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Remote Monitoring and Control of Boiler Feed Water in Power Generation Unit

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Abstract: Due to harmful working environment and remote location of Thermal power plant sites, it is dangerous and time expensive to operate and maintenance. As the demand for power increases, increasing safety and reducing operating and maintenance cost plays a vital role in increasing the reliability of the power plant. As the Thermal power plant has to work for 24 hours and 365 days, it is not possible to monitor the parameters in site at each and every moment. So remote monitoring is also needed. This project develops a sensor network based interlock control and remote monitoring system. The system mainly consist Temperature sensor, Flow sensor, Level sensor. All the sensors data is processed using 16F882 processor. Using this system we can control the operation of Thermal power plant in auto mode and monitor the parameters in work place. Also we can communicate the sensor data to other PCs in remote locations using (WAN)Wide Area Network.

Keywords: 16F882 Processor, WAN, Monitoring and Control, Wireless Sensor Networks (WSNs).

I. INTRODUCTION

In temperature sensitive systems, controlling the temperature is a difficult task. In thermal power plant, combustion of coal in the furnace converts the water into steam in boiler tubs. This steam which contains high pressure and temperature flows into turbine and rotates the turbine shaft. The turbine shaft in turn is connected to the generator shaft and thus by rotating the generator shaft, the power is generated. The parameters to be measured are pressure, flow and temperature.

As the temperature of the boiler increases the boiler tubes will get punctured. So the temperature of steam has to monitored and controlled continuously. Increase in the pressure as well as the flow of steam will increase the speed of rotation of the turbine shaft which may cause great damage to the Turbine and generator. Thus we can say that the pressure and flow of the steam should also be monitored and controlled. In boiler drum, there is 50% of water and 50% of steam is present. Increase in the percentage of steam will decrease the pressure of steam present in it. If the pressure of the drum increases then the drum might blast. So, we conclude that the level of steam has to be monitored and controlled. [1][2].

In the existing system, we use DCS in the industries, which is used to control and monitor the temperature and flow from panel control unit. But the limitation of this system is that there is a need for manual assistance at all times when the plant is in operation. Moreover, in case of any emergency, the person who is present inside the plant during emergency also is in risk of his/her life. [3]

Hence, we propose a system so that the operating personnel can obtain the data in his/her browser by logging into the local control unit portal for authentication via internet. The web page is designed using Microsoft visual studio 2012, which act as front end tool and SQL server 2008 as rear end tool. Through SQL, we setup database and gather all the real time process variables and parameters required for the monitoring and control operation.

II. RELATED WORK

Previously in thermal power plants there is no advanced technology to operate in auto mode. The major disadvantages of existing system a

- There is no Interlock control.
- There is no monitoring in remote place.
- Aimed for oil processing industries.
- Takes more time to process sensor data.

The power plant operating system in this paper adopted wireless communication technology and embedded systems. This paper mainly discusses the hardware and software of embedded components used in the system. It improves the safety and reliability of the system. This paper overcomes the disadvantages of existing system and improves the efficiency of thermal power plant. The major advantages of this project is

- Monitoring in remote and workplace.
- Processing speed is fast compared to the existing system.
- All the parameters in the plant are considered and increases the safety and reduces the man power.

III. PROPOSED SYSTEM

The system structure mainly consists of Transmitter Section and Receiver Section which are shown in figure 1, figure 2 respectively.

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Transmitter section mainly consists of four sensor networks in this system which senses various parameters in boiler. Various sensors used here are Temperature, Level and Flow Sensors. As the output through these sensors is a physical quantity, they are connected to ADC (Analog to Digital Converter) to convert this analog information to digital format and then this digital information is processed using *PIC 16F882* microcontroller. The controlling section of this system is of great interest. The entire sensor's data are stored in the processor memory and sent to database in central server via *ESP8266* wifi router. If any of the sensors data exceeds or below its threshold level, it indicates the workers through a buzzer in work place and through an alarming system in user system by internet receiver in remote place which have connectivity to the central server. Also we can automatically control the environment of Boiler if any sensor level is high or low.

