Industrial Process Control Using PID Algorithm

Soham Dani[1], Abhishek Murgeson[2], Snehal Sahare[3], Mrs. Bharati Masram[4]
[1,2,3] *UG Students, Department of Electronics and Telecommunications Engineering, YCCE, Nagpur*
[4]*Assistant Professor, Department of Electronics and Telecommunications Engineering, YCCE, Nagpur*

***Abstract*- The idea is to design a cost efficient incubator box which is primarily used to hatch eggs by controlling it's temperature and humidity with the help of PID algorithm. By setting the set point values of temperature and humidity on Nextion Human to Machine Interface (HMI) touchscreen one can set the desired value for the parameters to control. PID algorithm is developed which is nothing but a software code which will check for each instant that the process variable value being fed back to the controller is greater than or less than the desired set point value and perform controlling action given to the actuator so as to achieve desired temperature and humidity. Actuator circuit used is an electromechanical relay which will perform switching operation as soon as the process variable goes above and below set point. Glass heater tube is used as an heating element which will be connected to the relay whereas a motor pump and DC operating fan is used to generate humidity and to distribute it inside incubator box.**

Index Terms- Actuator, Human to Machine Interface (HMI), Process Variable (PV), Proportional Integral Derivative (PID), Set Point (SP).

I. INTRODUCTION

An incubator is an insulated enclosure used to grow or hatch various types of bird eggs, to treat premature infants by maintaining inner environment with proper oxygen levels, temperature, humidity, CO2 levels, etc and also to grow microbiological cells or its culture. Every application requires different parameters to control and maintain. We have designed an egg incubator which will control temperature and humidity inside and try to maintain at certain value with the help of PID algorithm. Proportional Integral and Derivative (PID) algorithm acts as a logical component of software code which will check at every instant that the process variable increases or decreases beyond the set point value and tries to control it with the help of commands given by microcontroller to the actuator circuit. Microcontroller being constantly receiving feedback from DHT22 sensor which measures both temperature and humidity changing values and acts instantly for both the process variables deviation from the set point. Along with the set point values, instantaneous changing values of process variables are also displayed on HMI interface so that one can monitor the controlling action. This enables the user to change the set point as desired for hatching different types of eggs.

HMI touchscreen is serially interfaced with the microntroller which will allow user to see instant feedback for every change in the process variable. User can change the set point value with the HMI interface which will be modified inside the software code. HMI display has its own processor and memory, and has its editor software for designing graphical user interfaces using simple drag and drop components present in the software. It helps to create an application oriented user interface which would be much more simple to use.

Incubator box is build using a wood boards and metal plates by joining wooden boards at the edges and are attached with the help of screws. The door to open or closed the box consists of a see through glass with the help of which one can verify that the heater element is working properly as well as to monitor eggs until they are hatched. To completely seal the door after closing, Styrofoam is attached at the edges at the front which becomes an effective way to completely isolate the eggs from outer environmental effects. It consists of three pipes out of which one is for inlet, one to provide flow of water and one is the outlet. To generate humidity water is pumped via 220v motor which would be present inside the water tank and a humidifier is implemented as the water enters into the pipe it is poured down from holes and is soaked by a cloth resulting in humidity to rise. Simultaneously excess of water is drain out from the outlet pipe. A 12V DC operating fan is used for

distribution of humidity inside the box pivoted at the upper wall of the box at the centre. For generating temperature a glass heater tube is used as a heating element which is connected via electromechanical relay to the microcontroller.

