CONTROLLING AND MONITORING THE BOILER APPLIANCES THROUGH WEB

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Abstract: - Over the years the demand for high quality, greater efficiency and automated machines has increased in this globalised world. The concept of internet of things binds the object around, to the web world to facilitate the remote access and control. Boiler appliances are used to produce hot water and thus it is used in central heating system and also in domestic hot water system. Boiler appliances should handle with care because sometimes due to mishandling the appliances leads severe damage to life. Regular and frequent checking should be made in order to check the condition of the boiler. Automating the boiler appliances solves this problem and hence the frequent testing and handling can be done efficiently as well as safely. This paper is about controlling and monitoring the boiler appliances. A design of embedded web server for Bosch proprietary boiler appliance capable of providing both central heating system and domestic hot water system is introduced. A web server embedded into controller is connected to the internet so that the appliance can be monitored and controlled from remote places through the browser. A web server is embedded into ARM cortex-A8 cortex controller and provides user interface to effectively monitor and control the various functionalities of the boiler appliances. This web server is connected to the Internet to enable controlling and monitoring of boiler from remote places through the web browser.

Key-Words: - Boiler appliance, remote controlling and monitoring, embedded web server, user interface.

1 Introduction

Due to fast growth in technology, automatic systems are playing important role in day to day life. Introduction of intelligent system and smart devices helps to save time, reduce the human effort, provides automatic control, eliminates the human error and reduce the energy wastage. Web-empowered or browser based systems are latest addition to building automation technology. These systems add more flexibility, easy and remote access for man-machine interface. Controlling any number of devices is made possible with an infrastructure less effective GUI through web based building automations.

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A web page graphical interface economizes user interface and is much easier to change according to the need as compared to a hardware user interface. The proposed work aims to provide a flexible and cost effective solution for monitor and control of boiler appliances through internet. All the appliances are connected to the web server via I/O port and the inbuilt ethernet controller in the web server is connected to the internet though the MODEM. The embedded web server is designed with a user friendly GUI which facilitate the interactive control of appliance.
Section (II) explains about the topic related to controlling and monitoring boiler appliances using different techniques. In that, concept of embedded web server along with web interfaces is discussed. Section (III) explains about the proposed system, system architecture along with concept of central heating system and domestic hot water system is discussed. Section (IV) explains about the performance evaluation. Section (V) explains about the conclusion.

2. Related work

Online monitoring is to control the appliances using Internet from remote places. So that user can control all the appliances through Internet. The real-time home automation control uses different methods like Home automation control using mobile, telephone, Radio frequency devices automations were used only for controlling. Monitoring of devices could not be done using these methods and has only limited distance for controlling of devices. This method requires one PC to browse Internet at the source, and it does not require another PC at the destination to control the device. The embedded Ethernet converts the Internet protocols to microcontroller hex file [8].

Once the microcontroller receives the instructions and ID, depending on the received ID that particular device is monitored. This is how the source end is linked with destination. If the operator needs to know the status of devices, the program sends a request to the destination device. Once the request is received, microcontroller scans the devices and then it sends the status of the devices through embedded Ethernet to the source end. The source end has mainly human operator and a computer with an Internet. The destination end has mainly an embedded Ethernet board along with microcontroller. The microcontroller is then linked with relay drivers and relays. The controlled devices are connected to the relays. The source end and the destination end are connected to the Internet. Capability brings the advantages of remote management and data accessibility to thousands of serial devices over the network.

3. BOILER SYSTEM

A boiler is capable of providing both central heating system and domestic hot water. Combination boiler is one which combines central heating and hot water in one application.

