Automation of coal bunker using arduino controller

Sapthika Parthi.P[1], Hemavigasini.T.R[2], Sarulatha.R[3]

email: pspeie@nandhaengg. org[1], hemavigasini1061@gmail. com[2],sarulathar1997@gmail. com[3]

Assistant Professor[1], 3UG student[2,3]

Department of Electronics and Instrumentation Engineering

Nandha Engineering College (Autonomous), Erode-638052

Abstract- *Coal bunkers are used for the purpose of storing coal in industries. Then the coal stored in the bunker sent to the furnace. In order to increase the life span of boiler and to maintain the accuracy automation is required. Automating the system also reduces the manpower and non-linearity in coal supply. Automation using Arduino controller instead of PID controller is presented. Real-time sensors are used for sensing main parameters like level, temperature, etc.*

Keywords— Coal Handling, Arduino Controller, Coal Bunker

I. INTRODUCTION

Coal is used as main fuel in many industries. The layout of Coal Handling System should be simple, reliable and with low maintenance. Coal is brought to industries by two ways i.e., roadways, railways and they are unloaded with the help of wagon tippler in a coal hopper. The movements of wagons are controlled by automatic in-haul and out-haul battle chargers. This coal is then fed on coal conveyor belt through vibrating feeder. These feeders are of electromagnetic type and controls the rate of feeding required for bunkering. The coal is sent to the surge house after the ferrous materials like stones, woods were removed manually.

From the surge house, coal is fed to the coal crusher through a mechanical feeder. Here the coal is crushed to the size of 20-25 mm. The coal is then sent to the coal bunker through conveyor belts and finally reaches the coal trippers and stored there for further processes like combustion in boiler furnace. This cycle is known as bunkering cycle. If bunkers are full or coal is not required due to any reason on units, then coal is diverted to the stack yard with the help of stacking conveyor belts. This cycle is known as stacking cycle. If coal is not available from any means of coal transportation and coal is urgently required for the unit, then the stacked coal is diverted to the bunkers with the help of reclaiming belts. This cycle is known as reclaiming cycle. Nowadays, this stacking and reclaiming of coal is done with help of an automatic stacker cum re-claimers. Hard coal and brown coal are the main energy carriers in coal-fired power plants. Delivered by train, the coal is unloaded into bunkers up to 30 m high. The coal then goes through a moderate grinding process and then is stored in the coal bunker.

II. OBJECTIVES

✓ To automate the coal handling system using Arduino controller.

✓ To provide optimum control to the system.

III. SYSTEM ANALYSIS

A) EXISTING SYSTEM

In the existing system to shut down the process the PID controller is used. Only one parameter controlled by single PID. To provide appropriate control, PID controller takes bunker level as the input parameter and control action to the conveyor belts as the output parameter.The input is sensed by the ultrasonic sensor and it is communicated with the help of cables. The output was send to the DC motor to stop or start the conveyor. These are the basic parameters and operations of existing system.

1383

Sapthika P P et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–06(02) 2018 [1382-1387]

B) DRAWBACKS

- When PID controller is used alone, it can give poor performance while PID loop gain is reducing, so that the control system does not overshoot, oscillate or hunt about the control set point value.
- They also have difficulties in the presence of non-linearity's, and regulation versus response time, it do not react to changing process behavior, and have lag in responding to large disturbances.

C) PROPOSED SYSTEM

In this project PID mechanism is performed by Arduino controller. Level and temperature are taken as the input parameters and actions of DC motor as the output parameter. The input is sensed by ultrasonic sensor and thermocouple. Then the output is sent to the DC motor to stop or start conveyor belt. In this system we have two set points. One for temperature and another for level. Once the set point reached, the door will automatically closes to stop the coal feed into furnace.