BLOCK DIAGRAM

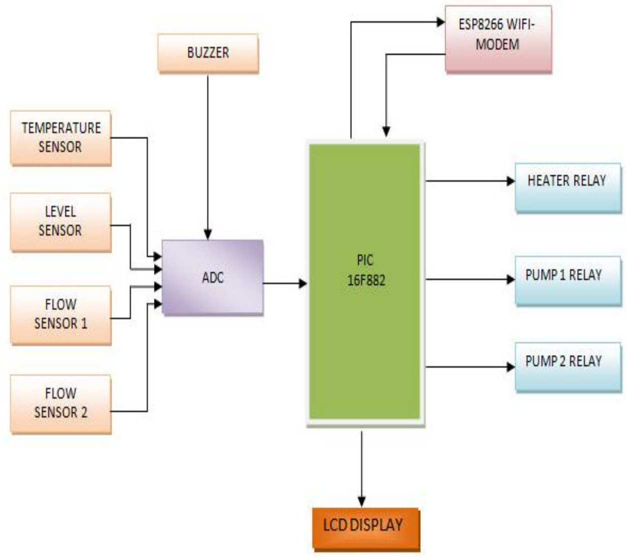

Fig.1. Block diagram: Wireless data acquisition using PIC microcontroller.

1. Temperature sensor:

The LM35 series are precision integrated-circuit temperature sensors. Whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range. While the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

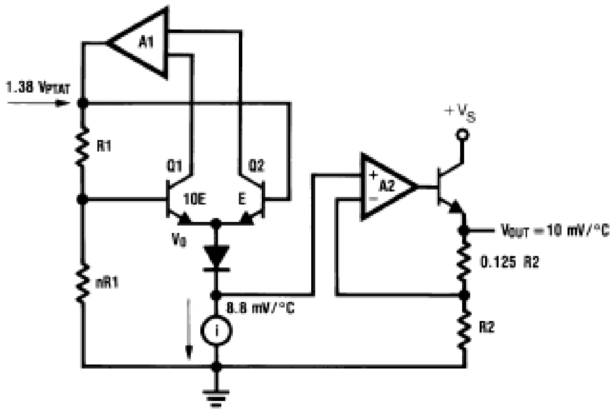

Fig. 2. LM35-Temperature Sensor.

2. Relay:

Relay acts as a switch which is electrically operated. Magnetic field is created by the current that runs inside the coil. This current makes the lever to change the switch position. Relay has two positions either one or two, depending upon the current through the coil. Relay can be single poled double throw or double poled double throw switch. If there are two different circuits, then the relay can be used to switch between two different circuits.

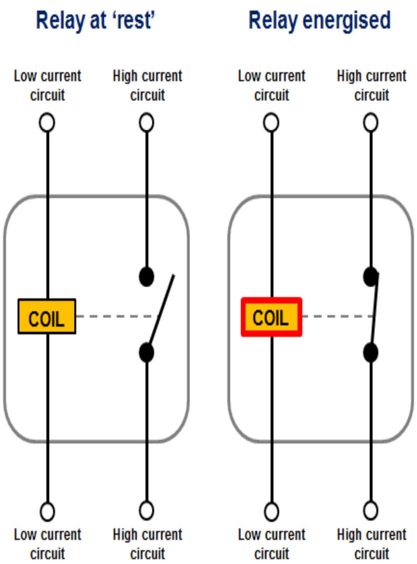

Fig. 3. Electromagnetic Relays.

3. Flow level sensor:

The flow meter is a volumetric measuring turbine type. The flowing fluid engages the vaned rotor causing it to rotate at an angular velocity proportional to the fluid flow rate. The angular velocity of the rotor results in the generation of an electrical signal (AC sine wave type) in the pickup. The summation of the pulsing electrical signal is related directly to total flow. The frequency of the signal relates to the flow rate. The vaned rotor is the only moving part of the flow meter.

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4. Float sensor:

Float sensors usually are used for measuring the level in liquid medium. It is also used in petrochemical, chemical, natural gas, offshore and power plant industries. A float sensor with a permanent magnet moves reliably along with a liquid level on a guide tube. Within the guide tube is fitted a reed contact which is energized through the non-magnetic walls of the float and guide tube by the approach of the float magnet.

