BOILER AUTOMATION USING LPC2138 & HTTP SERVER

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Abstract— In today's modern world, mechanical strength is only one of the many criteria, which decides the superiority of any boiler. There are many other more important aspects like efficiency, availability round the clock, ease in maintenance, environmental compliance, etc. The modern day high pressure boilers which are provided with optimized heat transfer areas for its rated duty require some of the important operating parameters to be controlled closely to maintain a steady output.

This paper highlights a few of the important instrumentation and control loops that are required for safe, economic and reliable working of the boilers. In this paper we are monitoring and controlling important parameters with which the process output will be steady output. Here we are using sensors for the parameters are Temperature sensor, Humidity sensor & Level sensor.

Here we will be using ARM microcontroller, sensors output produce the analog signal, this signal directly connected to ARM microcontroller. Microcontroller outputs connect to RS232 with PC. All the parameter will be mapped on the webpage designed using HTML on the PC.

Index Terms— ARM Processor, Boilers, Ethernet, Temperature, TCP/IP Protocol, Sensors

I. INTRODUCTION

Embedded Technology is an emerging field day by day with a lot of possibilities. Web access functionality is embedded in a device to enable low cost widely accessible and enhanced user interface functions for the device. An ARM based web server in the device provides access to the user interface functions for the device through a device web page. A web server provides access to the end devices for the client by uploading web pages as per the client request. It is the central functional unit that hosts web pages thereby provides services as per client request. When the configured IP address is entered in the web browser, the predesigned HTML web pages gets displayed through which we can remotely monitor and control the sensor and device status respectively. The heart of communication is TCP/IP protocol. Network communication is performed by the IEEE 802.3 Ethernet standard. It is the most modern technology of embedded systems that has brought Ethernet access to the same. An ARM based web server can be embedded into any appliance and connected to the Internet so the appliance can be monitored and controlled from remote places through the browser in a desktop.

While it is theoretically possible to operate a boiler with manual control the operator must maintain a tedious, constant which for disturbances and variations of parameters. Time is needed for the boiler to respond to a correction and this lead to over correction with further upset to the boiler. An automatic controller once properly tuned will make the proper adjustment quickly to minimize upsets and will control the system more accurately and reliably. Apart from

mechanical strength, it is control logic & instrumentation which decides the safety & reliability of any modern boiler. There are different types of process in which the parameters are to be controlled at specified range. So in this project we concentrated upon some parameters, which are described below.

The block diagram of proposed system is shown in figure (1) as below

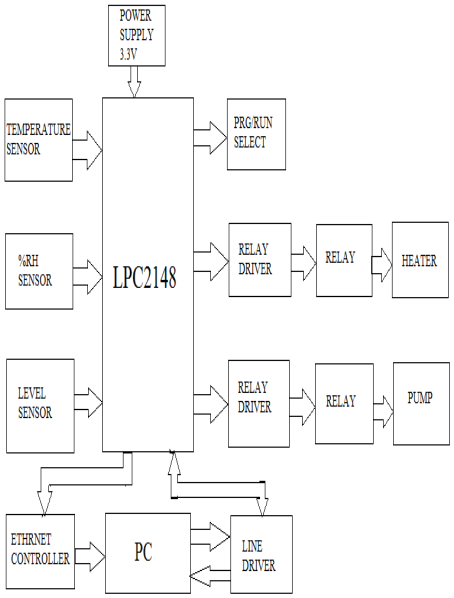


Figure (1) Block Diagram

A. Boiler level monitoring & controlling system

Keeping proper water level in the boiler is of paramount importance from boiler safety point of view. This instrument maintains necessary operating water level by controlling the water inflow. In this we are using level sensor which detects the level of the liquid in the boiler. Here we use two level sensors one is low level & other is top level, which show the lower liquid & higher liquid level, so that the liquid level can be maintained with in a range .The following figure (2) shows that in manual configuration the water level increases, but after using level sensors trough controller it's level can be withstand within 15 to 20 (say for any boiler level specified).