D) ADVANTAGES OVER EXISTING SYSTEM

- System is more flexible.
- This requires low cost, when compared to PID controllers.
- Programming arduino controller is simpler.
- It's easy to change or rewrite programmable.
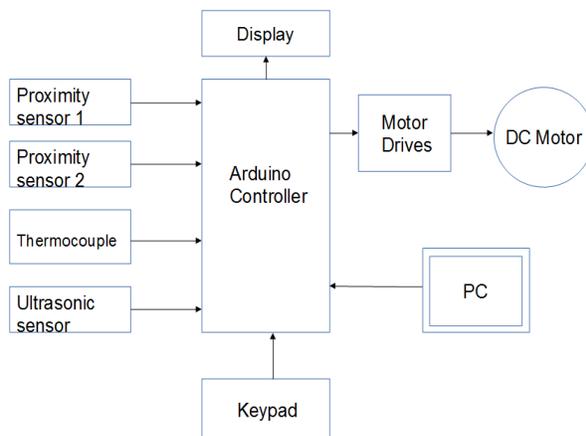
IV. BLOCK DIAGRAM

Fig.1 Block Diagram

The proximity sensors, thermocouple, keypad and ultrasonic sensors are acts as input devices and motor drives and LCD are output devices. PC is used to program the arduino controller. The signals of proximity sensors an thermocouple are very low to be sensed by arduino controller. So a signal conditioning unit is needed to boost the signals. Then the boosted signals will be sent to the arduino controller.

V. HARDWARE REQUIREMENTS

A) ELEMENTS USED

   a) Arduino MEGA
   b) Thermocouple
   c) Proximity sensor
   d) Ultrasonic sensor
   e) DC Motors
   f) Keypad
   g) LCD Display
   h) PC
   i) Relays

B) ARDUINO MEGA 2560

This board based on the ATmega 2560 microcontroller. It has 54 I/O ports (15 of I/O pins can be used as PWM outputs), 16 analog inputs, 4 UARTs, a crystal oscillator, a USB connection port, a power jack, a built-in voltage regulator. It has everything needed for a microcontroller. We simply need to connect the board with the PC and start programming. This board is compatible with most shielded design.

The controller can be programmed with the Arduino IDE. The ATmega2560 comes pre-programmed with a boot loader that allows us to upload a new program into that controller without using external programmer. It communicates using the original STK500 protocol. The ATmega2560 has 256kb of flash memory to store the code(8kb is used for boot loader) 8kb of SRAM and 4kb of EEPROM.

1384

Sapthika P P et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–06(02) 2018 [1382-1387]

C) INPUTS AND OUTPUTS

➢ The ATmega2560 has 54 digital I/O pins. They can be used as an input or output, using PinMode(), digitalWrite() and digitalRead() functions. They operate at 5v. The recommended operating condition is 20mA for each pin. Some pins have specialized functions:

- Serial TX and RX (4 pins)
- External interrupts (6 pins)
- PWM (15 pins)
- SPI (4 pins)
- LED (1 pin)
- TWI (2 pins)

➢ The ATmega2560 has 16 analog inputs, each provides 10 bits of resolution. There are some other pins also present on the board:

- AREF
- Reset

D) PIN DESCRIPTION

Pin No	Name	Description
1	RESET (bar)	Resets and clears the memory
2-6, 11, 12	PORTD	8 bit bi-directional I/O port
9, 10, 14-19	PORTB	8 bit bi-directional I/O port
23-28	PORTC	8 bit bi-directional I/O port
7	VCC	Digital Supply Voltage
8,22	GND	Ground
20	AVCC	Analog Supply Voltage
21	AREF	Analog Reference Voltage

Table.1 Pin Description

E) THERMOCOUPLE

Thermocouple is used for measuring boiler temperature. It has many types as type K, J, T, E, N, S, R, B. We are using Type K thermocouple. Type K thermocouples are widely used in industries because of it's wide range of temperature measurement and low cost. It measures temperature in a range of -270°C to 1260ºC. Power supply is given to thermocouple in order to sense the temperature of boiler coal. The output signal of thermocouple is given to the signal conditioning circuit because the output voltage of thermocouple is too low to be picked by Arduino controller. The voltage from the signal conditioning unit is given to the Arduino controller as input.

F) PROXIMITY SENSOR

Proximity sensor can detect objects without physical contact. Their operating principle is based on a high frequency oscillator that creates a field in the close surroundings of the sensing surface. The presence of a metallic object in the operating area causes a change of the oscillation amplitude. The rise or fall of such oscillation is identified by a threshold circuit that changes the output state of the sensor. The operating distance of the sensor depends on the actuator's shape and size and is strictly linked to the nature of the material.

G) INDUCTIVE SENSORS

Sensitivity when different metals are present. Sn = operating distance.

