# Design and Implementation of the PLC Control Lab Using GSM System

Ping-Huang Wu
*Department of   Electrical Engineering*
*Tung Nan Institute of Technology, Taiwan*
*johnwu@ms15.url.com.tw*

Chin-Hwa Kuo
*Dep. of Computer Science and Information Engineering*
*Tamkamg University Taiwan*
*chkuo@mail.tku.edu.tw*

Chin-Chung Lin
*Department of Electrical Engineering*
*Tung Nan Institute of Technology, Taiwan*
*chjlin@mail.tnit.edu.tw*

Pei-Lin Wu
*Department of Information Computer Education*
*National Taiwan Normal University, Taiwan*
*u92193@ice.ntnu.edu.tw*

## Abstract

*It has become a trend to integrate automatic industries via Internet and wireless applications over network. Along with the advancement of technology development, research on wireless applications and remote control has become significant and popular today. Thus, we have designed and implemented a teaching platform with wireless applications and remote control using GSM system in the Mobile-PLC (M-PLC) control lab. The integration of the mobile control and measurement using the GSM Short Message Service (SMS) provides a teaching platform where students can learn anytime and anywhere. We can monitor machine operations using GSM system. The usability and economy of teaching media is apt, since cell phones are cheap, easy to operate and portable.*

## 1. Introduction

Distant learning on the Internet has become a trend in the world due to the rapid growth of the Internet and computer multimedia technology; learning environment has also shifted from a traditional classroom to a virtual network learning environment using the Internet. There exist many designs of remote control systems which enable learners to access resources and operate equipments in the lab remotely [1][2].

Furthermore, the interface of remote control and monitoring using a laptop may benefit from its portability; however it still suffers from relatively large sizes and heavy weights. Therefore, mobile devices, such as Personal Digital Assistants (PDA) or cellular phones have become preferable in regards to remote accesses to lab equipments. They enable mobile communication, immediate information transfer without limitation of space and time, and could be exploited for personal and industrial data acquisition. In addition, they have become revolutionary to automatic industries.

In this paper, we explore applications of remote control via the GSM Short Message Service (SMS) on PLC remote control lab and to build a PLC remote monitoring over this platform. This platform enables users to access resources and information in the remote laboratory at any place and any time. Furthermore, events occurring in the distant lab are monitored for error and emergency handling.

This M-PLC control system creates an environment where student not only have more time to practice PLC control, but also get more understanding of GSM system.   Students can control and monitor machinery operations in the lab using cellular phones  at any time and anywhere remotely to detect machinery malfunctions and to process error messages immediately.

## 2. The Advantage of Using Cell Phones on Teaching.

As the technology advances, more choices for teaching methods are available. The vast usability and economy of teaching media is evident, since cell phones are cheap, easy to operate and portable to anywhere, therefore cell phones are accepted by young generations. If we could take advantage of high frequency of young people using cell phones, we could improve the interactions between teachers and students, thus motivating students, improving their willingness to study and thus improving their grades as well.

Since 1996, Taiwan has opened the door of mobile communication to local companies, and since then, almost every individual has had a cellular phone on hand. In 2002, there were more than twenty-two million cellular phone user accounts and its penetration rate jumped to 106.15% which is ranked number one in the world.

Computer Delivered Instruction is a technology that uses the computer to deliver assignments, documents, course outlines, materials and other information related to the course. It is faster to transmit information using a computer. However, by using computers to receive information, one would need not only computer software, hardware but also other equipment. Although computers are not expensive, but comparing to cell phones' relatively low prices and availability, using cell phones as teaching media is seemingly a better option in this respect.

## 3. System Overview and Design

The system overview of the designed M-PLC control lab using GSM system is depicted in Fig. 1. This system can be divided into two parts, i.e. server end and user end. On the right side is the server end, and on the left side is the user end. Both server and user are connected to the GSM network. Major functionalities of the system are described as follows:

(1)The control server

The control server connects to the PLC to control the PLC's actions in sequence. We designed the user interface by using Visual Basic to apply "MS Comm" components. This control server use two "COM ports", one connects to PLC and the other connects to GSM Modem.

(2) PLC

PLC serves as a relatively stable controller for multiple usages. It possesses digital input/output and analog input/output devices. In this system, we use PLCs to control motor, robotic arms, and various kinds of automatics.

(3) GSM Modem

The GSM Modem used in this paper is a product of WAVECOM [3]. It uses RS232 serial communication standard to establish communication between ports on the PC and the SIM card inside GSM Modem.

(4) GSM Network

GSM used in this paper is wireless transfer equipment where Short Message Service (SMS) is the communication media.

SMS is one of the most popular mobile data services. The SMS operates like a paging service with enhanced capability where message can travel in both directions. The SMS enables the system to send and receive text messages to and from cellular phones.
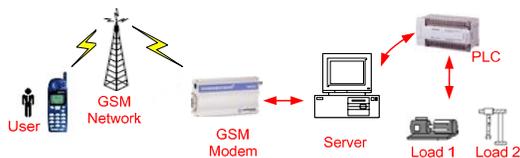


Fig. 1 The system overview of the designed M-PLC control lab using GSM system

## 4. Implementation and Results

We designed our programs on the server end using Visual Basic where we can control and monitor PLC's output. The left portion of the interface shown in Fig. 2 enables users to write data to PLC and the right portion is to read data from PLC outputs. PLC's control and monitor functions are described as follows:

(1) Control Interface enables us to data that specifies PLC's tasks to the corresponding textboxes, as "WRITE to PLC". PLC is then going to respond immediately with a string of characters.

