Real Time Monitoring and Controlling of Boiler Drum Parameters in Thermal Power Station

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Abstract - **The boiler drum level control unit is one of the main parameter in the thermal power station. Currently the boiler drum parameters are monitored only by using MATLAB software. There is no automatic control available. In the proposed system the boiler drum parameters such as temperature level, pressure level, water level and Droplet identifier are measured and controlled by using ARM8 Processor . Droplet identifier is used to check the steam that comes from the boiler .Pure steam is required to run the turbine so droplet identifier checks whether the steam is wet or dry if it is wet steam then turbine blades gets damaged. So it identifies the wet or dry steam and converted to dry steam. In order to meet out the steam requirement, to safeguard the boiler water tubes and turbine blades, the boiler water drum level control plays an important role in thermal power station. In the proposed system ARM 8 processor is used that controls all sub devices connected across to monitor and control the boiler parameters such as temperature level, pressure level, water level and droplet identifier is measured by using temperature sensor, water level sensor, pressure sensor is used. The boiler parameters are monitored and controlled by using LabVIEW and Eclipse software.**

Index Terms - **ARM8 processor, Temperature sensor, Pressure senor, Water level Sensor, Lab VIEW**

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I. INTRODUCTION

At present, industries are increasingly shifting towards automation. The boiler drum level must be controlled to the limits specified by the boiler manufacturer. If the boiler drum level does not stay within these limits, there may be water carryover. If the level exceeds the limits, boiler water carryover into the super-heater or the turbine may cause damage resulting in extensive maintenance costs or outages of either the turbine or the boiler.

If the level is low, overheating of the water wall tubes may cause tube ruptures and serious accidents, resulting in expensive repairs, downtime, and injury or death to personnel. A rupture or crack most commonly occurs where the tubes connect to the drum. In the existing system the boiler parameters are monitored by using MATLAB and it can be controlled by manual only.

In the proposed system ARM 8 processor is used that controls all sub devices connected across it. For monitoring and controlling the boiler parameters such as temperature level, pressure level, water level and droplet identifier is measured by using temperature sensor, water level sensor, pressure sensor and rain sensor.

II. LITERATURE SURVEY

Rahul Malhotra1 [1] *et al* describes Conventional Proportional Integral Controllers are used in many industrial applications due to their simplicity and robustness. The parameters of the various industrial processes are subjected to change due to change in the environment. These parameters may be categorized as steam, pressure, temperature of the industrial machinery in use. Various process control techniques are being developed to control these variables. In this paper, the steam flow parameters of a boiler are controlled using conventional PID controller and then optimized using fuzzy logic controller. The comparative results show the better results when fuzzy logic controller is used. Maximum overshoot for fuzzy logic controller is measured as 9.35% as compared with 47.3% given by conventional PID controller.

Erdal Kayacan [2] *et al* describes the concept of grey system theory, which has a certain prediction capability, offers an alternative approach for various kinds of conventional control methods, such as PID control and fuzzy control. For instance, grey PID type fuzzy controller designed in this paper, can predict the future output values of the system accurately. However, the forecasting step-size of the grey controller determines the forecasting value. When the step-size of the grey controller is large, it will cause over compensation, resulting in a slow system response. Conversely, a smaller step-size will make the system respond faster but cause larger overshoots. In order to obtain a better controller performance, another fuzzy controller is designed for changing the step-size of the grey controller. The value of the forecasting step-size is optimized according to the values of error and the derivative of the error. Moreover, the output of the grey controller is updated using the prediction error for better controller performance. It is clear that the proposed adaptive PID type fuzzy controller is effective in controlling such a non-linear system by changing the prediction horizon adaptively for real-time working**.**

Shital S. Chopade [3] *et al* describes the purpose of this paper is to present a programmable logic controller (PLC) control system that is applied to the water tube boiler which will increase high quality and greater efficiency. This system monitors boiler`s temperature and pressure and volume via different sensors which provide input to PLC. The output of PLC controls the boiler temperature and pressure and gives out the user required volume of steam. All pressure and temperature variations are shown on SCADA screen and are controlled through SCADA. Different automated check valves are used to release pressure and to inform the concerned authority through alarm in case of an emergency**.**

