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An Advanced Boiler Management System with Innovative Technology using IoT

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Abstract

Boilers have many applications from residential and commercial heating to power generation. Better control of boilers reduces environmental pollution. The over flow of boiler or drying of boiler is an important problem in thermal power plant that subject to sudden load disturbances, which are common in current market driven electricity industry. Experimental results are presented to support the performance of the control mechanism. The feedwater flow in a boiler is manually operated till now. In this project, a boiler is monitored and controlled by using internet of things.

Keywords: Boiler, steam,parameters,wireless communication sensors, internet of things.

1. Introduction

Internet of Things (IoT) is the latest emerging internet technology. IoT is used in all the home appliances, industries and in every device. IoT creates the relationship between people to people, people to things and things to things. If temperature of steam increases boiler tubes will be puncture. So, monitoring of temperature is important to avoid the problem in power plant. Measurement of water vapour content in atmosphere and surface provides the details about physical, chemical and exobiological process in the surface. Gas monitoring is a part of this system which monitors the LPG gas in and around the boiler. Monitoring of boiler tank level is important to avoid an increase of maintenance cost. If the water level increases beyond the limits, turbine will damage due to overflow of water. If the water level decreases below.The low limit value, boiler tubes will be puncture. So, the monitoring of boiler water level is important in the boiler. In this project various boiler parameters monitored by using sensors and controller. Parameters to be monitored are given below: – Temperature – Humidity – Boiler water level – Gas.If the level becomes too low, then the pipe gets heated unnecessarily and the energy is wasted also the pipes get damaged. The boiler drum level control strategy is designed as single element control, two element controls or three element controls. If there is any mismatch between inflow and outflow will cause a continuous difference in the drum level. The distributive control system or SCADA are existed to eliminate the problem. As the internet of things is widely used in recent days and also it makes monitoring and controlling simpler and less expensive. With the help of sensors to detect the drum level the water pump is opened and closed. The level of the boiler is displayed on the webpage.

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2. Existing System

Three element controls, it assures that the signals versus feedwater flow will have a constant relationship by replacing the open flow characteristics of the feedwater control valve with a closed loop feedback control of feed water flow. With the help of distributive control system, SCADA or PLC, the level of drum level is controlled. The alarm goes on for every fixed minutes and the controller off the feed flow to the boiler or it can automated through trip method.

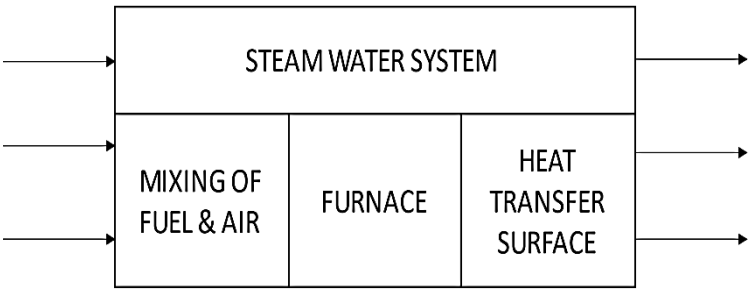

Figure 1Existing System

3. Drawbacks of Existing System

Long connections are needed so we have to use more wires.

- More spaces are needed for fitting wire communications.
- Monitoring action has possible only in control unit and man power needed.
- In the processing unit we need to measure three parameters.
- The methodology is complicated comparatively.

4. Proposed System

In our proposed system, it deals with the boiler drum level controlling. The boiler level is controlled by Arduino from the output of sensors. Arduino receives signals from the sensors and sends to the LCD display. Another side with the help of relay driver, the inlet valve is opened and closed automatically with respect to the signals received. All these information's are automatically send to the manager and assistants with the help of Web Server.

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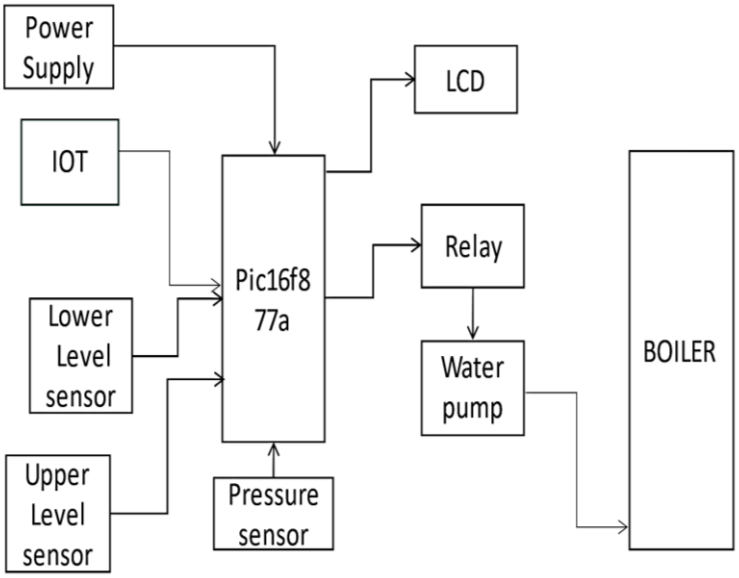

Figure 2Proposed system block diagram

5. Hardware Requirements

5.1 Arduino Board

Arduino is an open-source platform based on easy hardware and software. An Arduino board reads inputs-light on a sensor, a finger on a button, or a twitter message and turn it into an output that activates a motor, turning on an LED. The Arduino UNO board is a microcontroller ATmega328. It has 14 input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button.

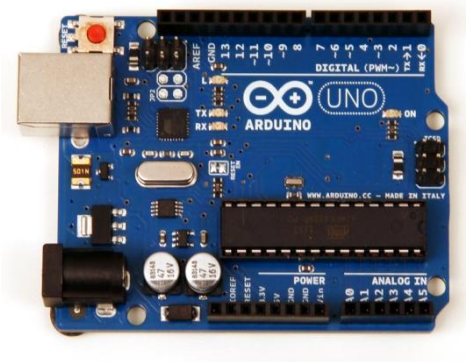

Figure 3Arduino Board

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5.2 Upper-Level Sensor

It is an overfill prevention switch that may be adjusted to operate over a wide range of level. It is based on float-switch technology and is made up of chemical resistant materials to assure compatibility with most liquids.

Figure 4Upper-Level Sensor

5.3 Lower Level Sensor

The high temperature and high pressure in the boiler need to use the level sensor to measure the internal liquid level to ensure its safety. The use of guided wave radar level sensors can solve the difficult problems of safety, accurate readings, and simple maintenance.

Figure 5Lower Level Sensor

5.4 Buzzer

Buzzer is based on the inverse principle of piezo electricity, It is based on the phenomena of generating electricity when mechanical pressure is applied to materials and the vice versa is also true. Such materials are called piezo electric materials. Piezo electric materials are either naturally available or also manmade. Piezo ceramic is a manmade material, which poses piezo electric effect and is widely used to make the heart of piezo buzzer. When it is subjected to an alternating electric field they compress, in accordance with the frequency of the signal there by producing sound.

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Figure 6Buzzer

5.5 Water Pump Motor

A pump is a device that moves the fluids such as liquids or gases, or sometimes slurries, by mechanical. Reciprocating hand pumps were widely used to pump water from water tanks and wells. It converts the mechanical energy of motor into the potential energy of flow that comes by means of multiple whirls, which are excited by the impeller.

Figure 7Water Pump Motor

5.6 Power Supply

Power supply is a source of electrical power. A system that supplies electrical power or other types of energy to an output load A relay driver circuit is a circuit which can drive, or operate, a relay so that it can function appropriately in a circuit.

5.7 Liquid Crystal Display

An LCD is an electronic display module which uses liquid crystal to display a visible image. The 16x2 translates a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix.

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Figure 8Liquid Crystal Display

5.8 Relay Driver

The driven relay can then operate as a switch in the circuit which can open or close, according to the needs of the circuit and its operation. In this project, we will build a relay driver for both DC and AC relays. Since DC and AC voltages operate differently, to build relay drivers for them requires slightly different setup. We will also go over a generic relay driver which can operate from either AC or DC voltage and operate both AC and DC relays. All the circuits are relatively simple to understand.is called a power supply unit. This term is most commonly applied to electrical power supplies, less often to mechanical ones, and rarely to others.

Figure 9Relay Driver

5.9 IOT

The 'Thing' in IoT can be any device with any kind of built-in-sensors with the ability to collect and transfer data over a network without manual intervention. The embedded technology in the object helps them to interact with internal states and the external environment, which in turn helps in decisions making process. In a nutshell, IoT is a concept that connects all the devices to the internet and let them communicate with each other over the internet. IoT is a giant network of connected devices – all of which gather and share data about how they are used and the environments in which they are operated.A developer submits the application with a document containing the standards, logic, errors & exceptions handled by him to the tester. Again, if there are any issues Tester communicates it back to the Developer.

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It takes multiple iterations & in this manner a smart application is created. Similarly, room temperature sensors gather the data and send it across the network, which is then used by multiple device sensors to adjust their temperatures accordingly. For example, refrigerator's sensor can gather the data regarding the outside temperature and accordingly adjust the refrigerator's temperature. Similarly, your air conditioners can also adjust its temperature accordingly. This is how devices can interact, contribute & collaborate.

6. Benefits of IoT

Since IoT allows devices to be controlled remotely across the internet, thus it created opportunities to directly connect & integrate the physical world to the computer-based systems using sensors and internet. The interconnection of these multiple embedded devices will be resulting in automation in nearly all fields and also enabling advanced applications. This is resulting in improved accuracy, efficiency and economic benefit with reduced human intervention. It encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. The major benefits of IoT are:

Improved Customer Engagement – IoT improves customer experience by automating the action. For e.g., any issue in the car will be automatically detected by the sensors. The driver, as well as the manufacturer, will be notified about it. Till the time driver reaches the service station, the manufacturer will make sure that the faulty part is available at the service station.

Technical Optimization – IoT has helped a lot in improving technologies and making them better. The manufacturer can collect data from different car sensors and analyse them to improve their design and make them much more efficient.

Reduced Waste – Our current insights are superficial, but IoT provides real-time information leading to effective decision making & management of resources. For example, if a manufacturer finds fault in multiple engines, he can track the manufacturing plant of those engines and can rectify the issue with manufacturing belt.

Nowadays, we are surrounded by lots of IoT enabled devices which are continuously emitting data and communicating through multiple devices. Moving ahead, let's discuss the required hardware for building an IoT application. We will also look at the IoT devices which we are using in our day-to-day life.

7. Software Requirement

7.1 Arduino IDE

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer.

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The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

7.2 PROTEUS 8

Proteus is a simulation software tool developed by Lab centre Electronics for Electrical and Electronic circuit design. It also possesses 2D CAD drawing feature. It deserves to bear the tagline “From concept to completion”.