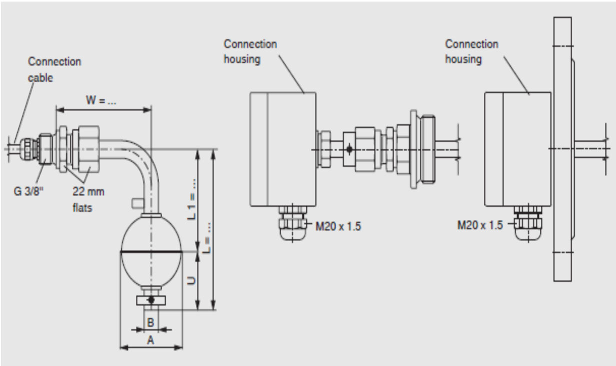

Fig. 4. Permanent magnet type Float sensor.

5. LCD:

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. In this tutorial, we will discuss about character based LCDs, their interfacing with various microcontrollers, various interfaces (8-bit/4-bit), programming, special stuff and tricks you can do with these simple looking LCDs which can give a new look to your application.

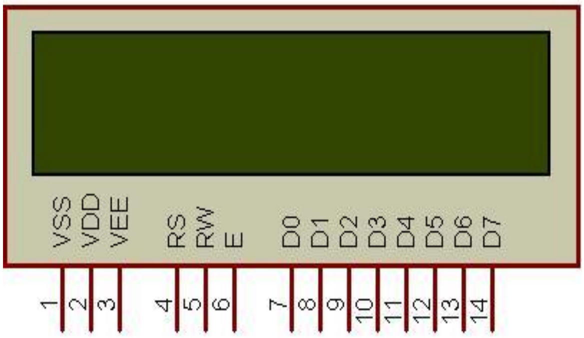

Fig. 5. HD44580 LCD Display.

Before using the LCD for display purpose, LCD has to be initialized either by the internal reset circuit or sending set of commands to initialize the LCD. It is the user who has to decide whether an LCD has to be initialized by instructions or by internal reset circuit. we will discuss both ways of initialization one by one.

To send commands we simply need to select the command register. Everything is same as we have done in the initialization routine. But we will summarize the common steps and put them in a single subroutine.

Following are the steps:

- Move data to LCD port
- select command register
- select write operation
- send enable signal
- wait for LCD to process the command

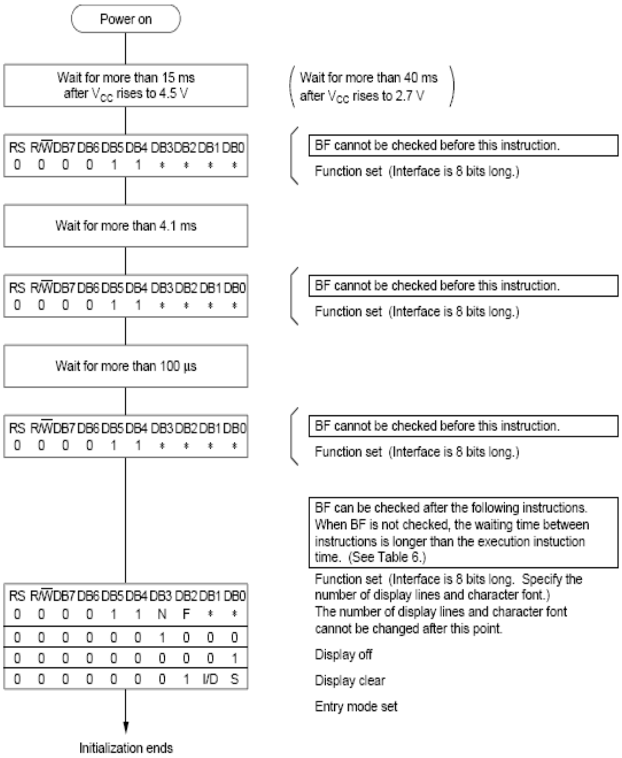

Fig. 6. Flowchart for initialization of HD44580 LCD Display.

6. Microcontroller:

The microcontroller used here is PIC16F88x series.