Fe37 (iron)	1 x Sn
Stainless steel	0.9 x Sn
Brass- bronze	0.5 x Sn
Aluminum	0.4 x Sn
Copper	0.4 x Sn

Table.2 Operating distance

Here inductive type proximity sensor is used for controlling the door of coal dumper and coal hopper. A steel plate rotating with 360 degree controls the door. Above that steel plate 1 inch metal lead is placed. The metal lead is sensed with proximity sensor with 0.4 mm sensitivity range. After the rotation the pulse gets generated. The proximity sensor measures the opening and closing of coal dumper and coal hopper door with reference to boiler temperature and coal level.

H) ULTRASONIC SENSOR

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a

1385

Sapthika P P et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–06(02) 2018 [1382-1387]

sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. To detect the level of the coal in coal bunker, ultrasonic sensor is used. The ultrasonic sensor is placed above the coal bunker. Once the level reaches the set point, the coal supply from the coal hopper to coal bunker is stopped.

I) DC MOTORS

DC motors are used to control the conveyor belts and crank mechanism of the doors of coal dumper and coal hopper. Arduino controller sends signal to the driver circuit and the driver circuit drives motor through relay switches.

J) SIGNAL CONDITIONING UNIT

Signal conditioning is manipulating the analog signal in such way that it meets the requirements of the next stage for further processing. Signal conditioning can perform amplification, filtering, converting, range matching and isolation. It amplifies the output signals of thermocouple and proximity sensors as able to be detected by Arduino controller.

K) LCD

Liquid Crystal Display displays the set point and current stage of the system.

L) PC

PC is used to program the Arduino controller. We can modify the program or control the system through PC

M) RELAYS

Relays are used for activating 12v DC motor.

VI. SOFTWARE REQUIREMENTS

A) ARDUINO IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board. Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions. Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. We can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

B) PROTEUS8

Proteus is a simulation and design software tool developed by Lab center Electronics for Electrical and Electronic circuit design. It also possess 2D CAD drawing feature. It deserves to bear the tagline "From concept to completion".
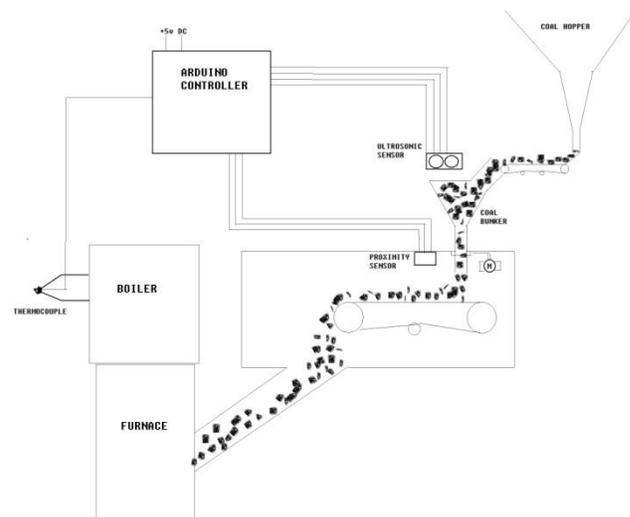
VII. PROCEDURE

Fig.2 circuit diagram of the proposed system

The coal comes to the coal hopper after crushed to the minimum size. From coal hopper the coal sent to the coal bunker. Conveyor belts carry the coal from coal bunker to coal hopper. The coal supply to the bunker should be stopped when the coal bunker gets completely filled. For this action, an ultrasonic

1386

Sapthika P P et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–06(02) 2018 [1382-1387]

sensor is placed above the coal bunker to continuously measure the level of the coal bunker. The supply will be stopped when the ultrasonic sensor reached its set point. This can be done by sending signals to the DC motor drive using arduino controller. When the level is below the set point, the motors start to run again to fill the coal into the coal bunkers to reach set point.

The coal from the coal bunker is sent to the furnace through feeder. Boiler temperature increased by the heat produced in the furnace. Boiler temperature continuously monitored by the thermocouple. The coal supply will be stopped after boiler reached the required temperature. Thermocouple sends signal to the arduino controller when it reaches the set point. Arduino controller sends signal to the motor drives of conveyor belt and coal bunker door. Then the coal supply to the furnace will be stopped. Again the signals sent to the drivers when the boiler temperature decrease below the set point temperature and the coal supply to the furnace will be started.

