

A Supervisory Control System for Temperature and Humidity in a Closed House Model for Broilers

Alimuddin¹, Kudang Boro Seminar², I Dewa Made Subrata³, Sumiati⁴, Nakao Nomura⁵

Abstract— Broiler is a kind of superior race results of crosses of chickens nations that have high productivity power, especially in the production of broiler. In broiler rearing business, the temperature is a crucial factor in chicken rearing in tropical regions. Closed house is a system house that offers a solution to provide thermal comfort of broilers. Research objectives are: (1) to model the temperature distribution in the closed house using Computational Fluid Dynamics (CFD) and to model humidity using psychometric in the closed house; (2) to create a mathematical model that determines the transfer functions of temperature and humidity in closed houses for broiler; (3) to apply a supervisory control system in selecting the control mode (PI, PD, PID) temperature and humidity in order to stabilize temperature and humidity in the broiler house so that growth of broiler chickens in the broiler house can be improved. Data primary and secondary data. The primary data (floor, wall, room, and roof temperature) was obtained from measurements using electronic measuring devices. The secondary data (external humidity, temperature, radiation) that was obtained from the report provided by BMG Bogor. The simulation results shows the trend of temperature increase at the outlet regions (roof, wall, and floor outlets) of the broiler house. This is caused by the accumulation of heat due to convection cock blowing air flow towards the outlet. Validation was done by comparing the actual measured data and simulated data. The supervisory control model that has been developed has been validated. The validation shows that coefficient of determination of temperature regression (R^2) is 92%, standard deviation 0.0916, and coefficient of determination of humidity regression (R^2) is 91%, standard deviation 0.065. Response characteristics of PD, PI and PID yield rise time, spike, time resident, steady state error have been confirmed to comply with standard values.

Index Terms— Supervisory control, Temperature, Humidity, Modeling Closed House, Broiler

Manuscript submitted November 10 2011

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I. INTRODUCTION

The protein consumption of the Indonesian peoples are predicted to be increase as increasing the population. To meet that requirement it was considered necessary to increased the animal production especially the chicken in both quality and quantity. One source of protein is the broilers meat. The chicken broiler meat has relatively the same nutritional value as other cattle. Moreover, the broiler meat readily available and relatively cheap, because of the maintenance is relatively short i.e: about 35 days. Nowadays, the chicken meat consumption level of the Indonesian peoples are still low, due to the economic level and broiler production is still low. Population of broilers in Indonesia amounting to 930,317,847 tails [1]. Production of 530,874 tons of broiler chicken tail in 2000, 621,870 tons of tail in 2001, 865,075 2002, 847,744 tons of tails of 2003, 778,970 tons of tail in 2004, 779,108 tons of tail in 2005, 861,263 tons of tail in 2006, 941,786 tons of tail in 2007, 1018 .734 tons of tail in 2008, 1. 016.876 tons of tails in 2009 [1]. Indonesian chicken meat consumption level should be 1.1088 million tons per year. When analyzed is still no shortage of as many as 91 924 tons (45.962 million head). To produce 383 chickens a number of these require a closed house (broiler house) for broilers. This is due to good management and maintenance that have not been effective. Only a small portion of the farm folk who have to apply the appropriate maintenance management and followed by the application of technology. This is one of the obstacles in improving broiler population. Where as Indonesia has a good environmental conditions for the development of broiler chickens, especially the outside temperature is higher than body temperature of chicken. So the chances of broilers maintenance in Indonesia are still very wide open This requires modern technological systems of control systems. The development of control there are two kinds of control theory, namely the theory of classical control and modern control theory. Classical control theory is characterized by SISO (Single Input Single Output), whereas the modern control theory is characterized by the MIMO (Multiple Input Multiple Output). Thus the modern control techniques able to solve complex control problems. The fundamental problem in control system design is to design a control that is able to produce the output of the engine control according to desired specifications.[2] Control design process is increasingly complex as the complexity of the machine control and process