II. METHODOLOGY

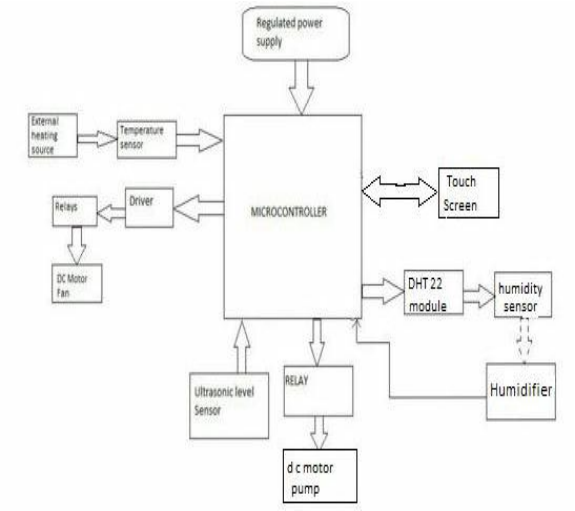

Fig-1 Schematic of Hardware components

The above figure shows input and output signal flow from hardware components to microcontroller and from microcontroller to other devices. Microcontroller received input from the user that are the set point values for temperature and humidity which will be displayed on HMI and gives commands to the relays to perform control action based on feedback obtaining from DHT22 sensor module. The arrows indicate the mode of communication between the microcontroller and other hardware components. The electronics used in the project is placed on the incubator box and only DHT22 sensor is placed inside the box for feedback of process variables.

To obtain a regulated power supply components like rectifiers, filters and IC7805 voltage regulator is used to provide constant DC voltage for the components interfaces on printed circuit board. An adapter is used to give 220v to 12v output for the operation of fan and a direct wire connection is given to the 220v relays.

After deciding the hardware components to use the programming is done by creating an algorithm of how the controller will perform the controlling action based on software code written. Each step of input to the microcontroller, process variable change, feedback, actuator circuit performing controlling action based on rise or fall from the set point value will contribute in generating the algorithm of the software code. The program flowchart is given in following figure.

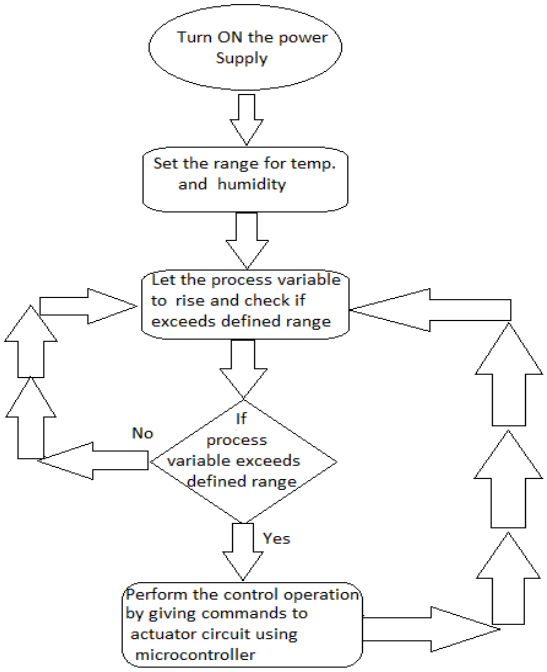

Fig-2 Program Flowchart

It indicates as user will set the desired values for the set point it will be fed to microcontroller to initiate the process and will wait initially for the process variable to rise if it is low or decrease if it is high. As the process variable value changes controller will give command to the actuator to perform controlling action and bring the variable value to the set point. This is an endless loop action since parameters are variables which will continuously rise or fall but it fluctuates above or below the set point value and so it is required to be maintained unless it always achieves set point value.

III. WORKING

As the power supply is turned on the HMI screen will display the user interface showing to set the values having up and down buttons for temperature and humidity to increase and decrease respectively. Set point values are stored inside HMI to display and is encoded and transmitted in terms of ASCII values

into the microcontroller which will wait for process variable values to change.

Consider for temperature, as the temperature value rises and goes beyond the set point the microcontroller will command actuator which is an electromechanical relay here to switch on the glass heater tube and let it rise so as to achieve the set point value. As soon as the value goes just a degree above the set point controller switches off the supply for the tube and let's it to fall to set point.

Since at the same time humidity is also set by the user and microcontroller simultaneously waits for humidity to change from set point value. DHT22 sensor used measures both temperature and humidity and sends the calibrated analog signal to the microcontroller. As humidity occurred to be low by the sensor microcontroller commands DC operating fan and motor pump to switch on there operation to generate more humidity. The water being pumped by the motor travels through a pipe fitted inside and has holes inside which pours down the water on a cloth which can hold water for some time which will help to increase humidity at a faster rate. The motor being continuously pumping water, incubator has an outlet so that water can be drained out and also another outlet to let air inside the pipe so that water should not remain steady it should be poured through the holes. Fan is desired to rotate at its full speed to distribute the humidity so that if eggs are placed each egg should get same moisture to grow which increases the amount of eggs being hatched after same time period. When relative humidity rises above set point value controller switches off the supply of fan the motor pump.