Figure (2): Level monitoring & controlling

So if top level sensor is mounted at 20 & low level sensor is mounted at 15, then level can be maintained between these two levels.

B. Temperature monitoring & controlling system

For heavy oil fired boilers, the fuel needs to be heated to reduce viscosity and improve atomization. Low fuel temp can result in incomplete combustion, unstable flame and backfiring. Fuel temp monitoring system should stop the burner firing below safe temperature. Since different process requires different operating temperature range, so in this as temp. Varied initially but using controller we maintained the temperature range. The figure (3) shows the idea about the proposed system for temperature monitoring & controlling.

The graph, in manual control the boiler is heated and has no ability to control the temperature in the specified range. Let here the temperature range is taken for the process is 300° C to 400° C. But after using of temperature sensor and controlling the range through ARM controller it can be achieved

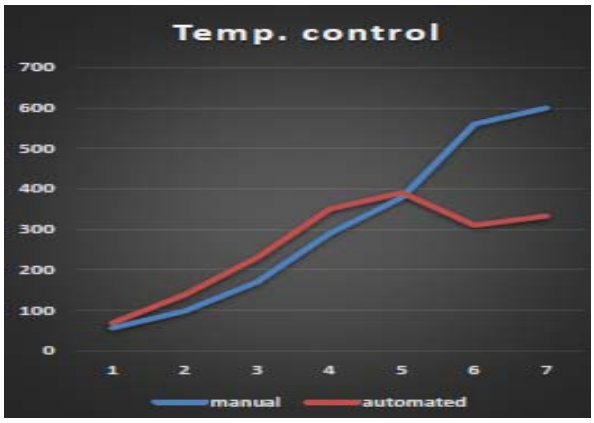


Figure (3): Temperature monitoring & controlling

C. Humidity monitoring system

Measurements of the water vapor content in atmosphere and surface are required for the better understanding of the physical, chemical, and possibly also exobiological processes in the upper Martian surface. So a humidity sensor is deployed in order to measure the humidity concentration near about the boiler. So that it would be known that the operation of boiler under that condition is allowed or not. Below is the figure (4) of a Humidity sensor.

Figure (4): Humidity sensor

II. SYSTEM HARDWARE DESIGN

The system consists of three different parts. First is the Embedded Web Server. Second is the user part or client and third one is the sensors and appliances to be monitored. The client thus monitors various parameter status through sensors and also controls many industrial appliances with the help of the web server.

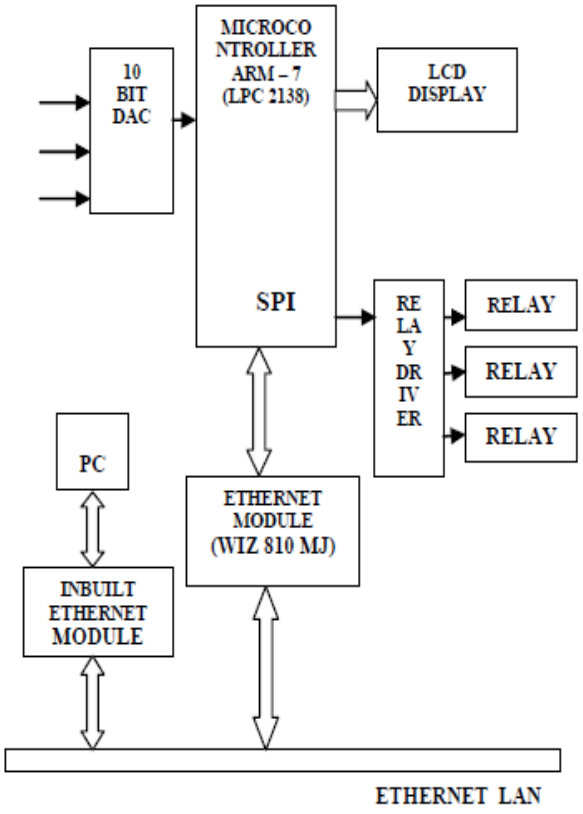


Figure (5): System Block Diagram.