that will be set therein, including the application of multiple green house or closed house. As discussed above turns out to produce meat that is needed for the national level requires a lot of a closed enclosure can be managed and controlled in an integrated and synergistic. One of the modern control techniques that have the ability to control the number of closed house is supervisory control. Capabilities that could be developed supervisory control is a function of coordination, rotation, synergy, mode selection and control parameters involving multiagent method for controlling the parallel or sequential against a number of chicken houses that can be located geographic area. Supervisory control theory is the development of adaptive control systems consists of: the control of the gain scheduling, model reference adaptive control, adaptive control of self-tuning [3, 4].

Adaptation Theory supervisory control in discrete systems was first introduced by Ramade and Wonham at the University of Toronto, Canada which defines the robot model in discrete systems and control mechanisms supervisory that minimizes interference and control of multiple control units, one of which can be disabled [5]. Supervisory control must have sufficient information to make decisions on the control of each control unit. There are two things into consideration: first specifically provided locally that is, if a process is controlled by supervisory control [6] and second in general that if a process is controlled by several supervisory controls [7].

In a control system known as a dynamic system model in differential equations to model the machine control, then transformed in the form of Laplace's equation. System transfer function is defined as the ratio of the Laplace transform Laplace transform inputs to outputs. System transfer function is also a mathematical model that connects the input variables with output variables. [2,3,8,9,10,11,12]. Transfer function as part of the control parameters to generate the output control (PID, Fuzzy Logic, ANN). The purpose of this study was to design a supervisory control system on a number closed house for broiler.

Previous research related to modeling and control of environmental temperature and humidity in a closed house including; discusses the stable temperature of 33-35°C using ON-OFF control with sling psychometric measurements [13]; discusses the simulation of airflow patterns and temperature distribution in a closed house using computational fluid dynamics (CFD) result in environmental air conditions are based on measurements of temperatures of 32.7°C and 71% RH and temperature CFD simulations 33.1170 C-35, 9720C and 49.712% -71.119% humidity [14]; discusses the use of ON-OFF control of the closed house with a temperature of 21°C and humidity of 60% in summer and winter [15]; study using ON-OFF control occurred two seasons of summer and winter, summer temperatures in a sealed closed house 26°C, humidity 70%, winter temperature in the closed house 34°C, humidity 70%, and ammonia <25ppm [16]; discusses the adaptive control of temperature, humidity nonlinear in cattle pens pigs which consists of two winter and summer, in winter temperatures 22°C, humidity 70%, wind speed 1 m/s and summer temperatures 26°C, 70% humidity, wind speed 3.7 m/s [17]; discusses the ON-OFF control of the closed house with a temperature of 20-30°C, ammonia 20 ppm, humidity 40-70%, 430 -2480 ou/m³ smell, the air speed of 0.14 m s, pH

6-7 ppm, CO₂ 0.25% [18]; The results of this study indicate that in order to simulate the temperature changes at the closed house for broiler using an empirical mathematical model based on the law of thermal equilibrium. The temperature in a closed house is determined by ventilation and construction materials. The model produces accurate temperature tendency towards a certain time. Which is an average temperature measurement and temperature prediction 24.43 24.40 and humidity 60%-90% with a correlation coefficient R² 0.978 [19]; research results on the hierarchy of control can be performed supervisory centralized, decentralized to the multi-agent product systems it. This indicates that the behavior of multiagent product can be controlled separately and simultaneously to each agent [20]; discusses the home system supervisory control plants (green house) has been developed and tested with cucumber plants. The results of development and testing are the work function control and objective criteria based on user preferences. This gives greater flexibility to the user to overcome the constraints of varieties or environmental conditions, type of plant must be controlled in house plants, hardware, and the type of control mode [21]; criticism of the design of information systems at the house for broilers with ANN discuss the optimization of the temperature in the enclosure 18°C-32°C with the protein in broiler chickens 9% - 60% and an average weight of 2 kg [22]; Modeling Temperatures in enclosed cages for broiler with Computational Fluid Dynamics (CFD) results in the distribution of yield variation 2.818 standard deviation of temperature preference, the standard deviation of the temperature of the floor 2810, the standard deviation of 2.022 wall temperature and temperature standard deviation roof 2.051.[23]. In this study conducted three times scenario of a period of 5 days starter, grower and finisher of 25 days 30 days. Input temperature fluctuates from 29 to 34.2°C in a sealed enclosure, the temperature set point 28°C, a temperature of 30°C. This control output using ANFIS control system with temperature measurement and simulation validation with error 0.18313.[24]. Previous research described above is still using a broiler house and a control mode. While studies using supervisory controls designed to control some of the broiler houses and several modes of control.