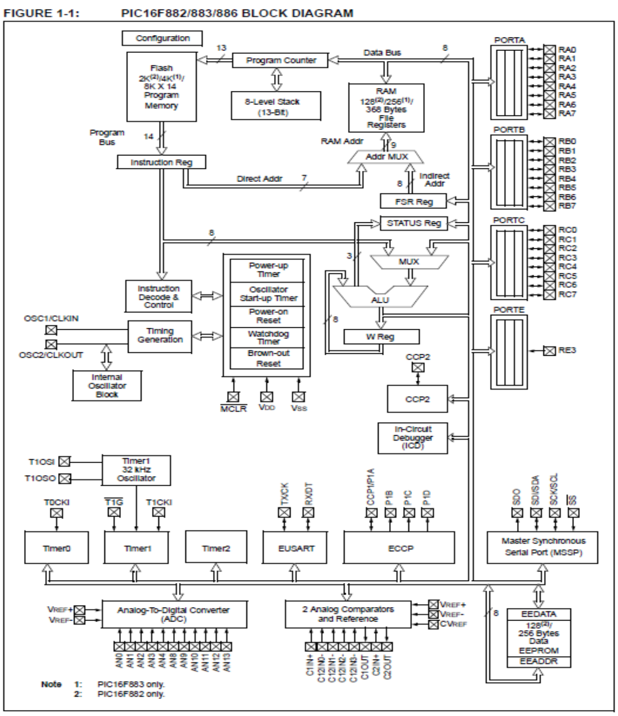

Fig. 7. Architecture of PIC16F88X series microcontroller.

There are a lot of low power features in this type of microcontroller. Other features include, brown out reset, power-up timer, wide operating voltage range, power on reset and so on. These increase the efficiency of the microcontroller.

7. ESP8266 WIFI-MODULE:

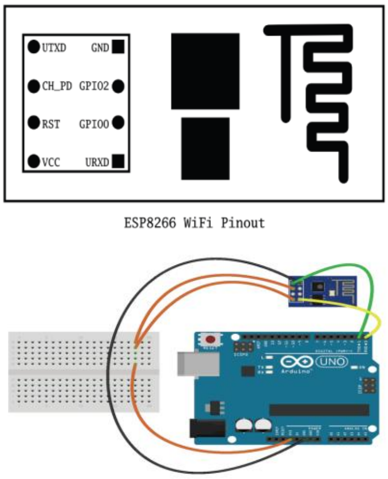

Fig. 8. Interfacing ESP8266 with PIC Microcontroller.

With the hardware connections in place, we can communicate with the Wi-Fi module through a serial terminal.

IV. EXPERIMENTAL SETUP AND SIMULATION

The hardware implementation of wireless monitor and control of boiler system constructed using 16F882 microcontroller is shown in the fig. 9. Here the microcontroller acquires the data from all the sensor modules and send the data to the sql database in the central server system using ESP8266 wifi-module interfaced with the microcontroller.

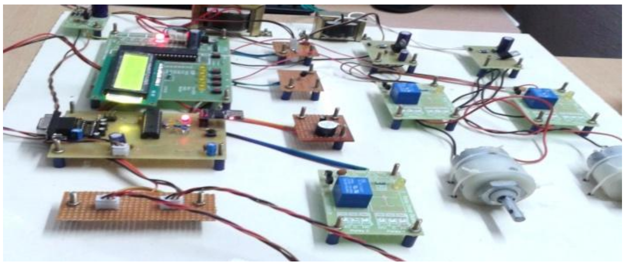

Fig. 9. Hardware implementation of boiler control system.

1. Sign up page:

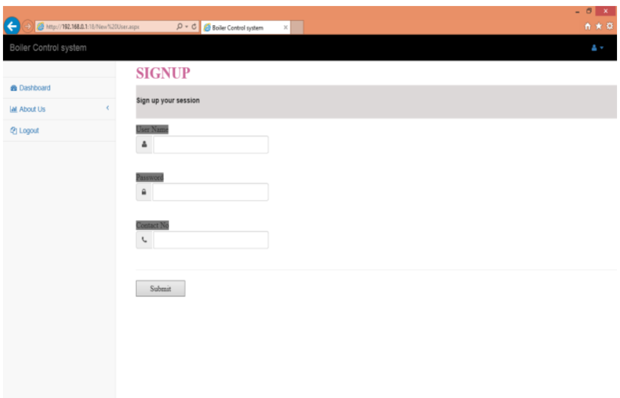

Fig. 10. New user sign up web page.

The sign up page is for aquiring required permission from the plant administrator inorder to access the particular local control unit or loop. Hence the operating personnel assigned for that particular loop must obtain his/her login id and password information from the administrator for secure access to the control system loop.

2. Login page:

In the login page, the engineer can feed in his user id and password inorder to view the process. This is used for safety to improve the protect the plant.