A. LPC 2138 Processor

This is a 32-bit ARM7-TDMI-S microcontroller with 32kB of on-chip static RAM and 512 KB of on-chip flash memory. It has 128-bit wide interface/accelerator that enables 60MHz of operation. Also has In-System Programming using on-chip boot loader software, 400ms of full chip erase and 256 B of programming in 1ms. For interfacing of sensors, it has 10-bit ADC with 8 analog inputs and a conversion time as low as 2.44μs per channel. CPU operating voltage is 3V to 3.6V so that the proposed system requires only lower power consumption as the same mentioned before. The Architecture is based on RISC principles and this simplicity results in a high instruction throughput and real-time interrupt response form a small and cost effective processor core. It also have another architectural strategy such as 16-bit Thumb instruction along with 32-bit ARM instruction set which will enhance the code density in restricted memory conditions while returning most of the ARM's performance advantage over a traditional 16-bit processor

using 16-bit registers. This is possible because THUMB code operates on the same 32-bit register set as ARM code. THUMB code is able to provide up to 65% of the code size of ARM, with minimum performance penalty, and 160%of the performance of an equivalent ARM processor connected to a 16-bit memory system. In sending a frame a controller receives the message to send and the destination address from higher-level software. It calculates the Ethernet frame check sequence and places data, addresses and other information in the frames field. Half duplex interface Detects collisions, cancels any transmitted frame with a collision and tries according to protocol standard IEEE 802.3; in full duplex Ethernet segment doesn't need to support collision detecting because there are no collisions to detect and provides an indication of success or failure of a transmission. In receiving a frame a controller detects and synchronizes to new received frames. It ignores any frame that is less than the minimum size, ignores any frames that do not contain the interface's address or a valid multicast or broadcast address in the Destination Address field. It calculates the frame check sequence value, compares the result with the received value and indicates the errors if they don't match.

B. Ethernet Controller (ENC28J60)

The ENC28J60 is a stand-alone Ethernet controller with an industry standard Serial Peripheral Interface (SPI). It is designed to serve as an Ethernet network interface for any controller equipped with SPI. The ENC28J60 meets all of the IEEE 802.3 specifications. It incorporates a number of packet filtering schemes to limit incoming packets. It also provides an internal DMA module for fast data throughput and hardware assisted checksum calculation, which is used in various network protocols. Communication with the host controller is implemented via an interrupt pin and the SPI, with clock rates of up to 20 MHz. Two dedicated pins are used for LED link and network activity indication.

Figure (6): Ethernet Module

III. SYSTEM SOFTWARE DESIGN

The software coding for the hardware functionality is written in embedded C language in Keil Software. The TCP/IP layered model of IEEE 802.3 standard is successfully implemented in embedded C language.

A. Ethernet

The name comes from the physical concept of the ether. It defines a number of wiring and signalling standards for the physical layer, through means of network access at the Media Access Control (MAC)/Data Link Layer, and a common addressing format. On top of the physical layer Ethernet stations communicate to each other by sending each other data packets, small blocks of data that are individually sent and delivered. Ethernet is standardized as IEEE 802.3. The combination of the twisted pair versions of Ethernet for connecting end systems to the network, along with the fiber optic versions for site backbones, is the most widespread wired LAN technology. It has been in use from around 1980 to the present, largely replacing competing LAN standards such as token ring, FDDI, and ARCNET. In recent years, Wi-Fi, the wireless LAN standardized by IEEE 802.11, is prevalent in home and small office networks and augmenting Ethernet in larger installations.

A basic 10/100 Ethernet frame consists of the following fields, as shown in Table 1.

10/100 IEEE 802.3 Frame	
7 octets	Preamble
1 octet	Start Frame Delimiter(SFD)
6 octets	Destination Address(DA)
6 octets	Source Address (SA)
2 octets	Length(≤1500) Type(≥1536)
46 octets to 1500 octets	Client Data(Payload)
4 octets	Frame Check Sequence

TABLE I. BASIC FRAME FORMAT

B. Transmission Control Protocol (TCP)

The TCP/IP protocol suite, also referred to as the Internet protocol suite, is the set of communications protocols that implements the protocol stack on which the Internet and most commercial networks run. It is named after the two most important protocols in the suite: the Transmission Control Protocol (TCP) and the Internet Protocol (IP).