3.1 Central heating system

A central heating system provides warmth to the whole interior of a building (or portion of a building) from one point to multiple rooms. When combined with other systems in order to control the building climate, the whole system may be an HVAC system. Central heating differs from space heating, in that the heat generation occurs in one place, such as a furnace room in a house or a mechanical room in a large building. The heat is distributed throughout the building, typically by forced-air through ductwork, by water circulating through pipes, or by steam fed through pipes. The most common method of heat generation involves the combustion of fossil fuel in a furnace or boiler. Increasingly, buildings utilize solar-powered heat sources, in which the distribution system normally uses water Circulation.

Fig 1 shows the various process of central heating system. When the water is heated in the boiler the steam is passed to the tank and radiators through zone valve and pump. After the heat is absorbed and released to the room and tank the water is again returned to the boiler through the return flow. Central heating system along with the domestic boiler is used in order to warm the buildings in cold countries in winter season, the hot water which is heated to certain degree celsius is passed through fin tubes in radiator. Thus the air is blown in the radiator like circuit and hot air is taken out from the hot water and passed to the room in which the radiator is fixed. Hence the water with low temperature again returned to the boiler, thus the water is reused.

3.2 Domestic hot water system

Water heating is a thermodynamic process that uses an energy source to heat water above its initial temperature. In industry, hot water and water heated to steam have many uses. These metal vessels that heat a batch of water do not produce a continual supply of heated water at a preset temperature.
Rarely, hot water occurs naturally, usually from natural hot springs. The temperature varies based on the consumption rate, becoming cooler as flow increases. Appliances that provide a continual supply of hot water are called water heaters, hot water heaters, hot water tanks, boilers, heat exchangers, geyseres or calorifiers. Fig 2 explains about the domestic water system process. Through the gravity tank the water is fed to the heat exchanger or hot water storage tank through the hot water circulation pump. Through the supply pump and bypass valve the water is drawn to consumers. These names depend on region, and whether they heat portable or non-portable water, are in domestic or industrial use, and their energy source.

3.3 Control parameters in boiler

Boiler appliances use different types of sensors in order to control different types of boiler operations. Various types of sensors are used. Here boiler water heating is used for central heating and domestic hot water mechanism.

Pressure sensor

Pressure sensor measures pressure of gases and liquid. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensor in boiler appliance can be used to measure the pressure in the valves and pipes of the boiler.

Ionization current

Mixing of gas and air begins combustion. Electrical potential across spark plug after it fires to start combustion

Windbreak functionality

Windbreak functionality is used, when there is heavy wind in outside environment. It is started while the ignition may not happen after two failure attempts.

Air pressure switch

Air pressure switch monitors the speed of the fan. Closure of air pressure switch is to push out air from chamber with respect to fan speed. Air pressure switch will open automatically when pressure in chamber is less.

Frost Protection

Frost protection is applied in order to prevent forming of frost in pipes. The mode is activated when the temperature is below seven degree Celsius. If the frost is formed in the pipes, water is blown with heavy pressure to clear the frost formation.

Temperature Sensor

Thermostat is used as the temperature sensor and according to the temperature level the burner ignition is controlled. It is done by switching on or off the device or regulating the flow of heat transfer fluid as needed to maintain the correct temperature.

4. Proposed System

In controlling and monitoring the boiler appliances, the web interfaces are designed in order to control boiler appliances. Hence manual effort in operating hardware setup is reduced. In the existing approach, controlling and monitoring of boiler appliances is done manually. Controller knobs are increased for every heating circuit and hence the controller device size will be increased. In case of manual handling, human effort is spent more. Using software for boiler control reduces the hardware cost and size of appliance holder for fitting multiple tabs, knobs and circuit is also reduced. Using software design it is controlled by LCD touch screen with lot of operations in both controlling and monitoring of appliance. Bosch proprietary boiler appliance is used in the boiler operation.
4.1 System architecture

Fig 3 shows the two major operations concerned with appliances, the controlling and monitoring of central heating system and domestic hot water system. By using the web interface the boiler can be switched on and switched off. Also it is used to increase and decrease the temperature of the boiler. Boiler appliance is connected to the beagle bone black processor. It consist of ARM processor, in which all the developed software’s using JSP, java code, apache tomcat 7.0 server are embedded into the controller to host the developed web application in the Internet.