Subodh Panda [4] *et al* describes the important issue in the modern thermal power plant is to develop methodology concept algorithm technologies for designing a control system which must be able to evolve, self develop. self organized and self evaluated and to self improve. Although linear model can provide acceptable performance for many systems they may be unsuitable for non linearity. So it is highly required for a model that reflect the non liner relationship between cause and effect variable. Implementation of soft sensor in neural network estimate process data using self organizing neural network. Here basic requirement of design an neuron control with soft sensor are the knowledge of fundamental relationship of process variable and the parameter in the question .It is called a process neural network which is an extension of traditional neural network in which the input and output are time variant. So the data processing is better than traditional neural network so it is highly suitable to minimize heat loss at blow down station and increase its ability by operating at peak.

Roopalagrawal [5] describes Internet Based Boiler Drum Level Control System using Lab VIEW in this Internet based PID control system is introduced to regulate the drum level with the fixed PID parameters .the control is not ideal .so some other control is required to improve the performance of drum level control system. The 3 types of control of boiler is established using the internal model control method. It is designed tool kit in LabVIEW.

T. Raj Kumar [6]*et al* describes Boiler drum level control by using wide open control with three element control system. If the drum level goes below the desired lower drum level, there will be a every possibility of starvation of water tubes inside the furnace is expected and the boiler may get damaged and if the water level in the drum raises above the desired upper drum level, there will be a carryover of water particles in the dry steam flowing to the turbine and thus the turbine blade damage is expected. In order to meet out the steam requirement, to safeguard the boiler water tubes and to safe guard the turbine blades the boiler drum water level control plays an important role in thermal power station. It is implemented in advanced adaptive PID controller field control processor.

III. EXISTING SYSTEM

In thermal power station, the boiler parameters such as water level, pressure, temperature is monitored using MATLAB tool. These parameters are controlled by manual only. In this conventional type of monitoring if there is a chance of fault it can come to knowledge only after the occurrence of fault. Immediate alert system is not available. The data are maintained only in log book so there is no possibility of effective data analysis for taking preventive action leading to production loss, workman hour. MATLAB is basically a scripted language and it is not applicable for the graphical representation. There is no automation system is available.

IV. PROPOSED SYSTEM

In order to overcome the existing problem the conventional proposed system is employed. In the proposed system of this project is to monitor and control of the boiler parameters by using the ARM8 processor. The ARM8 processor for embedded applications is automotive for industrial control. The embedded processor is used for real time monitoring of data. In this conventional type of monitoring if there is a chance of fault it can come to knowledge before the occurrence of fault. Immediate alert system is available in Data are maintained only in log book so there is no possibility of effective data analysis for taking preventive action leading to production loss, workman .For automatic monitoring of boiler drum parameters such as water flow, pressure, and temperature are measured and it is displayed in the LabVIEW. The temperature level is measured by using temperature sensor. The pressure level of the boiler is measured by using Pressure sensor. The Water level to the boiler is one of the main parameter; it can be measured by using water level sensor. Rain sensor is used for droplet identification in the boiler. All the output is given to the processor and if it reaches the threshold level it is automatically controlled by using the ARM 8 processor and the output is displayed in the Lab VIEW as graphical representation .In the existing system only the waveform are used .so this Lab VIEW help us to overcome this problem by giving graphical view
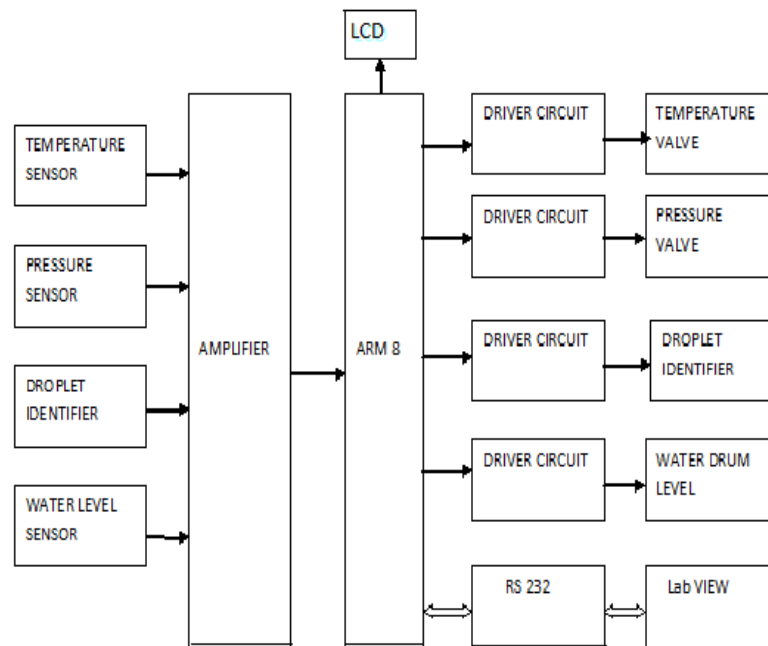
Figure 1.Block Diagram of Proposed System

The boiler is an enclosed vessel that provides a means for combustion of heat to be transferred into water. The drum level should be controlled to limits specified by the manufacturer. If the limit of level exceeds, water will be carried over to the super-heater or the turbine may cause damage resulting in the increase in the maintenance cost. The steam temperature has to be kept under control in order to avoid the excess usage of feed water in the boiler. Droplet Identifier is used to find out any drops in the steam outcome. If any drop is found out then turbine will be damaged. The boiler parameters such as pressure level, temperature level, water level are measured and this information is given to the ARM 8 Processor. The ARM 8 Processor monitors the real time values of the parameters and if the value reaches above the threshold value it automatically controls the values by using the driver circuit which is connected to the boiler. The boiler parameters are monitored and the values are displayed in Lab VIEW by using RS 232 Serial Communication. Lab VIEW provides the graphical representation.

ARM8

The ARM 8 Cortex processor, based on the ARMv7 architecture, has the ability to scale in speed from 600MHz to greater than 1GHz. The processor is particularly suited to high-performanceapplications.ARM8 processor is used to monitor and control of the parameters automatically. According to the input and output ports, the devices can be connected to the processor. By using the pin diagram the sensors can be connected and control the parameters. The port13 is connected to the temperature, pressure, water level sensor. Power supply is connected to the pin 50 and 51. The port60 is connected to the LCD. The parameters at normal and abnormal conditions can be displayed by using the LCD.

V. LabVIEW

The LabVIEW consists of the front panel and the block diagram. The graphical approach also allows non-programmers to build programs by dragging and dropping virtual representations of lab equipment with which they are already familiar. For complex algorithms or large-scale code, it is important that the programmer possesses an extensive knowledge of the special LabVIEW syntax and the topology of its memory management. In the block diagram all the four parameters can be represented. All the parameter variations like temperature, pressure, water level and can be done by using the comparator. We have to set the limit value for these parameters. If the parameters can be raised above to that particular limit value, it can be represented as high in the front panel. Otherwise, it can be mentioned as normal. The temperature is set as 1500° c .The values is continuously monitored and if the level reaches above the set value .It will alert and automatically controls the value .The water level is monitored .

If the temperature can be raised to higher level, it can be displayed as temperature is high. Then automatically lowered to the preset value. These variations can be represented in the graphical of thermistor. If the temperature cannot be raised to higher level, it can be displayed as temperature is normal. All these conditions of the parameters can be graphically monitored and controlled by using LabVIEW.

VI.UBUNTU (OPERATING SYSTEM)

Ubuntu offers Ubuntu Cloud Images which are pre-installed disk images that have been customized by Ubuntu engineering to run on cloud-platforms such as Amazon EC2, Open stack, Windows and LXC. Ubuntu is also prevalent on VPS platforms such as Digital Ocean. Ubuntu 11.04 added support for Open Stack, with Eucalyptus to Open Stack migration tools

added by Canonical in Ubuntu Server 11.10. Ubuntu 11.10 added focus on Open Stack as the Ubuntu's preferred offering though Eucalyptus is also supported. Another major focus is Canonical Juju for provisioning, deploying, hosting, managing, and orchestrating enterprise data centre infrastructure services, by, with, and for the Ubuntu Server

Ubuntu Touch is a variant for smart phones and tablets which was announced in January 2013 and is expected to be released in Q4 2014. THigher-end Ubuntu smart phones will be able to run a full Ubuntu desktop when connected to a monitor and keyboard, a feature pioneered in Ubuntu for Android. Each of these parts appears and fades each after the other, while changing the colour of the circles in the background and the placement of the little ones. From the Welcome screen, the user could swipe to any of the four directions: up for notifications, left for the app menu, swipe from the right to launch the previous app, and swipe from the bottom to display the operations menu.

