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Remote Operation and Monitoring of Power plant Equipment using IOT Environment

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Abstract: The main components of power generation in thermal power are boiler, turbine and generator. In addition to these main components, there are some auxiliary systems like electrostatic precipitator, static excitation system, Ash disposal pump house system etc. This paper is based in ESP (Electro static precipitators). Majority of Indian thermal power stations have ESP for as the collection. An Electro Static Precipitator (ESP) is a device that removes dust particles from a flow gas (such as air) using the electrostatic attraction force of an induced. The control and monitor process of ESP by manually. The main aim of the project is to control and monitor the operation of power plant equipment (ESP) by using IOT environment. Internet of things (IOT) is the latest and more advantageous technique used in remote controlling process. "IOT" is all about physical items talking to each other, where machine-to-machine (M2M) communications and person-to-computer communications will be extended to "things"

Keywords: **ESP, IOT, Turbine, M2M, Ash disposal pump house system.**

I. INTRODUCTION

In thermal power plants, the burnt ashes of coal are sent through stack after it has been precipitated. At present ESP (Electro Static Precipitator) is used and it is been monitored in control room and controlled manually on field. The signal are based on relays which it is brought to cable to the control room. To make the ESP automated and to control and monitor automatically a new wireless ESP Control system is proposed to develop as prototype. The traditional signal acquisition systems are mostly by wire, i.e., the sensor connected acquisition system by cable. When measuring point is dispersed and hidden, especially when we control and monitor large complex equipment, it needs a large number of cumbersome cabling work, For the traditional wiring methods not only affect the reliable operation of equipment, but also extend signal acquisition time, so it is difficult to meet safety requirements. It requires manual presence to shut down the plant. Short Distance. To implement real time Control and monitoring system by wireless, various sensors and motors are connected to GPIO and processed by ARM Micro processor, the data is stored on SQlite. A Light http server runs on the ARM board process the Data received from GPIO.

II. ELECTROSTATIC PRECIPITATOR

The principle of an electrostatic precipitator (ESP) is an device that removes dust particles from a flowing gas (such as air) using the force of an induced electrostatic attraction .it is used to control atmospheric pollution caused by fly ash ,to meet statutory requirement of pollution control (maximum permissible 150mg/Nm cube),to get fly ash as a byproduct.

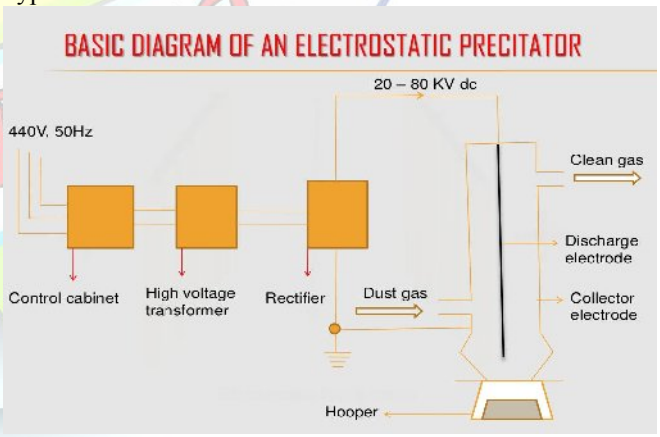

Fig.1 Electrostatic Precipitator

Precipitator components

All electrostatic precipitators, regardless of their particular designs, contain the following essential components:

- Discharge electrodes
- Collection electrodes
- High voltage electrical systems
- Rappers
- Hoppers

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- Shell

1. Discharge Electrodes

Discharge Electrodes are either small-diameter metal wires that hang vertically (in the electro-static precipitator), a number of wires attached together in rigid frames, or a rigid electrode-made from a single piece of fabricated metal. Discharge electrodes create a strong electrical field that ionizes flue gas, and this ionization charges particles in the gas.

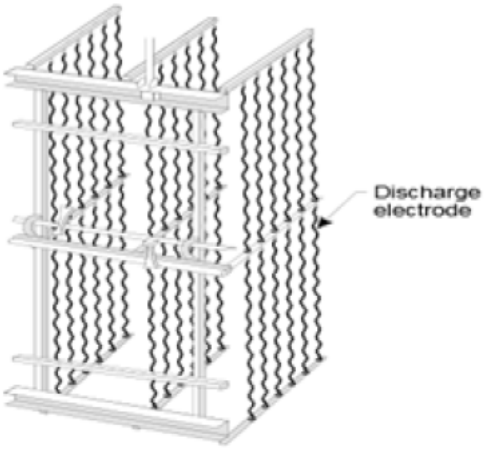

Fig.2 Discharge Electrodes

2. Collection Electrodes

Collection electrodes are collect charged particles. Collection electrodes are either flat plates or tubes with a charge opposite that of the discharge electrodes.

