

# Industrial Process Control Using SCADA and Open Source Tools

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**Abstract-**This paper present about SCADA system which gathers data from different modules and controls them simultaneously. SCADA includes both software and hardware which are interfaced one after another. The main aim of the paper is to develop SCADA system to monitor and control liquid levels in tanks and temperature of heaters. This design creates extremely low cost SCADA for different SCADA application by using open source tools. Master station can be observed remotely with help of remote desktop viewer through wireless network. **Keywords:** IGSS, PLC, Remote Desktop Viewer, Modbus, SCADA.

## I. INTRODUCTION

SCADA is used to monitor and control a plant (or) equipment. It enables users to collect data from distant facilities and sent limited control instruction to those facilities. Here, monitoring and controlling is done by IGSS (Interactive Graphical SCADA System) software. SCADA system consists of IGSS software, PLC's which are connected to sensors, switches, motor, heaters etc. PLC circuit consist of relays, L293D and Atmega328p microcontroller. The interface between SCADA software and PLC is maintained by Modbus RTU protocol.

The GUI of IGSS SCADA software is master station can be viewed by using remote desktop viewer. Thus, by using remote desktop viewer monitoring and controlling of SCADA system can be done. This paper mainly concentrates on measurement of liquid level and temperature by using IGSS SCADA software and PLC. So, the design consist of IGSS SCADA software as master station to monitor and control the sensor operations through PLC.

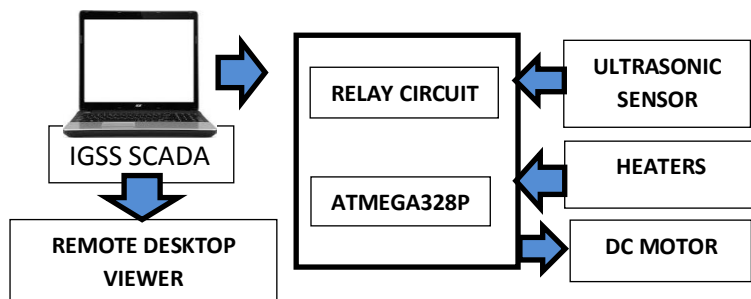


Fig:1 SCADA system for liquid level and temperature monitoring

The main objective of our paper is to implement SCADA using open source tools: IGSS, Arduino IDE, Arduino Modbus slave library, Open source remote desktop viewer, Modbus RTU protocol.

## II. SYSTEM ARCHITECTURE

For liquid level monitoring, SCADA system is divided into 3 stages: master station, control unit, ultrasonic sensors and AC motors. For temperature monitoring, control unit is connected to heater whose temperature varies by varying the voltage.

Control unit consist of PLC which is relay circuit with Atmega328P. Master station communicates with PLC by Modbus RTU (RS232) protocol. Modbus RTU is a serial, open protocol derived from master/slave architecture. Holding registers of Modbus RTU are used whose entity number is 4 and spans from 40001 to 49999.

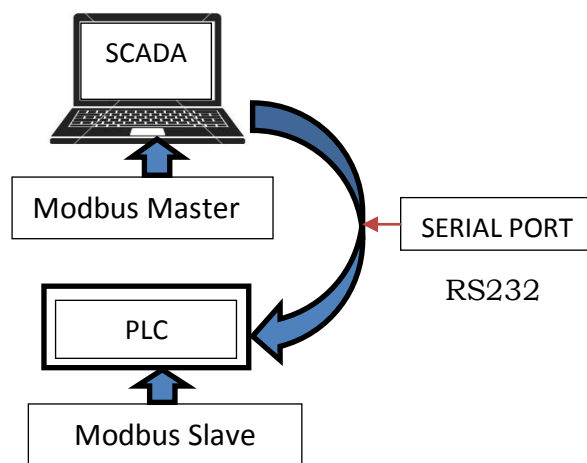


Fig:2 Modbus RTU between PC and PLC

The device requesting information is called Modbus master. Device supplying information is called Modbus slave. IGSS is master and PLC is slave.

### III. IMPLEMENTATION OF SCADA SYSTEM

#### A. Software Development

Softwares involved are IGSS SCADA, Arduino IDE, AVR complier, Arduino Modbus Slave library, Arduino boot loader, USB to serial libraries, Remote Desktop Connection

##### A. IGSS SCADA:

IGSS is a SCADA system used for monitoring and controlling industrial process. IGSS is true object oriented program. IGSS consists of a number of programs each with its own specific purpose. Programs are divided into two main user types: System designers and operators.