II. MATERIALS AND METHODS

Materials

The research was conducted among others in the laboratory of Bioprocess Control Engineering University of Tsukuba Japan, Instrumentation and Control Laboratory Faculty of Agricultural Technology and the University of Farm Closed House Cikabayan Bogor Agricultural University from January 2009 to April 2011. Materials used consist of as many as 20,000 broilers, closed house systems that exist in the research field with a length x width x height width is 120 m x 12 m x 2.5 m, chicken feed, drinking water, using computational fluid dynamics software (CFD), 2/2/30 & fluent gambit 6.2. Tools used include: sensor of kestrel 3000 for measuring temperature, humidity and air velocity, A set of computers and peripherals, weather station, One set of broiler house with insulation systems, exhaust fans 8 units, evaporating cooling

of 2 pieces, heater as much as 2 pieces, temtron as much as 2 pieces, place of drinking water, place chicken feed. For supervisory control simulation PD, PI and PID using Matlab version 7.

Stages of research are as follows: the first (development stage) study of a closed system of the broiler house for broilers with these steps: a). formulation of models to move heat and mass balance in a closed system of the broiler house room, b) simulation of moving heat, air flow, air velocity and humidity using a CFD using psychrometric c) measurements of temperature, humidity and temperature control room without an environment with 30-minute intervals for 9 hours by the time morning afternoon and evening measurements of humidity and temperature of the room and retrieval of data around the model building irradiated broiler house, the measurement of air velocity, e) to validate the model to move heat, absolute humidity and the mass that has been created and calculate the value of the correlation and error. numerically solve the formula method Euler-order differential equation with Laplace transformasi to control and simulate the transfer function supervisory control with matlab version 7.0. In this phase include identifying the needs of the control parameters in a closed cage environment, the study of systems of supervisory control (SCS). Next is the architectural design of SCS which continued with the development of all modules (components) SSK form of knowledge modules (climatic and environmental, chickens, control, I/O), the module SCE (Supervisory Control Engine) which contains instructions supervisory control and control, the module selection of user preferences (user interface module). Functional testing modules that have been developed SSC done with computer simulations with test data (variable control and control modes) are prepared, so that each response and the output generated by the module components can be checked SSK truth, (the test phase and implementation) includes preparation of interconnection and integration of SSC covered by the building enclosure. Observations that have been integrated system performance is focused on measuring temperature and humidity.

Methods

Mathematical Modeling of Dynamic Systems Control Temperature and Humidity in a broiler house. Assumptions used preformance modeling concepts of temperature and humidity are: 1) floor and air temperature in the broiler house uniform, 2) air humidity in the henhouse uniform, 3) ambient air temperature and humidity uniform, and 4) environmental conditions surrounding the broiler house following physical factors, which influence the chemical as a result of interaction between environments with broiler chickens, 5) steady state of the fluid system is a fixed time interval, 6) forced convection (force convection), 6) Numbers constant coefficient of air (specific heat, conductivity and viscosity constant air). Accordingly, to predict the temperature and relative humidity are arranged in a mathematical model broiler house under the law of energy balance as follows:

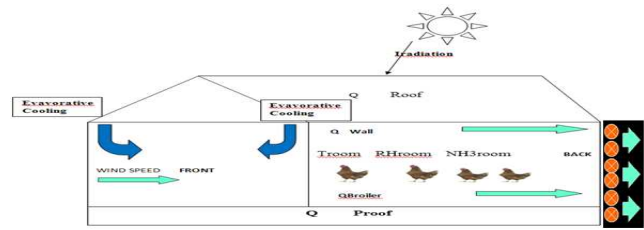


Figure 1 Schematic Concept Modeling Temperature and Humidity in a Broiler house

The room temperature (Troom)

$$m c_p \frac{dT_{room}}{dt} = h_1 A_{floor} (T_{floor} - T_{room}) + h_2 A_{roof} (T_{roof} - T_{room}) + Q_{broiler} + Q_{fan} + Q_{env} \dots\dots\dots(1)$$

Floor temperature (Tfloor)

$$m c_p \frac{dT_{floor}}{dt} = h_1 A_{floor} (T_{room} - T_{floor}) \dots\dots\dots(2)$$

The roof temperature (Troof)

$$m c_p \frac{dT_{roof}}{dt} = h_2 A_{roof} (T_{room} - T_{env}) + h_3 A (T_{roof} - T_{env}) + \sigma A_{roof} T^4 \dots\dots\dots(3)$$

The wall temperature (Twall)

$$m c_p \frac{dT_{wall}}{dt} = h_2 A_{wall} (T_{room} - T_{wall}) + h_3 A (T_{roof} - T_{env}) + \sigma A_{wall} T^4 \dots\dots\dots(4)$$

Humidity

$$\frac{dH_p(t)}{dt} = \frac{m_{air} \nu_{air} (H_{ambient} - H_{room}) + H_{ev,cooling}}{m_p} \dots\dots\dots(5)$$

Mathematical model of the broiler house heating system described in the form of transfer function [25]. The working principle is developed by heating the Law of the first and the second Thermodynamics. Heat transfer in the case of space heating is the transfer of energy in the form of heat from a point of high temperature to the point that a lower temperature [9,26,27,28]. To warm the room needed a fluid (in the form of water, air or steam) that is heated in the heater with room air, the fluid will flow back to the heater to be heated again.

Referring to Figure 1, the heat used to warm the room comes from the latent heat of condensation of the fluid, which is a heat that is used by each unit of fluid to change its form. In this case, heat is used fluid is steam heat and the heat of condensation. If the room temperature for Troom (t), the vapor of the fluid will flow from the cooling evaporative into the room enclosure with a flow rate of heat flow Qflow indoor (heated air in the room). The existing temperature difference heat transfer results in a temperature broilers Troom is the room temperature, Twall is the walls temperature, Tfloor is the floor temperature, Troof is the roof temperature, room temperature and outdoor air (disturbance) the temperature Tambient.

Transfer function of Equation Temperature and Humidity

In modeling the control of Euler-order dynamic equations are formulated into a single transfer function. To find the transfer function of the temperature equation with a space heater in a closed control system with zero initial conditions. [11,25].

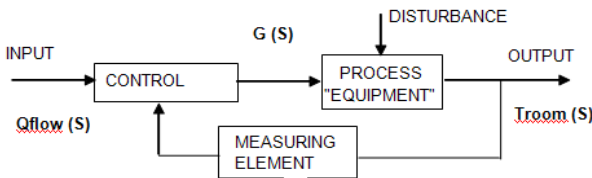


Figure 2. Closed Loop Control System

Subsequently sought from the output of Laplace transformation $Troom (S) = Qflow (S) G (S)$ of the inverse Laplace of $Troom (S)$ is $Troom (t)$.