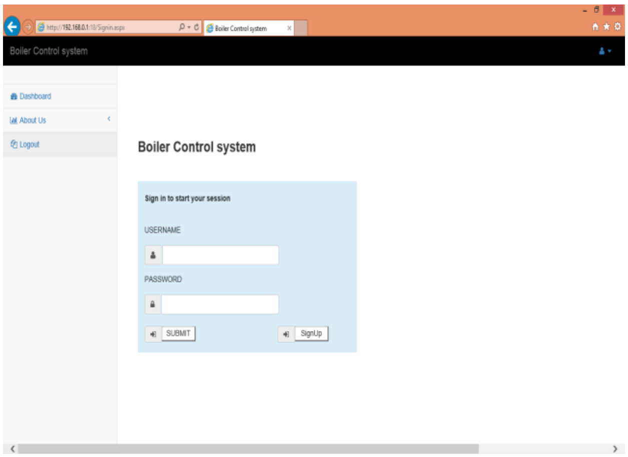

Fig. 11. Login page of boiler control system.

3. Dashboard Data visualizer:

Dashboard data page tells us about the various portions present in the plant and gives their readings. The necessary changes can be made after viewing the data in the dashboard screen of the boiler control system browser page.

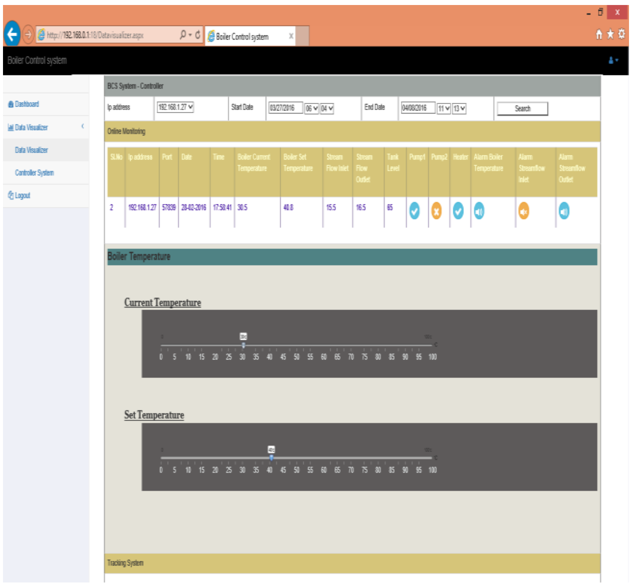

Fig. 12. Boiler control system dashboard panel.

4. Boiler control parameters:

Boiler control system tells us the details like temperature, inlet flow into the boiler at periodic intervals. By using this, the engineer can monitor the plant even from a remote area.

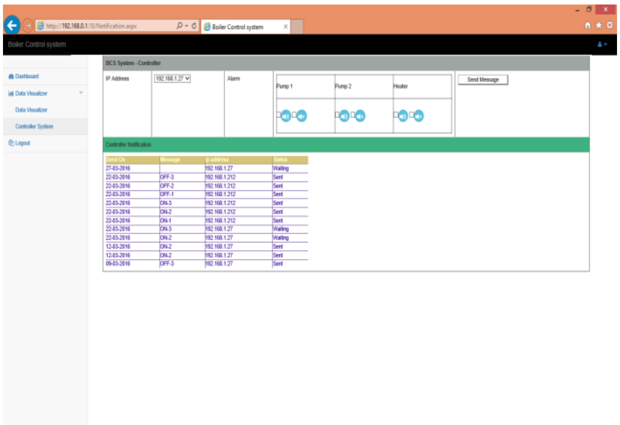

Fig. 13. Live data feed of boiler control system.

V. CONCLUSIONS AND DISCUSSIONS

The hardware and software design of an embedded wireless boiler monitoring and control system for real time applications is presented in this paper. Thus we conclude that the proposed system is more efficient and this helps us to monitor the plant from remote places during the case of hazardous conditions. But certain limitations in the system have to be modified and improved.

VI. FUTURE WORK

The proposed system does have a lot of advantages at the same time there are few limitations too. The limitations are a person always needs internet connectivity and the engineer has to always stay online to monitor the entire process. Moreover, there is no way to indicate emergency conditions to the engineer unless he/she himself login to the server to find the necessary status.

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