Heating Arc Furnace with Human Machine Interface

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ABSTRACT

The industrial heating furnace (IHF) necessitates continual temperature monitoring and management because little changes can substantiallyinfluence the system. Traditional controllers employ PID (proportion, integral, and derivative) and typical tuning techniques.The human machine interface (HMI) is used to communicate data between the operator and the machine. The best appropriate controller for temperaturecontrolled systems is determined via time domain and error criterion analysis.The best controllers have the shortest rising time, setup time, and overshoot.HMI integration in factory automation boosts productivity and system efficiency.

Keywords-Human Machine Interface (HMI), Industrial Heating Furnace (IHF), Proportion, Integral And Derivative (PID)

I.Introduction

As we all know, technological advancements are increasingly increasing the requirement to correctly detect temperatures in a variety of locations.A furnace is a device that is used for heating materials in industries.The furnace will generate heat by combining fuels and air.Industries employ furnace equipment to melt metals, combine two metals, forge (shape) metals, galvanize, enamel (coat glass on metals), and so on.Household furnaces, metallurgical furnaces, and industrial furnaces are examples of furnace types[1].

Temperature regulation is a critical component of the industrial process at IHF.This temperature control can thus be accomplished using a typical PID controller [2].Many classic tuning approaches are available to determine the gain settings for this PID controller [3].

Based on a comprehensive literature review, we can infer that the PID controller has become the most extensively used controller in a variety of application domains due to its simple form and ease of implementation. These features allow the PID controller to adapt to changing system dynamics and improve its performance over time.

Additionally, the PID controller's ability to handle both linear and nonlinear systems makes it a versatile choice for a wide range of applications

[4].PID parameters and temperature data from RTD and Thermocouple will be saved.The temperature of the plant may be kept stable by using a PIDloop in a 16bit controller. Ziegler Nichols closed

loop approach can be utilized for PID control.Manual tuning and auto tune PID are two temperature control methods.The control parameters in manually adjusted PID are established manually by studying the characteristics and behavior of the controlled unit[9].

The PID controller is a popular feedback network tool due to its clarity, ease of implementation, and ability to reduce the difference between process variables and set points. It offers zero steady state error, fast response, short rise time, no oscillations, and higher stability. PID controllers are preferred over PI controllers due to their reduced overshoot and employability for higher order systems [5].

Furthermore, because of their simplicity and ease of control, the fuzzy self-tuning PID control algorithm and the fuzzy immune PID control algorithm are more feasible in the temperature control of the heating furnace in many industrial heating furnaces [1].

A human machine interface is a component of an electronic machine or a device that seeks to exchange information between the user and the machine.HMI is made up of three parts: operating elements, a display, and an inner framework.Inner structure compasses and software displace and transfer information about the machine to uses such as tropical and operational elements transfer information from the operation to the machine application.HMI are becoming an integral aspect of factory automation, aiding in productivity and system efficiency. In order to see the status of the furnace, the temperature of the furnace is monitored by a graphic LCD. The real-time temperature is displayed on the graphic LCD, and commands are given through the touch screen to control the parameters of the furnace.

The HMI (Human Machine Interface) allows for simple control and monitoring of temperature and time values. It has a userfriendly interface where operators can change the upper and lower limits to meet their specific needs, and it also provides realtime feedback on the current temperature status, ensuring accurate and efficient system control.

The paper contains Section II PID Controller, Section III Rasberry pi, Section IV working of HMI, Result in Section V, Section VI Conclusion.

II.PID Controller

PID is the most often used type of closedloop controller design, and it is used in this paperPID controllers, when properly tuned, can improve system stability, minimize response time to the reference value, and reduce steady state error to zero.