Fig 3. System Architecture of proposed system

Connectivity flow of controlling and monitoring system is shown in Fig 4. It shows the block diagram of how a controller is linked to appliance, network and to the display unit. Universal Asynchronous Receiver/Transmitter chip sends commands to the appliances.

Fig 4. Block Diagram of Beagle board connection

Fig 5 shows the different stages in process flow to monitor the boiler appliance. The web page designed for controlling boiler appliance is hosted in the web server through commands. The request and reply messages are sent and received through web server. The controller commands are passed through JNI calls which is again passed through the UART and received by the appliance. The appliance parameters such as temperature, pressure, ionization current is fetched by the controller and hence it is returned back to the server and shown in the appropriate web page. The developed web interface is hosted in LAN network and accessed in the Bosch network. It can be accessed by multiple client browsers inside the network.

In the front end, web pages are created and hosted in the tomcat7.0 server. In the back end, code is embedded for controlling appliances in board and with the JNI call process; commands are sent and received to the controller.

Fig 5. Process block of boiler monitoring system

Appropriate web pages are created using HTML, JavaScript and CSS in order to frame the application to control the appliance. This user interface consists of five main pages namely, (i) Home page (ii) Status Page (iii) Modes page (iv) Demo page (v) Settings page. The home page describes the different modes and usage of overall application. The status page describes the current boiler temperature, central heating temperature and domestic hot water system temperature. It displays the temperature range as high, moderate and low. The modes page provides functionality of switching on or off the two modes of boiler which contains the central heating modes and domestic hot water mode.
The demo page describes about the diagrammatic representation of the boiler with current temperature. The settings page contains the login screen which supports the creation of twenty five users to control heating circuits. There are two types of login exists, one is admin login and another is user login. Admin login is created implicitly with all permission rights. User login can be created by new user sign up. The user name and password are saved in web local storage. Settings page contains the three modes (i) Manual mode (ii) Test mode (iii) Chimney sweeper mode and five menus namely, (i) Information menu (ii) System parameter menu (iii) Boiler parameter menu (iv) Boiler limit menu (v) System limit menu. User can view only the menu which are read only and can set the temperature in particular range.

4 Performance Evaluation

The developed application with apache tomcat 7.0, c-code, java code and java run time environments is transferred to the beagle board and the board is connected to the Bosch proprietary appliances. With the help JNI calls, the values posted in the web interface hits the c-code. Hence the values are given to the appliance by controller. The web interface is shown in beagle board display screen which is mounted above the board. From this, appliance was monitored and controlled in two ways by beagle board display and through browser. Instructions from web browser are fetched and used to turn on or off and to increase or decrease the temperature of boiler. Fig 6 shows the overall setup of the application. Fig 7 shows the beagle board connected to the Bosch local area network. The application is hosted in Internet through the tomcat server, which can be accessed by all other client browser through the URL.

As a result, two types of boiler operations are controlled and monitored namely, turning on or off the central heating system and domestic hot water system with changing the temperature to a predefined limit value. Web interfaces was created with JSP and servlets for hosting the request. The application is tested for various systems. Changed values are reflected in board and appliance. Fig 8 and 9 shows the screen shots of modes and menu page.

5 Conclusion

The home environment with boiler appliance has seen a rapid introduction of networked digital technology. This technology offers new and exciting opportunities to increase the boiler appliance. Moreover, with the rapid expansion of the Internet there is added potential for the remote control and
monitoring of such network devices. The proposed method is used to remotely control and monitor the boiler appliances through web. Thus web interfaces for various operations in boiler are created, hosted in the Internet through embedded web server. The system can be used to control and monitor the boiler appliances as web application. As a future work, this web application can be developed as mobile application for controlling and monitoring the boiler appliance.

References:


