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# Automation of boiler process at thermal power plant using sensors and IoT

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**Abstract**

Internet of Things is the new era for industrial automation to produced quality products, by implementing automation in accordance with the existing man power at low cost. Despite the use of Distributed Control System or Programmable Logic Controller (DCS/PLC) in Thermal Power Plants, controlling parameters like temperature, humidity and pressure is a critical and essential process, and require a well-organized and trained labor for the completion of tasks without any mishappening. This paper focuses on developing a

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smart simulation and automated system to makes use of modeling and pattern discovery along with the data mining techniques to collect data from the thermal power plant. Each boiler is attached with each other through a sensor which in turn is connected to an IOT driven application at remote location. The sensors work on a specific pattern depending on the possible situations that may arise while the plant is in process. The same pattern is recognized in a simulated environment with the help of modeling technique. The message passing service in the whole system makes the working of the automation project prone to accidents since modification can be made according to the environment conditions. This paper also tends to propose an idea for an IOT device that provides a virtual knob facility to adjust the parameters of the furnace from the remote area.

***Subject Classification:*** *(2010) 68U99*

***Keywords:*** *Automation, Internet of Things, Thermal power, Simulated, Sensors, Modeling, pattern.*

## 1. Introduction

In the past decade there has been an extensive increase in the area of Industrial automation. Over the past few years, machines have taken the command of the manual tasks and reduced the mental as well as the physical presence of the human at the location. Thermal Power Plant is one such process which requires regular inspection and proper management. Any change in the parameters controlling the power plant should be reported directly to the central controlling area for required amendment [1].

The boiling section of the thermal power plant produces high temperature steam due to which it often becomes resistant to operate from the site. Moreover, gone are those days when labors used to stand at a particular location for hours and manage the complete process. Though, there has been some work in the area for automating the boiler processes, each research study show that there had been some drawbacks at each step.

### 1.1 *PLC / DCS System*

Distributed Control System (DCS) was used to centralize the digital binary information produced at each boiler level as an output of the logic statement stored in the memory of Programmable Logic Controller (PLC). Though PLC was a bit outdated automation technique but the slow scanning time of DCS allowed both of them to be used together [3]. Testing of problems at subsystem level was much more economical than at the centralized level, however, the cost effectiveness in the whole system could not be achieved.

### 1.2 *Embedded System and GSM Technology*

This system generates an identification number to measure the current temperature of the boiler even when offsite using GSM technology. The operator has to make sure that the location is set to permanent on condition for receiving SMS. There is still requirement for a team to be present to complete the manual task [2].

### 1.3 *Dynamic Optimization of a Boiler*

This work was initiated to attempt a study of boiler behavior under abnormal operating conditions. It made use of an improved control system to optimize the dynamic performance of a dynamic plant behavior. An online digital computer was incorporated whose function is to compute or predict the form of optimal or suboptimal control action, based on present or future output states of the system [3].

Internet of Things has gained attention from modern technology fields due to its effect in automation. Seeing the complex structure of power plants, it has certainly become necessary to provide a method that could sustain the energy resources method at the lowest direct human interaction level. The era of machines is to be utilized to the best of its knowledge providing a better platform for building a brighter technical future.

This paper gives an idea on how the whole boiler process could be converted into a smart simulated system and controlled with the help of sensors and automated IoT devices. The modeling and pattern discovery are used as data acquisition techniques for collection of data from the thermal power plant. This data is send with the help of sensors to an IoT device that is attached at the centralized remote location. The parameters of the boiler could be controlled with the help of a virtual knob system depending upon the situation at that instance of time [4-9].

## 2. The Concept of Boiler

Thermal Power Plant is a renewable energy resource which produces power with the help of water and steam. What matters the most in a thermal plant is the boiler which is used for the conversion of water into steam. It has been a job of high labor and risk to manage the tremendous pressure as well as the heat. For betterment, we have provided a way of automating all the processes but some practical knowledge about the working of boiler is mandatory for complete understanding [10, 11].

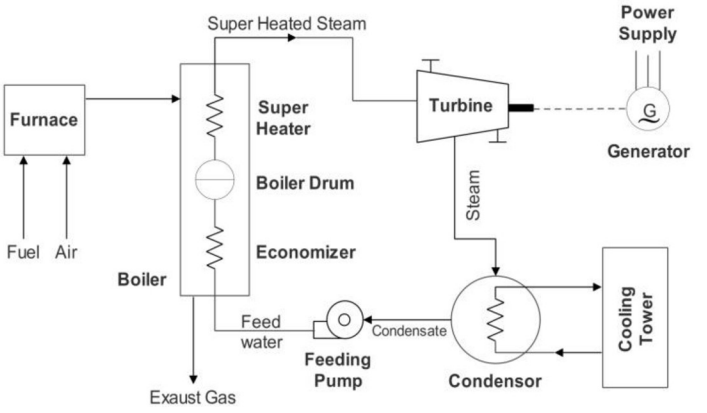


**Figure 1**

**Working of a Boiler**

2.1 *Working Principle of the Boiler*

A boiler is a closed vessel into which water is heated, until the water is converted into steam at required pressure. Fuel is burnt in the furnace and hot gases are produced. These hot gases come in contact with water vessel where the heat is subsequently transferred and steam is produced in the boiler [11].

The basic principle, how easy it seems involve various factors to be kept in mind while managing the proper flow of heat to the boiler and then the flow of steam from the boiler. The steam generated is then moved forward through various valves until the turbine is rotated with the force that is imparted on it.

2.2 *Need of Manual Work*

Considering the present scenario of thermal power plants, it is more towards the era of automation but still in a developing phase. The operator has the responsibility to adjust or override automatic settings in the context of monitoring the status of the plant. The degree to which these decisions are automated varies across various processes in the thermal power plant. The act of balancing these input parameters requires highly skilled laborious operators who could deal with the situation instantly. Plant operators are again required at the time of soot blowers within the boiler. Due to combustion, soot is formed over the tubes of the boiler which reduces the amount of heat transfer to the water and hence reduces the efficiency of the plant [12][13].

Though there are soot blowers for the purpose but still some manager is needed at the spot to control the system. It is evident that plant operators have a significant impact on the efficiency of the plant as a whole. Therefore, we need a manageable resource that could handle all the manual operations, critical or normal, with a right approach at that particular instance [8, 10, 12].

This paper sets a better example of how a system can be revolutionized while considering only the smallest details. Internet of Things could be understood as the central idea around which the whole theory rotates.

## 3. IoT exploited for Automation

IoT in general can be defined as the interconnection of things with each other via internet. The devices so connected could be anything, like, part of a daily house hold routine to huge machines in industries, a lamp post on the street to the concept of smart cities and its virtual implementation. By combining these connected devices it is possible to gather information, analyze it and create an action. IoT is all about networks, devices and data [6].

Typically, internet of things has sensors and software that enable the collection of data via internet. IoT objects can be controlled remotely to allow direct integration with computer systems, which results in improved efficiency for the users. A system of such massive interconnection would have significant benefits, allowing universal access to information and forged transparency on governments [5, 6].

With IoT, it is possible that a phone rings the morning alarm and simultaneously sends a message to the coffee machine to make coffee. The coffee machine, if required, could also directly order ingredients from the grocery store and get it filled up automatically. On the other hand, a shopping application can track user's phone location in due course of time. Companies use this data to target individuals with special offers for their favorite shops and products.

The exploitation of internet of things for automation has brought certain privacy and potential alerts along with it. Since it is not easy for the IoT driven devices to connect to each other, there are certain security issues that are required to be addressed. The additional needs are emerging for standardization. Ultimately, what makes internet of things exciting is that the exact use cases of IoT is still unknown and it has the potential to have a major impact on our lives [5].

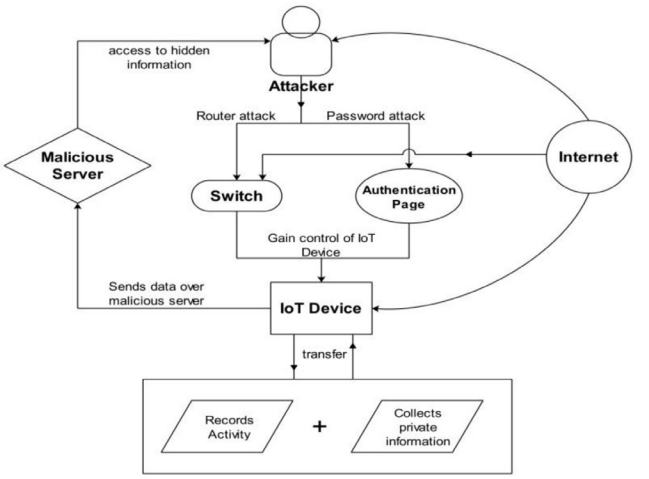


**Figure 2**

**IoT Exploited**

## 4. Conversion of Manual Task to Automated System

Though the use of an automated system is much more convenient than dealing with all the situations manually, it takes great effort to convert a complete manual task into a system that can manage everything on its own. There are several instances to be understood while building up a system. The data required for its proper functioning is to be collected from various resources and fed into the system [2, 5]. The basic idea that has to be kept in mind is the general flow among different working modules that make up the entire cyclic process starting form one part of the crew till the end [8].

The core of this paper is the process of how automation is developed in thermal power plant using sensors and IoT. The obvious flow of data is represented in the form of data flow diagrams – whole automated system and the IoT application. The complete process is divided into two parts – first one comprises of how the conditional data is transferred from the environment to the IoT application till the output in the form of changed state. The second part consists of the processes that take place within the simulated application for pattern recognition and full synchronization.