In this IGSS, program used by system designers is Definition window and by operators is Supervise window. Definition is used to create graphical process diagrams. It also holds the configuration of objects from PLC. Supervise module is used by operator for monitoring and controlling processes.

##### B. Arduino IDE:

It is a cross-platform application written in programming language JAVA. It includes code editor with features such as syntax highlighting, brace matching etc.

These programs are known as sketches. It supports C and C++ language using special rules to organize code. User written code only requires two functions for starting the sketch and main programs loop. Compiling and uploading of programs is done in simple one click mechanism.

##### C. AVR Compiler:

The compiler is the GNU compiler collection or GCC. GCC compiles a high-level computer language into assembly. GCC is coupled with another project, GNU Binutils, which provides the assembler, linker, librarian, and more. Since GCC is just a driver program. It can automatically call the assembler and linker directly to build the final program. Arduino IDE is inbuilt provided by AVR compiler.

#### D. Arduino Modbus Slave Library:

```
#include <stdint.h>

#define _MODBUSPROTOCOL

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//Maximum device list for network

#define DEVMAX      10

//Maximum control register que size

#define QUEMAX      10

//Maximum serial wait in micro seconds

#define SERIALMAXDELAY  100

#define SERIALBAUD      9600

//the total silence time needed to signify an EOM or SOM in RTU mode

//Modbus function codes

#define READ_DO      0x01

#define READ_DI      0x02

#define READ_AO      0x03

#define READ_AI      0x04

#define WRITE_DO     0x05

#define WRITE_AO     0x06

#define RTU          0x01

#define ASCII        0x02

#define MASTER       0x01

#define SLAVE        0x02

#define DO            0x00

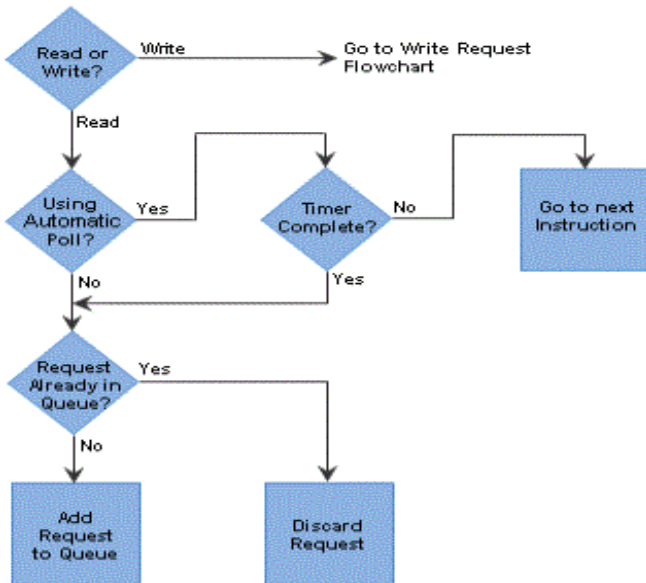
#define DI            0x01

#define AI            0x03

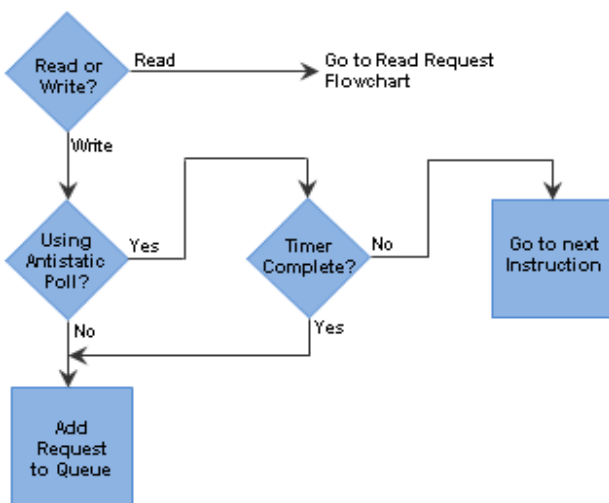
#define AO            0x04

#endif
```

**Read Request Flowchart**



**Write Request Flowchart**



proprietary protocol developed by Microsoft. It provides user with GUI if another computer.

**B. Hardware Implementation**

PLC consists of relay circuit, L293D IC, Atmega328p. Atmega328P is operated at 5V,40mA is connected to L293D IC which is operated at 5V, 600mA. L293D is a typical motor driver IC which allow AC motor to drive on either direction. The IC is connected to relays. Relays act as switch between L293D IC and AC motor. Therefore, relay provides 12V,1A to operate the AC motors and heaters. Ultrasonic sensors calculates the level of water by using reflection mode. By varying voltage levels, corresponding temperatures are set.