VIII. RESULT
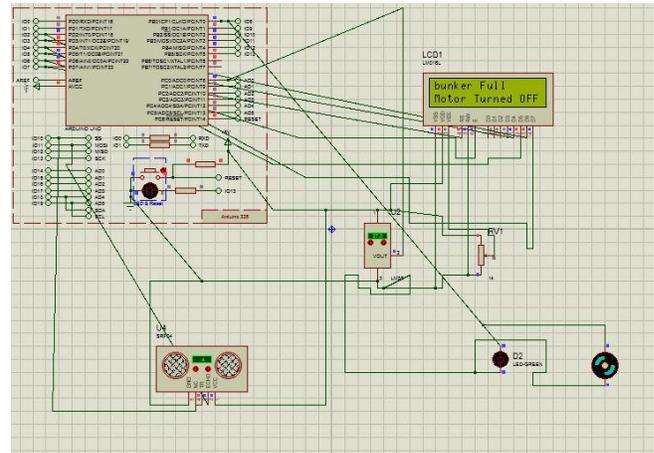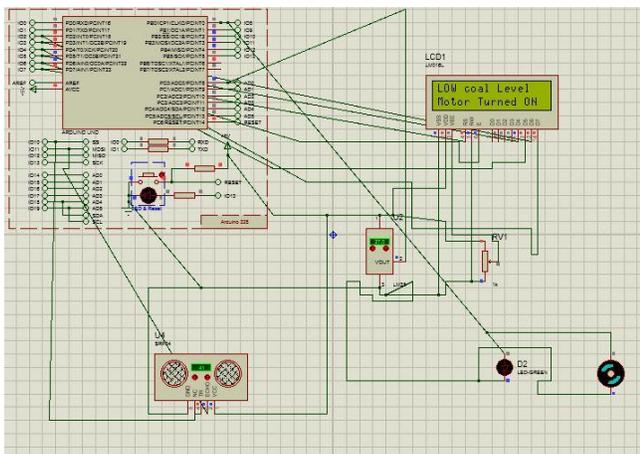
Above diagrams shows the simulation of the proposed project. If the coal in the coal bunker decreased below the set point value the motor will turned ON and the coal will be filled in the bunker.

If the coal level reaches the set point, the coal supply to the bunker will be stopped. Hence this project compensates the coal level in coal bunker.

IX. CONCLUSON

This paper has presented the method to control the coal dumping process using arduino controller instead of PID controller. By this method all the parameters can be controlled using a single controller. The movement of coal from the coal hopper to the furnace can be controlled by a single controller. Less complicated programming can be possible by this method.

REFERENCES

[1] Ahmed El Shafee, Kareem Alaa Hameed (2012) 'Design and Implementation of a Wi-Fi Based Automation System ', International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol. 6 No 8, pp.452-461.

[2] Allcock W., Bester J., Chervenak A., Liming L., and Tuecke S,(2003) 'GridFTP: Protocol extensions to FTP for the grid', Global Grid Forum GFD-RP, Vol. 20, pp.375-382.

[3] Arora N. and Kumar D. (1997) 'Analysis of steam and power generation systems in the thermal power plant', Vol.34, pp.795-799.

[4] Gu Y. and Grossman R.L (2007) 'UDT:UDP-based data transfer for high speed wide area networks', Computer Networks, Vol.51 No.7, pp.1777-1799.

[5]Khosravi F, Azli N., and Babaei E. (2010) 'A New Modelling Method for Reliability Evaluation of Thermal power plants', IEEE Int, Conf. On Power and Energy, Kuala Lumpur, Malaysia, Nov 29-Dec 1, pp.555-560.

[6] Tolle K.M. and Tansley D.S.W,(2011) 'AJG: The fourth Paradigm: Data intensive scientific discovery' Proc. IEEE, Vol.99 No.8, pp.1334-1337.

[7] Rozita Teymourzadeh, Salah Addin Ahmed, KokWai Chan and MokVeeHoong (2013) 'Smart GSM Based Home Automation System', IEEE conference on Systems Process & Control.

[8] HoudovaLenka, Lucy Houdova, Jelinek L., and Janecek E. (2010) 'Approach to solving the task of Availability Prediction and cost optimization of a steam turbine', 32nd Int. Conf. On Information Technology Interfaces, Cavat, Croatia June 21-24, pp.629-634.