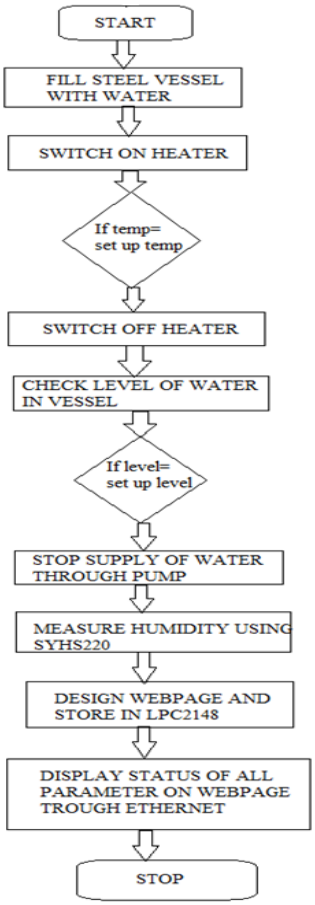
The Transmission Control Protocol (TCP) is one of the core protocols of the Internet protocol suite. TCP is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as *TCP/IP*. TCP provides reliable, ordered delivery of a stream of octets from a program on one computer to another program on another computer. TCP is the protocol used by major Internet applications such as the World Wide Web, email, remote administration and file transfer. Other applications, which do not require reliable data stream service, may use the User Datagram Protocol (UDP), which provides a datagram service that emphasizes reduced latency over reliability

TCP/IP is a two-layer program. The higher layer, Transmission Control Protocol, manages the assembling of a message or file into smaller packets that are transmitted over the Internet and received by a TCP layer that reassembles the packets into the original message. The lower layer, Internet Protocol, handles the address part of each packet so that it gets to the right destination. Each gateway computer on the network checks this address to see where to forward the message. Even though some packets from the same message are routed differently than others, they'll be reassembled at the destination.

C. Hyper Text Transfer Protocol (HTTP)

The transfer protocol used throughout the World Wide Web is HTTP (Hypertext Transfer Protocol). The HTTP is an application level protocol. It is a generic, stateless, object oriented protocol that can be used for many tasks, such as name servers and distributed object management systems, through extension of its request methods (commands). It uses a client-server relationship and is based on a stream-oriented transport layer, such as TCP. Today, the most important use is transferring HTML documents with multimedia contents between Internet servers and clients (WWW). It works with the principle of request and response. The simplest case is that a client establishes a connection to a server and requests a content referred by a Uniform Resource Identifier (URL) that specifies the path and name of the resource. Commonly, this is done by navigating with the web browser. These URLs are structured like a tile path. After decoding the request, the server starts transferring the resource to the client. The requests (also called methods) are sent as simple ASCII strings with a trailing carriage return (CR) and line feed (LF). The response from a server contains some header lines. Each one has a CR and LF at its end. An additional CR and LF at the end of the last line of the header indicate that the data is following. In most cases, this will be an HTML page or a picture file. After transferring the content, the connections usually closed again.

D. Flow Chart of the System



IV.CONCLUSIONS

In a head-to-head comparison with manual control system & proposed system, the proposed system outperforms than that of manual system. The major advantages to the system are that it can be aimed toward a small target and then accurately feedback data to the control system. However, the major care to be taken that, the system is the controller & sensors should be maintained properly & regularly as they are performing in hazardous conditions. So in this proposed project all the parameters are monitored & controlled using different sensors & PIC controller, in order to produce effective product through the process using boiler system. And all the parameters are controlled with in arrange of values which are different or specified for different processes.

And also in order to transmit the data from an existing device with SPI interface to network, an embedded Ethernet monitor and controlling system based on web browser is designed. This design can be used widely in remote data acquisition and control system in industry.

The system performance could be enhanced with more security provision when the software coding is upgraded from embedded C to RT-Linux as future work.

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