Considering the inverse relationship between temperature and humidity if temperature is more water will evaporate at a faster rate here there are two other variables forcefully changing the humidity by pumping more amount of water and distributing the air. The sensor used to measure temperature and humidity has sensitivity of 0.1degree Celsius and 0.1% Relative Humidity which increases the speed of response. Since for the application like eggs hatching there are standard values which are always higher than the normal temperature and humidity and varies for each types of birds.

IV. IMPLEMENTATION

Fig-3 Hardware Implementation

V. RESULTS

The HMI screen will display each integer value change in process variable as well as for the set point value we have added a waveform for humidity change and indicating status of low or high values for both the parameters.

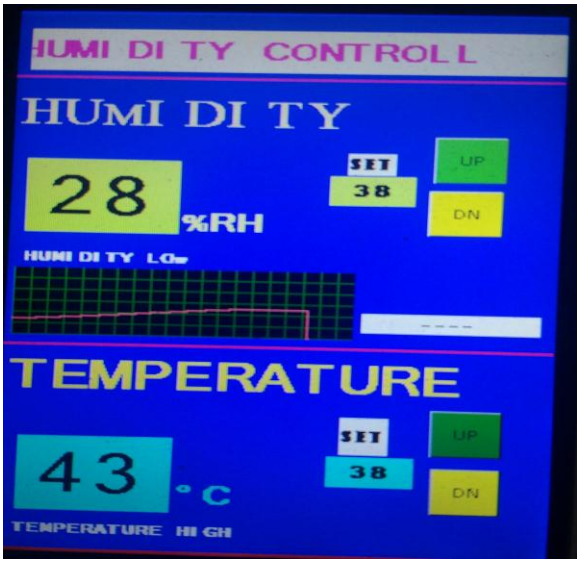

Fig- 4 Display of temperature above set point and humidity below set point.

Relative humidity measured is below desire value so microcontroller will give command to actuator circuit to increase and graphically touch screen shows the increasing value of humidity. However for temperature gone beyond set point controller has turned off the heating element.

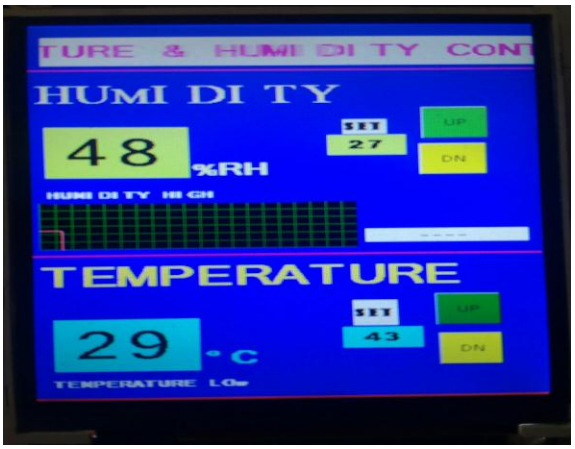

Fig-5 Display of temperature below set point and humidity above set point.

At this state temperature is below set point so heater element will be switched and remain in on state and motor pump, fan will be switched off to decrease humidity.

VI. CONCLUSION

Thus by building a cost efficient incubator small scale poultry farmers can hatch eggs and increase there scope rather than buying a large, costly and high electricity consuming incubators. The water consumption can be controlled by using a 12V motor but the time require to achieve the set point value will be compromised.

REFERENCES

[1] Zain-Aldeen S. A.Rahman, Farahan S. A. Hussain, 'Smart Incubator Based on PID Controller', International Research Journal of Engineering and Technology (IRJET) , Dept. of Electrical Techniques, Technical Institute/ Qurnah, Basrah, Iraq, Volume: 04 Issue: 03 | Mar -2017.

[2] Omar Jones, 'DESIGN AND DEVELOPMENT OF AN EMBEDDED DC MOTOR CONTROLLER USING A PID ALGORITHM', Linköping /London 2010-06-15.

[3] https://www.elprocus.com/the-working-of-a-pid-controller/.

[4] https://www.backyardchickens.com/articles/homemade-chicken-egg-incubator-designs-pictures.47737/.

[5] https://www.britannica.com/technology/incubator