In this case the transfer function for the temperature of the broiler house as follows:

$$G(s) = \frac{Troom (s)}{Qflow (s)} = \frac{6.804591 (s)+ 0.0007}{4.2 (s^2)+ 0.517 (s)+ \dots(5)}$$

To determine the performance of the system, then made a graph of output $Troom (t)$, disetelah know the graph of the system, given the control action on the system by using a model of PI control, PD and PID.

Changing in the indoor RH is calculated based on the assumption that the room air from the outside air is heated by building a broiler house. Air does not have additional water vapor due to evaporation of water from the chicken broiler assumed all sucked out. Then the model equations on a broiler house $Wm RH (t)$ is the controllable input variables, $Hambient (t)$ is an uncontrollable input variables and Hr is the output variable. Subsequently sought from the output of Laplace transformation $RHroom (S) Wflow (S) G (S)$ of the inverse Laplace of $RHroom (S)$ is $RHroom (t)$ To determine the performance of the system, then made a graph of output $RHroom (t)$, after knowing graph of the system, given the control action on the system by using a model of PI control, PID. Transfer Function for Humidity (RH).

$$G(s) \frac{RHroom(S)}{Qflow (S)} = \frac{16911.8161}{4.2s^2 + 0.517s} \dots\dots\dots(6)$$

System Supervisory Control Broiler House

Supervisory control system used to organize, coordinate, and integrate the control units. By adopting supervisory control system for greenhouse developed Seminar et al, (2006), then supervisory control architecture for broiler house broiler can be implemented as shown in Figure 3.

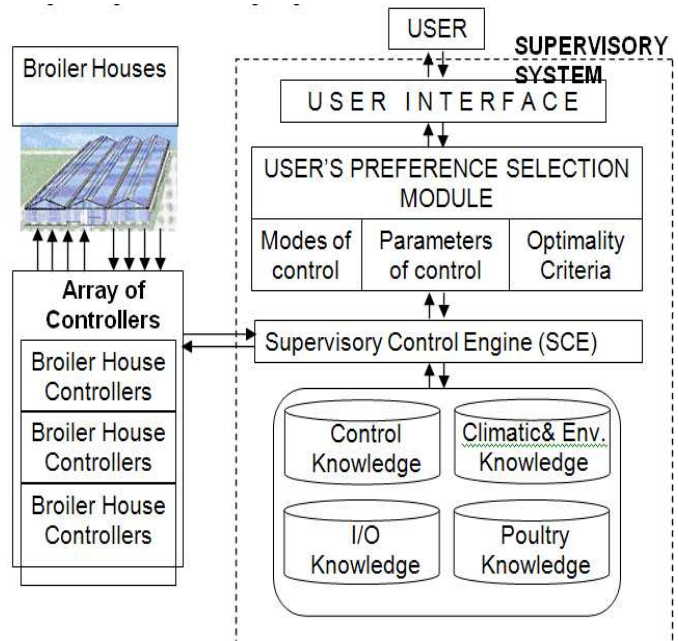


Figure 3. Architecture Supervisory Full House Closed For broiler chickens [21].

The architecture of control system for poultry supervisory with a closed circulation comprises a user interface, the user's preference selection module, supervisory control engine and knowledge module. Users interact with the system to perform supervisory control mode selection and variety of control variables with a variety of optimization criteria considerations. Supervisory control is to control some of the control process of mutual cooperation is not separated from one another. Supervisory control system used to organize, coordinate, and integrate cock control units.

Supervisory control is the coordinate system of control that occurs in a system. The working principle of supervisory control is coordinating the control system of control systems simultaneously and cooperate in control of the existing process that consists of one or more control processes in place that one or more than one place. Supervisory control system in various knowledge modules include: control knowledge can choose the mode of control (PI, PD, PID) in accordance with the purposes of environmental supervisory control farms that use two (PI and PD) or three (PI, PD and PID). Knowledge of climate and environment (dry season and rainy season) in the data base already available temperature and humidity are ideal in the dry season and rainy season, when the change of seasons there is no need to change the temperature of the dry and rainy seasons supervisory enough control that works that have been previously programmed automatic mode climate. Knowledge broiler houses (chicken weights from the starter, grower and finisher have been stored in the data base supervisory control, the amount of feed, the amount of drinking water). Knowledge Input/output (sensors, transducers, actuators) functions to store all the relevant characteristics and needs of such use of the sensor characteristics. The design has two parameters supervisory control temperature, humidity. In the climatic and environmental conditions in the dry season mode is used for temperature control of the PD, PI for moisture, while the rainy