- Ubuntu provides wide range of software that includes Libra Office, Firefox, Empathy, Transmission and several lightweight games such as Sudoku and chess.
- The home and Private directories can be encrypted.
- The Ubiquity installer allows Ubuntu to be installed to the hard disk from within the Live CD environment.
- Beginning with Ubuntu 5.04, UTF-8 became the default character encoding, which allows for support of a variety of non-Roman scripts.
- It is one of the open source operating system.

ECLIPSE (SOFTWARE)

Eclipse is the most widely-used open source integrated development environment. In computer programming, Eclipse is an integrated development environment (IDE). It contains a base workspace and an extensible plug-in system for customizing the environment. Written mostly in Java, Eclipse can be used to develop applications. By means of various plug-ins, Eclipse may also be used to develop applications in other programming languages: Ada, ABAP, C, C++, COBOL, Fortran, Haskell, JavaScript, Lasso, Natural, Perl, PHP, Prolog, Python, R, Ruby (including Ruby on Rails framework), Scala, Closure, Groovy, Scheme, and Erlang.

The initial codebase originated from IBM Visual Age. The Eclipse software development kit (SDK), which includes the Java development tools, is meant for Java developers. Users can extend its abilities by installing plug-ins written for the Eclipse Platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules.

In addition to allowing the Eclipse Platform to be extended using other programming languages, such as C and Python, the plug-in framework allows the Eclipse Platform to work with typesetting languages like Latex and networking applications such as telnet and database management systems. The plug-in architecture supports writing any desired extension to the environment, such as for configuration management. Java and CVS support is provided in the Eclipse SDK, with support for other version control systems provided by third-party plug-ins. With the exception of a small run-time kernel, everything in Eclipse is a plug-in. This means that every plug-in developed integrates with Eclipse in exactly the same way as other plug-ins; in this respect, all features are "created equal".

Eclipse implements uses the graphical control elements of the Java toolkit called SWT, whereas most Java applications use the Java standard Abstract Window Toolkit (AWT) or Swing. Eclipse's user interface also uses an intermediate graphical user interface layer called JFace, which simplifies the construction of applications based on SWT. Eclipse was made to run on Wayland during a GSoC-Project in 2014.

- It's an Integrated Development Environment (IDE) product.
- Eclipse uses plug-ins to provide all the functionality within and on top of the runtime system. Its runtime system is based on Equinox, an implementation of the OSGi core framework specification.
- It's to be extended using other programming languages such as C and Python, the plug-in framework allows the Eclipse Platform to work with typesetting languages like Latex, networking applications such as telnet and database management systems.
- Eclipse is used to create the bin (.BIN) file.

VII. RESULTS
Hardware Results

By using ARM processor we can monitor and control the boiler parameters In the ARM8 processor, the control panel consist of four options are temperature sensor, pressure sensor, water level sensor and rain drop sensor. When selecting the option 1, it represents the temperature. If the temperature can be raised to higher level, automatically it shows the value is abnormal. When selecting the option 2, it represents the pressure. If the pressure can be raised to higher level, it automatically represents as abnormal condition .When selecting the option 3, it represents the level of water in the boiler drum .If the water level decreases to lower level, It automatically represents as abnormal condition. It can also represent in LED .When normal condition means green light is indicated and when abnormal means red is indicated.

Figure 4. ARM8 Processor Output

If the water level and pressure decreases to lower level, it automatically represents as abnormal condition. otherwise water and pressure level is normal.