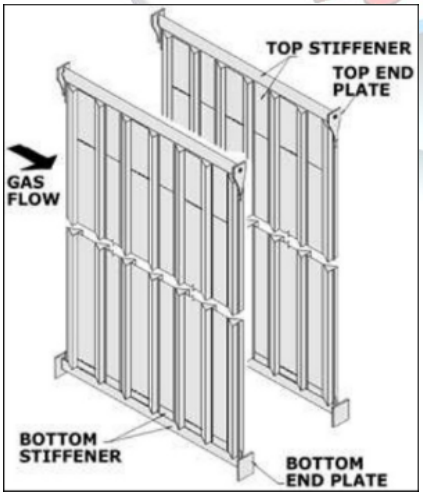

Fig. 3 Collection Electrodes

3. High Voltage Equipment

High voltage equipment provides the electric field between the discharge and collection electrodes used to charge particles in the ESP.

4. Rappers

Rappers impart a vibration, or shock, to the electrodes, removing the collected dust. Rappers remove dust that has accumulated on both collection electrodes and discharge electrodes. Occasionally, water sprays are used to remove dust from collection electrodes.

Fig. 4 Rappers

5. Hoppers

Hoppers are located at the bottom of the precipitator. Hoppers are used to collect and temporarily store the dust removed during the rapping process.

Fig. 5 Hoppers

6. Shell

Shell provides the base to support the ESP components and to enclose the unit. A typical ESP with

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wires for discharge electrodes and plates for collection Electrodes. This ESP is used to control particulate emissions in many different industries.

III. PROCESS OF ESP

The main process of Electrostatic Precipitators is ash collecting process in thermal power plant. The combustion of coal, lignite are produced a mixture of as fog, smoke, etc., that can be passed to the ESP through Turbine. The gases are produced to the chimney. The ash will be entered into the ESP. Now, the high negative power supply is applied to the electrodes. The ESP contain vertically placed metal wire act as anode and horizontally placed metal plate act as a cathode. Due to this process the ash will be allowed to the ESP. the metal wire repel the ash particle and the metal plate cathode attract the ash particle. The ESP contains two servo motors one is collecting rapping motor and emitted rapping motor.

If the motor is on the rapper will be rapping are vibrating the metal plate. Now the ash will be collected. The whole process in ESP has 24 panels the 24 panel can be controlled by EPIC Controller by using high voltage transformer (HVRT). Now the whole process can be control manually by using wired medium (cable). Our process is used to control the whole process from remote area without using any wired medium.

IV. INTERNET OF THINGS (IOT)

"IOT" is all about physical items talking to each other, where machine-to- machine (M2M) communications and person-to-computer communications will be extended to "things". Key technologies that drive the future of IOT are related to smart sensor technologies including WSN, Wi-Fi nanotechnology, and miniaturization. Since IOT is associated with a large number of wireless sensor devices, it generates a huge number of data. Sensor data acquisition interface equipment is one of the key parts in IOT applications. Data collection is the essential application of WSN and more importantly it is the foundation of other advanced applications in IOT environment. Today commonly accepted definition for IOT is "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network".