season is used for temperature PID, PID for moisture. Reasons during the dry season temperatures humidity is very volatile, while the rainy season, temperature, humidity fluctuate. The next stage is simulated in both existing broiler house chicken starter-finisher period. Then compared with simulations in an empty broiler house without broilers. Design of supervisory control in the broiler house influenced by convection and conduction, irradiation by using the mode control that adjusts the climatic and environmental conditions that exist. For one variable using PI control mode, the PD and PID with one of the controlled temperature, humidity. The temperature is controlled in the morning using a PD, PID daytime, evening PD of starter, and finisher growth. Humidity is controlled in the morning using the PI, PID daytime, evening PD of starter, and finisher growth. If there is one broiler house harvest (no chicken) supervisory control can be used with other broiler house chicken begins to fill the stable, chicken without making the existing control mode because it works automatically.

III. RESULTS AND DISCUSSION

Model Validation Temperature and Humidity in broiler house

In comparing the simulation results validate the CFD model of the temperature and humidity with a psychrometric and field measurements of temperature and humidity. Temperature recorded during the experiment fluctuated range of 28⁰C-33⁰C. The data fed into boundary condition as an input in CFD is divided over three conditions in the morning, afternoon and evening for starter broilers.

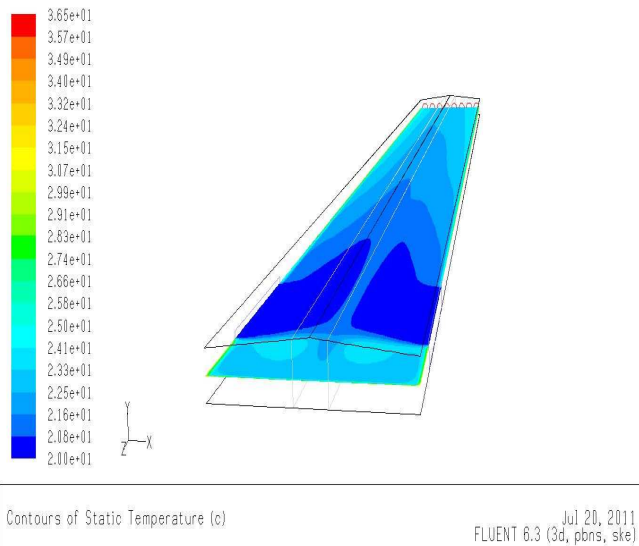


Figure 4 Scenario 1 for the age of broiler starter (Enlargement) on Morning at 09.00 (1-10 days)

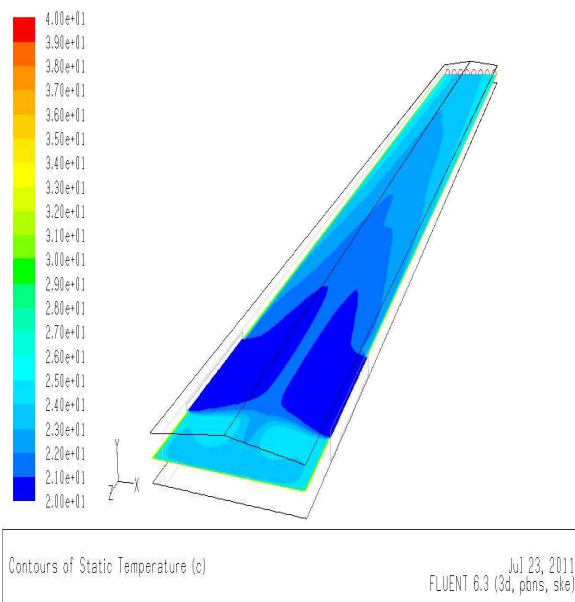


Figure 5 Scenario 1 for the age of broiler starter (Enlargement) Day at 12.00 (1-10 days)