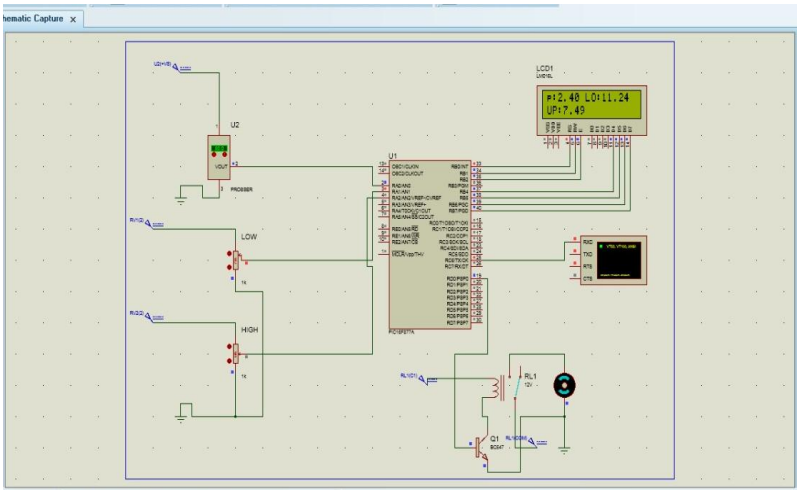

Figure 10 Simulation Results

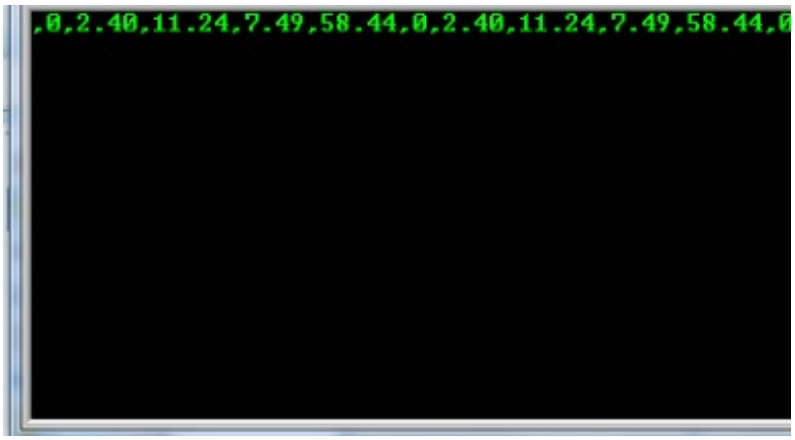

Figure 11Simulation Results

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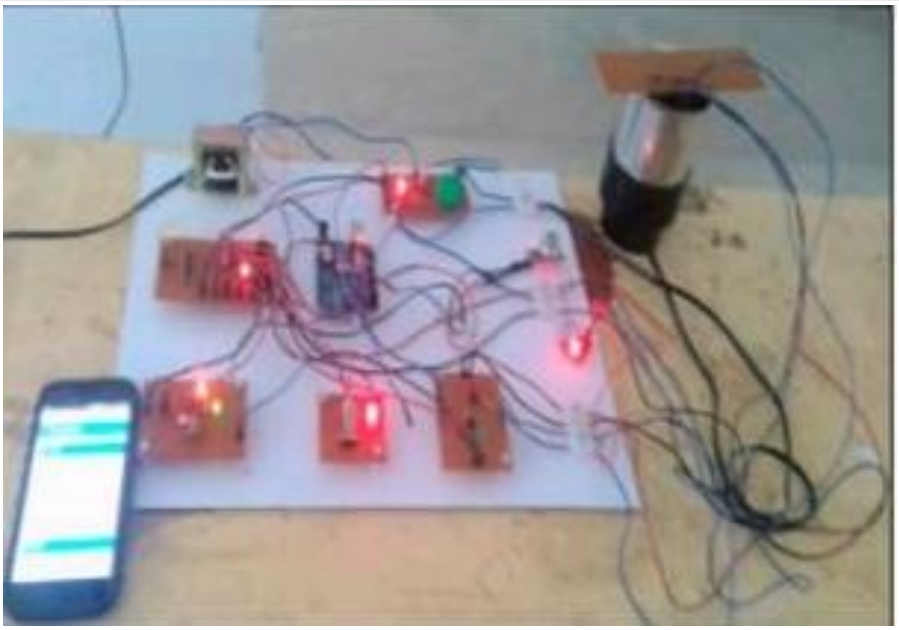

Figure 12Prototype Model

8. Results and Discussions

In this paper, monitoring and control over flow system is proposed. The feedwater flow can be controlled in a better way by using IOT. By using IOT, instead of other communication control system it has been easier to achieve higher speed of control with low power consumption. If it is needed, we can also include additional three elements in the boiler drum. The three parameters such as temperature, pressure and humidity of feed water in the boiler drum can be controlled using this current IOT technology. It is easier to monitor and control most of the parameters in boiler drum.

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