Figure-5.3 Representation of temperature

If the temperature decreases to lower level, it automatically represents as abnormal condition. otherwise temperature level is normal.
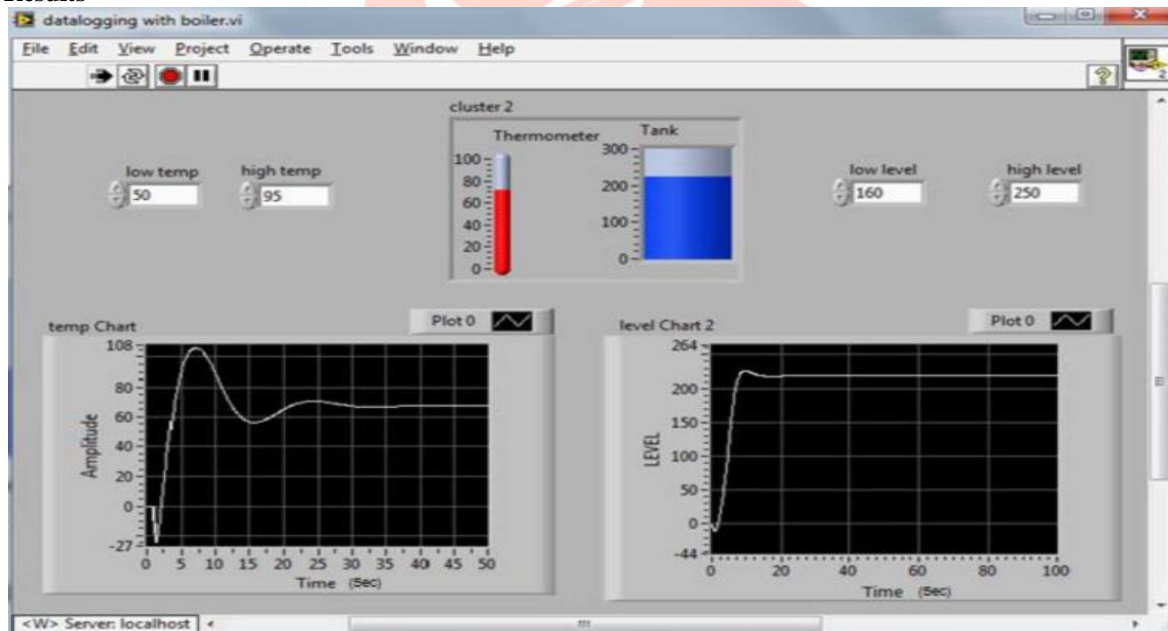
Software Results

Figure 5. Result of front panel

Using the front panel various parameters are monitored .the temperature level, pressure, droplet identifier and water flow to the boiler are measured. If any problem occurs it will control the value and the normal level is maintained. The parameters values are compared by using comparator .If the pressure value is set as 150psi but the measured value is greater than that means then it will alert and the pressure value is controlled to the normal level. Through LabVIEW we can monitor the values graphically as well as waveform .There is no program coding for LabVIEW.

Results Comparison

By using LabVIEW all the parameters like temperature, pressure and water level can be monitored. These parameters are controlled automatically by using LabVIEW .All these parameter variations can be represented by using the graphical method. If the parameter can be raised to higher level, it can indicated by using the graphical method like temperature, pressure variations in the front panel. By using the ARM processor of eclipse software, the parameters normal and abnormal condition can be mentioned by using the LCD. If the parameters move to an abnormal condition, it can be displayed by using the GLCD. GLCD

(Graphical Liquid Crystal Display) is used to represents the variations in the colour format .By using the eclipse software, it is also very easy to identify the variation of parameters by using the colour representation of GLCD.

VIII. CONCLUSION

In this project the boiler drum parameters like temperature, pressure, water level and droplet identifier can be monitored and controlled automatically by using ARM8 processor. The parameter variations of normal and abnormal conditions are represented graphically represented by using LabVIEW. If the drum level goes below the desired lower level, there will be a possibility of starvation of water tubes inside the furnace and if the water level in the drum rises above the desired drum level, there will be a carryover of water particles in the dry steam flowing to the turbine .In order to meet out the steam requirement, to safeguard the boiler water tubes and turbine blades, the boiler water drum level control plays an important role in thermal power station. In future, droplet identifier parameters is enhanced The parameters of the boiler unit are temperature, pressure, water level can be monitored and controlled by using Effective communication medium. The values can be send to the users by sending an SMS.