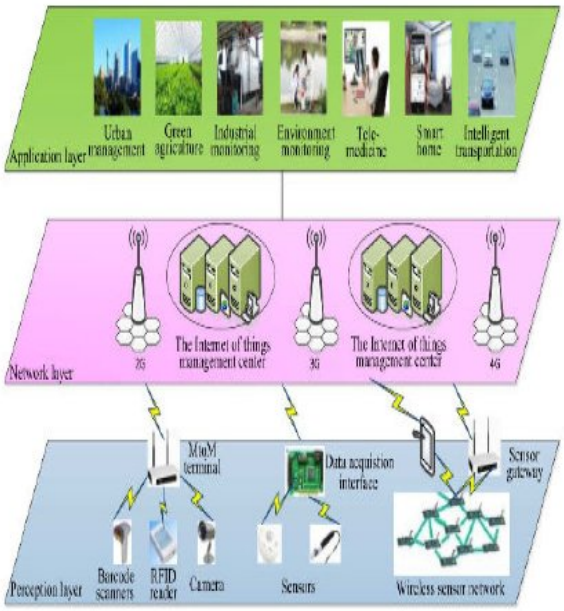

Fig. 6 Internet of Things in various applications

V. ESP on Field with IoT Environment

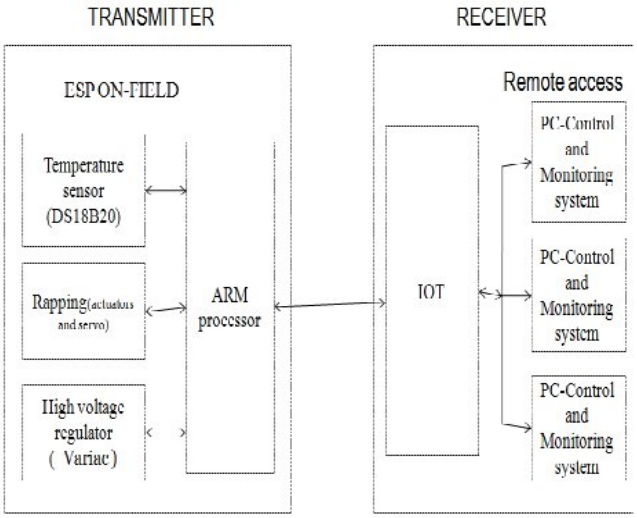

Fig.7 Remote Operation of ESP on field

The ARM board is powered with 5V; it supplies the required powered to Temperature sensor, the ultra sonic sensors, ARM processor. The ARM processor runs on Linux (ARCH). The wireless module is connected to the USB on the ARM board. The sensors are located in appropriate process area and connected to the GPIO of the board via

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Relays. The ping test is done to check the healthiness of the system.

Additional 12 v power is supplied to servo motor and the ground is connected to the ARM board where the control signal is provided for the servo. The data received from Temperature sensor, ultra sonic level sensor is stored on SQlite database. The servo acts as a rapper which raps the ashes from the electrode. The time delay was programmed in the micro processor.

The light httpd which runs on ARM microprocessor acts as a web server, and the scripting is done on python where the logics are written based on the input received from the various sensors. The router plays a major role in creating a network between the ARM board and the User PC Which is used as a monitoring and controlling system.

Requirements

- Processor – ARM
- Temperature sensor – DS18B20
- RAM – 512MB
- Hard Drive (Data Logger) – 8 or 16 GB
- Wireless – Wi-Fi b/g/n
- Servo Motor – Tower Pro SG90 mini (Gear Motor)
- Level Sensor – Ultra sonic Level Sensor
- Operating system – Linux
- Interface – Relay
- Programming Language – Python
- Web server – Light Http

V. IMPLEMENTATION OF IOT ENVIRONMENT IN ESP

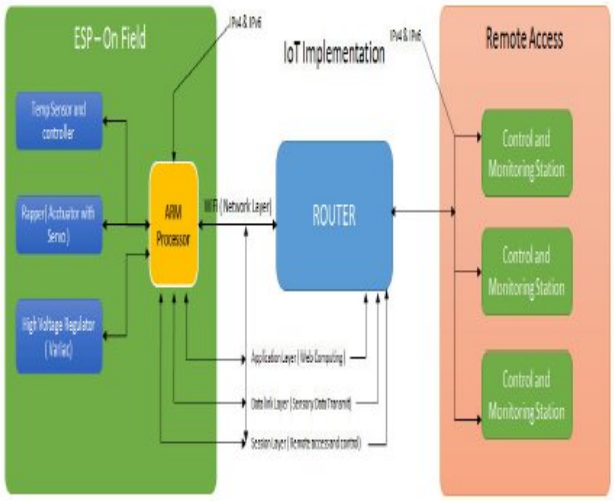

Fig. 8 Implementation of IoT in ESP

Layers of IoT

- **Data Link Layer -** It is the lowest layer IoT can be considered as a worldwide physical interconnected network.
- **Network Layer -** It provides basic networking support and data transfer over wireless network by using internet.
- **Session Layer -** It is used for remote access and control.
- **Application Layer -** For web computing process. It provides user interface for using IoT.

VI. WI-FI Module

For IOT implementation in ESP Wi-Fi module is used. The Wi-Fi Shield allows an ARM board to connect to the internet using the 802.11 wireless specifications (Wi-Fi). It is based on the HDG204 Wireless LAN 802.11b/g System in-Package. An AT32UC3 provides a network (IP) stack capable of both TCP and UDP. Use the Wi-Fi library to write sketches which connect to the internet using the shield. The Wi-Fi shield connects to an ARM board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top.

The Wi-Fi Shield can connect to wireless networks which operate according to the 802.11b and 802.11g specifications. There is an onboard micro-SD card slot, which can be used to store files for serving over the network. The onboard micro-SD card reader is accessible through the SD Library. When working with this library, SS is on Pin 4. ARM Board communicates with both the Wi-Fi shield's processor and SD card using the SPI bus (through the ICSP header). This is on digital pins 11, 12, and 13. On both boards, pin 10 is used to select the HDG204 and pin 4 for the SD card. These pins cannot be used for general I/O. Digital pin 7 is used as a handshake pin between the Wi-Fi shield and the ARM Board, and should not be used.

VII. CONCLUSION

Thus the operation and monitoring of Electrostatic Precipitators in Thermal Power Plant is done by using IOT environment. IOT is used to control the ESP and its equipment from the remote area. By using this technology we used to reduce the problem and distortion occurs in cable/wires due to reduce the cable installation. Hence monitoring and controlling of process can be performed through the PC right from the desk. Moreover Internet of

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things requires low maintenance cost, problem can be easily identified and more flexible can made in the system without terminating the process.

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BIOGRAPHY

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