network developed has been the Internet that has proved a powerful tool for distributed collaborative work.

The automation systems in process industries have to deal with a growing amount of information. Because of the size and the complexity of the systems, application development, maintenance, and adaptation to faults and changes in requirements are challenging issues. However, flexibility and fault tolerance are key requirements in the tightening global markets. The emerging Internet technologies offer unprecedented interconnection capability and ways of distributing collaborative work, and these have great potential to bring the advantages of these ways of working to the high-level control of plants. These advantages include enabling remote monitoring and adjustment of plants, enabling collaboration between skilled plant managers situated in geographically diverse locations and enabling the business to relocate the physical location of plant management staff easily in response to business needs.

Industrial applications and systems still lack in adopting the Web Services architecture. Legacy systems, either OLE for Process Control (OPC) based or proprietary ones compose a huge source of data, which can be
migrated and integrated into enterprise level information systems. Within the context of prevailing and emerging technologies, such as Hyper Text Transport Protocol (HTTP), EXtensible Markup Language (XML), Simple Object Access Protocol (SOAP), OPC and Web-enabled application servers, an architecture that allows for the integration of existing stand-alone industrial automation systems into web-based distributed environments, forming the base for the provision of large scale e-services by a multitude of service providers to industrial-type clients has been proposed.

1.6 BRIEF OUTLINE OF THE THESIS

There are a number of challenges that web-based Industrial automation solutions must face regardless of whether established on wired or wireless networks. The major challenges are requirement specifications, network latency, safety and security, architecture solution for remote monitoring and fault diagnosis and multiple user access. By introducing the Internet into industrial automation solutions, the design methodology for web-based systems can be made different from computer-based control systems.

The issues that arise from web-related features of web-based industrial automation are investigated such as requirement specification, architecture solutions, web-based interface design and control over the Internet, latency issues, concurrent user access and system safety checking. This thesis is organized and presented in seven chapters as mentioned below.

The first chapter presents a brief introduction about Industrial automation and recent trends and challenges. Chapter 2 contains a review of published literature. Chapter 3 deals with the scope for the present research, objectives of the research work and experimental plan. Chapter 4 presents the study and implementation of Web-based supervisory Control and Information System (WBSCIS) in Multi Process Experimental Setup. Chapter 5 delineates
the Study and Implementation of WBSCIS in Temperature Process Control Experimental Setup. Chapter 6 deals with the experimental study of Real-Time Web-enabled platform for Information Monitoring and Fault diagnosis in a Distributed Control System. Chapter 7 presents the conclusions of the research and scope for future work.