PID Closed-loop Control A proportional-integral-derivative (PID) controller is a generic feedback controller widely used in industrial control systems that calculates and reduces an error value, e(t), as the difference between a measured process variable, y(t), and a desired set point, v(t), to a minimum degree by adjusting the process control inputs. The altered variable, u(t), is then utilized to activate a final control element that directly acts on the process variable. The PID control action in a feedback control loop is represented by the block diagram in Fig. 1.
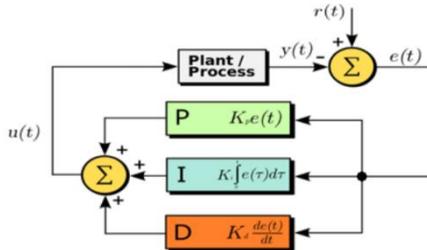

Fig.1.PID Controller

A proportional-integral-derivative (PID) controller is a type of control loop feedback mechanism (controller) that is commonly employed in industrial control systems. PID control is a proven control approach that has been utilized for many years. The best controller for a temperature-controlled process is found using the results of time domain and error criterion analysis.

This algorithm has three distinct constant parameters. It is also known as a three-term controller. Where P is the current error, I is the accumulation of previous errors, and D is a forecast of future errors based on the current rate of change. It is widely utilized in the chemical industry due to its high rate of success in practical applications, robustness, and simplicity. The PID temperature control method is used for practically all loop control in the process industries and serves as the foundation for many advanced control algorithms and strategies. A PID temperature controller generates an error signal by monitoring the current temperature and adjusting the output to get it closer to the target temperature.

The major alternative for temperature PID controller is an ON/OFF controller, which functions similarly to a thermostat. The best controller for a temperature-controlled process is found using the results of time domain and error criterion analysis. The best tuned controlled technique is identified as a good outcome of lowest rising time, setting time, and overshoot [7].

III.Raspberry Pi

The Human Machine Interface (HMI) allows for simple control, and a PID temperature controller is a popular option. It measures current temperature, generates an error signal, and adjusts output to achieve a target. The ON/OFF controller, like a thermostat, is the most suitable for temperature-controlled processes.

The Raspberry Pi, a credit-card-sized computer, is used in this project as a microcontroller. Python is the main programming language, as it supports GPIO modules. Raspberry Pi has 26 pins, 17 of which can be used as GPIO pins. These pins can provide voltage of 0V or 3.3V, and are typically used for communication between Raspberry Pi and other devices.

IV.Working of HMI

The Human Machine Interface (HMI) is used for simple control in the furnace industry. A PID temperature controller measures current temperature, generates an error signal, and adjusts output to achieve a target. The main alternative is an ON/OFF controller, which functions like a thermostat. The most suitable controller for temperature controlled processes is determined through time domain and error criterion analysis.

The system monitors and controls temperature in the furnace industry, plotting temperature versus time on a real-time graph. A touch screen is used to set test points and communicate between the machine and human. Figure 2 shows the proposed work of industrial heating furnace temperature monitoring.

For the development of the system, ARM 9 is used. The sensor used to read the temperature is a PT 100, which is an industrial standard sensor. The ADC is used to provide input to the ARM. The graphical LCD is used to plot a real-time graph of the temperature versus time ARM 9's inbuilt RTC is utilised.
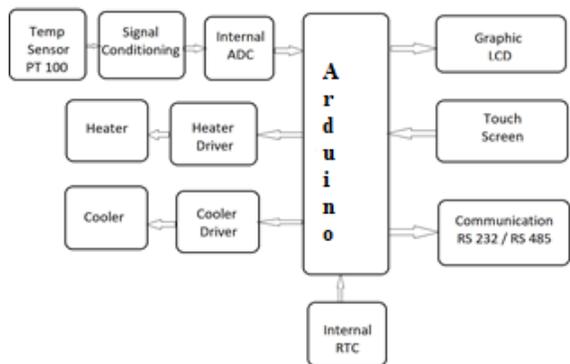
Fig. 2. Block Diagram

Touch screen is an interface for changing the value of set points, and another way to communicate with the machine is through PC communication, which is done through the 232 for controlling action against temperature systems that employ heaters and coolers in various industrial applications.

A.   Flowchart of system

After configuring all devices connected in the system, we proceed to set the desired temperature values for the metal. Once the system is started, we can monitor the status on the screen and patiently wait for the final process to complete
After configuring all devices connected in the system, we proceed to set the desired temperature values for the metal. Once the system is started, we can monitor the status on the screen and patiently wait for the final process to complete. This process can be repeated for subsequent cycles to ensure accurate result as per in figure 3.