### 4.1 *Working of complete system with IoT and automation*

The sensors are present in the environment near each boiler. The systems will automatically instantiate the process by sending the initial

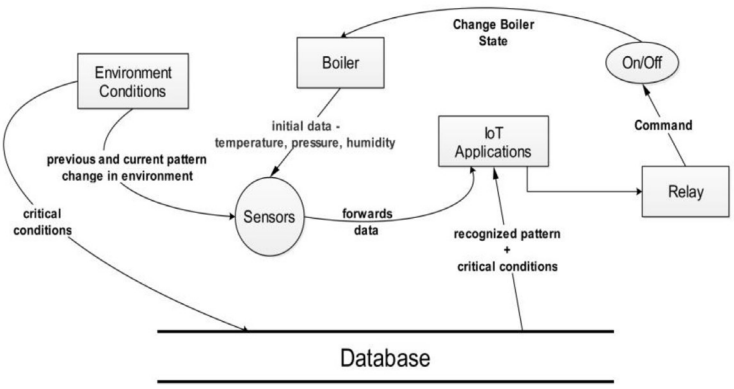


**Figure 3**

**Data Flow Diagram of automated system**

parameters of the boiler such as temperature, pressure, humidity and the working conditions from the environment. The data is then forwarded to the IoT application which is a simulated version of the actual thermal power plant installed at some remote location [2].

The application in turn undergoes some processes, synchronizes the data from the sensors with the data stored in the database. Then a command is generated in the form of output to a relay which acts as an on or off switch for the boiler. The state of the boiler could be changed from minimum to maximum, according to the affecting conditions of the environment [2, 7]. Therefore, the efficiency of the whole system is increased reducing the cost required for labor as well as minimizing the manual task.

### 4.2 *Inside IoT Application*

The model simulation process is the main head of all the tasks undergoing within the application. It is the part which signals the relay to alter the state of the boiler. Pattern recognition depicts the pattern matching condition with the current environmental conditions for future references of the boiler to work. The data is then forwarded to the model part [7]. The complete test of the conditions and its synchronization with the database is done in another module. The synchronized data is again forwarded to the model and simulation part. This module processes the entire operation and generates a command as an output of the application. Based on this, the relay alters the state of the boiler or completely cuts off the supply for the working boiler [6, 8, 11].

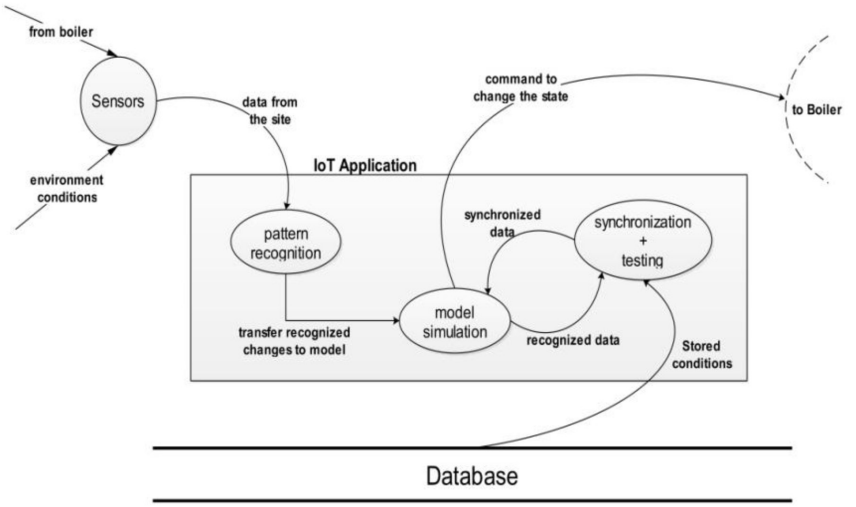


**Figure 4**

**Process within application**

## Conclusion

This paper focuses on the automation of boiler processes in thermal power plant using IoT. To the extent of the current knowledge, the paper represents a wonderful idea along with the complete flow of data from one end of the system to the other end. Considering the previous works being done in the field of study, the paper also mentions about the drawbacks of those processes.

Internet of Things is imagined a very advanced area for research purpose. But the origin as well as its exploitation is descriptively covered in the paper. It also briefs about the working principle of the boiler and actual requirement of labor in the power plants, which sometimes become mandatory. However, more attention is paid to the conversion of manual task to automated system; the other processes are also explained in a well-oriented manner.

Hence, the above mentioned details about the working of an automated system will provide help in maintaining the efficiency of the entire power plant without compromising with the cost required to manage the resources. The further study and research in this respect of industrial automation is indispensable.

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