IX.CODING

```
#include "macros.h"
#include <ulk.h>
int main(void) PROGRAM_ENTRY;
int main ()
{
int i,m,n,o,p;
unsigned long*base=0x80500000;
{
        *(base+i)=0x000000;
}
ulk_cpanel_printf("Welcome power plant System\n");
ulk_cpanel_printf("Enter the option 1 or 2 or 3\n");
ulk_cpanel_printf("1.temperature\n");
ulk_cpanel_printf("2.pressure \n");
ulk_cpanel_printf("3.level of water\n");
ulk_scanf_hex(&m);
switch(m)
{
case 1 :
ulk_fpga_7seg_led_enable();
ulk_fpga_7seg_led_write(1);
ulk_fpga_clcd_init();
ulk_fpga_clcd_display_on();
ulk_scanf_hex(&n);
if(n<4)
{
ulk_fpga_clcd_display_string("normal");
for(i=0;i<320*240;i++)

{
        *(base+i)=0x0000ff;
}

}
else
{
ulk_fpga_clcd_display_string("abnormal");
for(i=0;i<320*240;i++)
{
        *(base+i)=0x0ff000;
}

}
break;

case 2 :
ulk_fpga_7seg_led_enable();
ulk_fpga_7seg_led_write(2);
ulk_fpga_clcd_init();
```
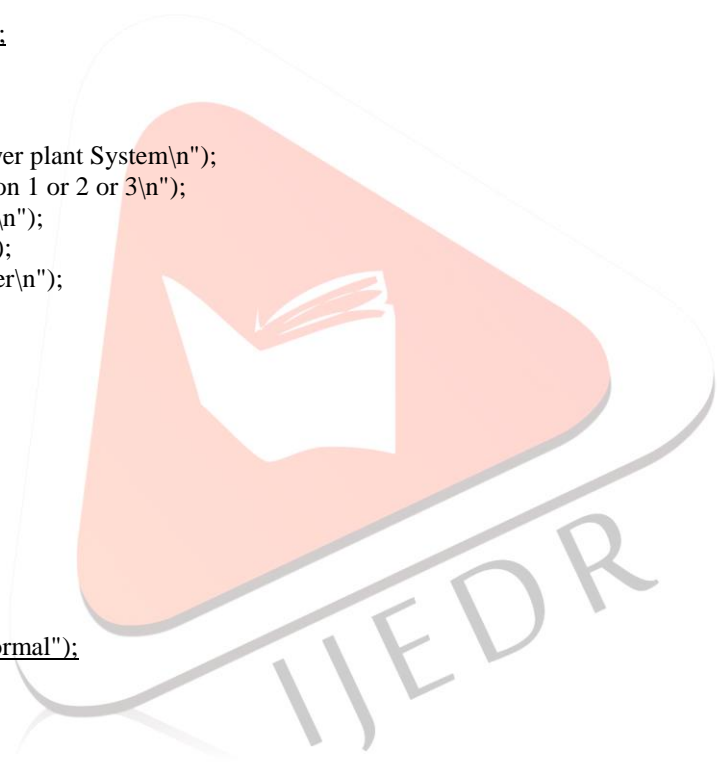
```
ulk_fpga_clcd_display_on();
ulk_scanf_hex(&o);
                if(o<=5)
{
                ulk_fpga_clcd_display_string("normal");
                for(i=0;i<320*240;i++)

                {
                        *(base+i)=0x000fff;
                }
}
else
{
ulk_fpga_clcd_display_string("abnormal");
for(i=0;i<320*240;i++)
{
        *(base+i)=0x0ff000;
}
}
break;

case 3 :
ulk_fpga_7seg_led_enable();
ulk_fpga_7seg_led_write(3);
ulk_fpga_clcd_init();
ulk_fpga_clcd_display_on();
ulk_scanf_hex(&p);
if(p<6)
{
ulk_fpga_clcd_display_string("low level");
for(i=0;i<320*240;i++)
{
        *(base+i)=0x000ff0;
}
ulk_fpga_clcd_display_string("normal level");
}
else
{
ulk_fpga_clcd_display_string("low level");
for(i=0;i<320*240;i++)
{
        *(base+i)=0x0ff000;
}
}
break;
default:
ulk_fpga_clcd_init();
ulk_fpga_clcd_display_on();
ulk_fpga_clcd_display_string("Warning!");
for(i=0;i<320*240;i++)
{
        *(base+i)=0xf0000f;
}
}

}
```

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