Time-Domain Response Analysis

The system sets real-time upper, lower, right, fall, and full temperature values through a touch screen. It calculates right time for temperature rise, fall time, and full time for stable temperature. The system controls coolers and heaters, sending temperature data to the PC via RS 232 communication.

V.Hardware Result

Table.I Increment Table for temperature of furnace

Sr.No.	Set Value	Actual Value	Heater Status
1	100	80	Heater ON
2	120	120	Heater ON
3	130	125	Heater ON
4	130	135	Heater OFF
5	130	120	Heater ON

Table.II Decrement Table for temperature of furnace

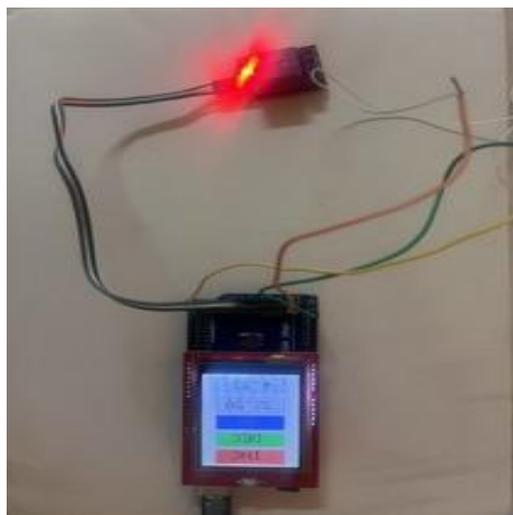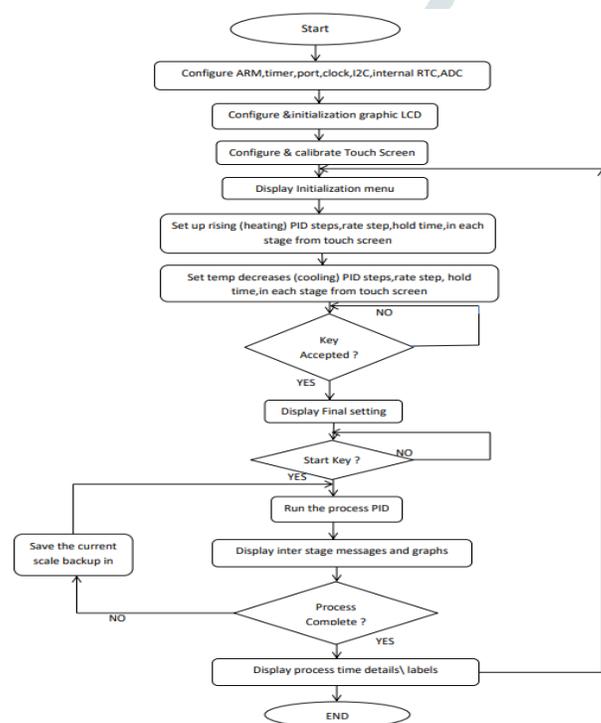| Sr.No.	Set Value	Actual Value	Heater Status
1	130	140	Heater OFF
2	120	123	Heater OFF
3	120	110	Heater ON
4	110	115	Heater OFF
5	100	100	Cooler ON

Fig.3 Hardware Impelmentation

Fig.3.flow chart of HMI System

VI.Conclusion

As temperature-controlled operations, the Human Machine Interface (HMI) enables for simple control, and a PID temperature controller is used. The time domain response using HMI offers the operator easy control, and this dada is sent to the PC for further usage. It takes the current temperature, generates an error signal, and changes the output to meet the goal. The ON/OFF controller, which functions similarly to a thermostat, is ideal for temperature-controlled processes. PID controllers offer automatic tuning, which attracts the attention of industrial users. PID controller tuning is a broad study field with nearing experimental and theoretical results. HMI designs can be tailored to a variety of channels and users.

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