(2) Monitor Interface enables us to read PLC's output status and then transfer the data to user's cellular phone via GSM network.

(3) This system also has a feature to write and read analog parameters. A warning message will be generated and sent to inform the user with a short message.
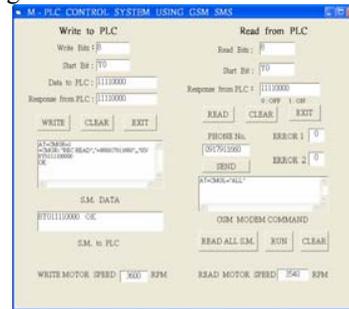


Fig. 2 Control and monitor interface in server end

As shown in Fig. 3, 4, and 5, the short messages sent and received by a cellular phone are used as the control and monitor PLC status. The functions are described as follows:

(1) A "send short message to PLC" is shown in Fig. 3 and a template of short message is shown in Fig. 3a. As long as the users enter the status of PLC control, as illustrated in Fig. 3b, string 11110000, is sent as a short message to the GSM modem SIM card, and VB program will access the control data of the short message and send this control data to PLC to control its output. In Fig. 3a, we create a template of short message to illustrate its convenience for users to enter control data.

(2) When PLC receives the short message of control data from the user, it will automatically report the status of PLC output to the user. If PLC's output is all correct, it will report a in a short message "SUCCESS" to the user as shown in Fig. 4a; otherwise, PLC will report a short message "FAIL" to the user as shown in Fig. 4b.
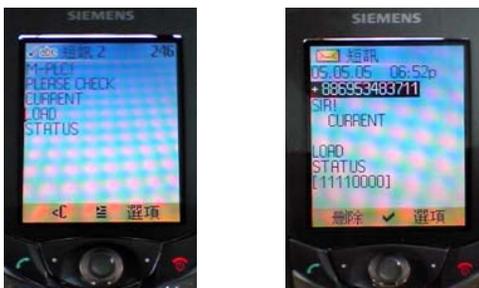
(3) When the user wants to query the status of PLC output, the user will apply the template of the short message as shown in Fig. 5a. The user sends the short message to the server to query PLC; PLC will report the short message with output status, as shown in Fig. 5b.



a. template       b. input data
Fig. 3 Send short message to PLC
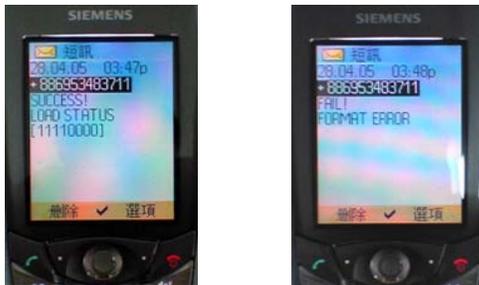


a. correct       b. incorrect
Fig. 4 Report from PLC



a. template       b. report from PLC
Fig. 5 Query the status of PLC output

The home page and learning materials of designed PLC remote-control lab discussed in this paper are shown in Fig. 6. It can be accessed on the following URL, http://e-learn.tnit.edu.tw/. The web page includes the following functions: Student Management, Curriculum Management, Assignment Management, Examination Management, Score Management, and so on. The course here consists of remote robot, conveyer, PLC controls.

The facility of the control experiment hardware in the server end is shown in Fig. 7. It includes a PLC controller, a motor, a GSM Modem, and the server.
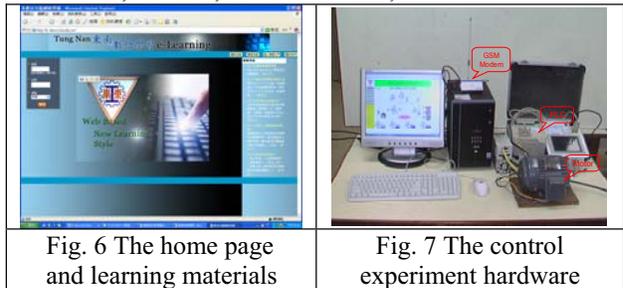


| Fig. 6 The home page and learning materials | Fig. 7 The control experiment hardware |
|---|---|

## 5. Conclusion and Future Works

Using the proposed technology, students can learn by remote data retrieval and monitoring via the wireless network, and, in addition, it enhances students' learning experiences via network learning because now equipments in the lab are accessible from everywhere which provides students with sufficient learning resources. Moreover, our proposal can also be applied to various fields, such as home appliance automation, remote factory control, and first aid in an emergent situation.

PLC equipment can not only be applied on SMS control methods that are mentioned in this paper, but in the future continue to develop WAP Server control methods and make wireless communication via cell phones, as well as create cell phone processes and control information.

SMS can be applied on daily information transmission and business, so how to use this technology in order to improve studying motivation and effectiveness will be another topic for everyone to consider.

## 6. Acknowledgements

## 7. References

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