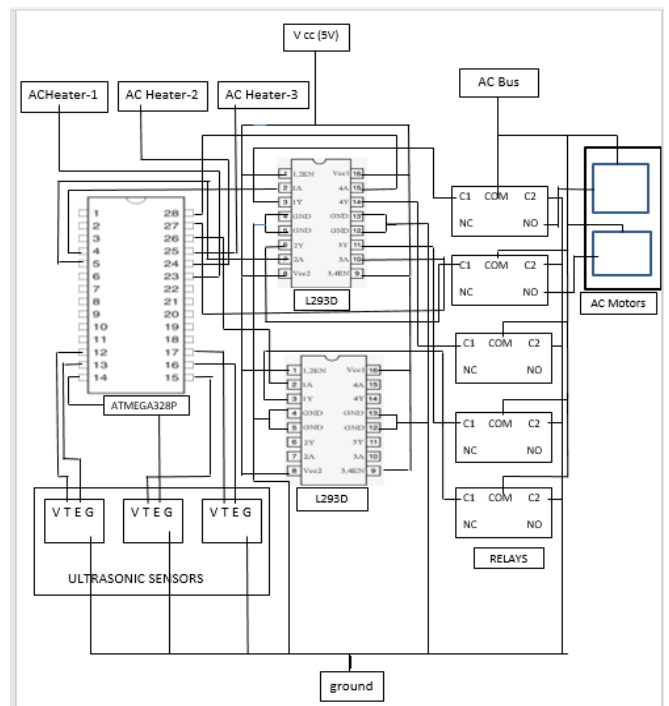


Fig-3: Block Diagram.

**E. Arduino Boot Loader:**

Boot loader is a firmware in ATMEGA328P that allows implementation of functions without need of any external programmer. The program allows an AVR with bootloader capabilities to read/write its own Flash. To enter programming mode an input pin is checked. If this pin is pulled low, programming mode is entered.

**F. USB To Serial Libraries:**

The CP210x USB to UART Bridge Virtual COM Port drivers are required for device operation as a Virtual COM Port to facilitate host communication with CP210x products. These devices can also interface to a host using the direct access driver.

**G. Remote Desktop Connection:**

The desktop of computer can be viewed remotely with help of remote desktop connection through LAN network. The protocol used in remote desktop connection is RDP which is



Fig-4: Prototype of Overall System.

#### IV. RESULTS AND ANALYSIS

SCADA consist of two windows: Definition, Supervise. Through supervise window, user can monitor and control liquid level in tanks and heater's temperature. Implementation of functions in Arduino IDE can be interfaced with Atmega328p with help of Arduino bootloader. L293D receive signal from Atmega328P and connected to relays. These relays acts as switch and provides 12v to operate AC motors and heaters.

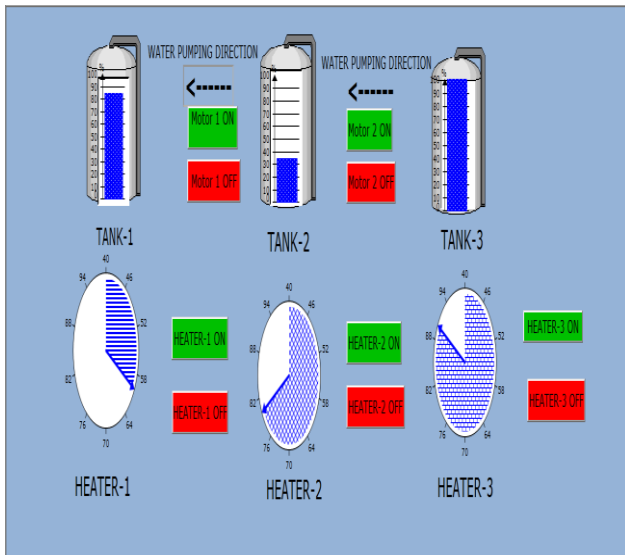


Figure-5: IGSS Supervise Window for Liquid Level in Tank and Heater Element

#### V. CONCLUSION

Liquid level monitoring and control, temperature monitoring and control are implemented in the LAN domain, timings of the monitoring and actuation are well within tolerable limits and IP based SCADA can be developed in future. Hardware part using open source tools have been successfully implemented. The entire implementation can be used as it is in any real control because it has a PLC controller with relays.

#### VI. REFERENCES

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