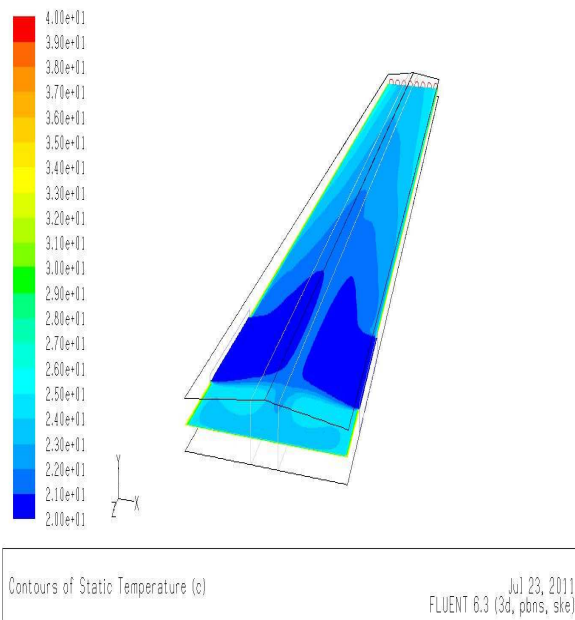


Figure 6 Scenario 1 for the age of broiler starter (Enlargement) Afternoon at 16.00 (1-10 days)

Figure 4, 5 and 6 scenario 1 above describes the morning spread room temperature 20⁰C-32⁰C environmental temperature (ambient temperature) 32.40 C 35.50 C temperature of the roof, the floor temperature of 330C, the broiler temperature of 40⁰C, wall temperature left and right 33 0 C , temperature of cooling evaporating 20⁰C -20.6⁰C. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler. The figure above is viewed from the roof-floor piece describes the X Z axis to the y axis. Time for lunch at the top explaining the spread of the room temperature 20⁰C-40⁰C environmental temperature (ambient) 32.4⁰C 35.5⁰ C temperature of the roof, the floor temperature of 33⁰C, the temperature of 40⁰ C

chicken, left and right wall temperature 33°C, the temperature of evaporating cooling 20°C-20.6°C. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler. The future above in the top of the roof-floor piece describes X Z axis to the Y axis Time to explain the spread of the afternoon on the room temperature 20°C-40°C environmental temperature (ambient) 32.4°C 35.5°C temperature of the roof, the floor temperature of 33°C, the temperature of 40°C chicken, left and right wall temperature 33°C, the temperature of cooling evaporating 20°C -20.6°C. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The picture above is viewed from the roof-floor piece describes the X Z axis to the Y axis.

Scenario 2 in the morning to explain the spread above room temperature 20°C-36°C environmental temperature (ambient temperature) 31.3°C, 34.4°C temperature of the roof, the floor temperature 33°C, the temperature of 40°C chicken, left and right wall temperature 33°C, cooling temperature of evaporating cooling 20°C-20.6°C, irradiation 315 W/m², power fan 8800 Watt and wind speed 1.75 m/s. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The picture above is viewed from the roof-floor piece describes the X Z axis to the Y axis Time for lunch at the top explaining the spread of the room temperature 20°C-40°C environmental temperature (ambient) 33°C, the roof temperature 35.5°C, floor temperature 36°C, the broiler temperature of 40°C, left and right wall temperature 33°C, the temperature of the cooling evaporating 20°C -20.6°C, 315 W/m² radiation, fan power 8800 watt, 18 watt lamps and wind speed 1.8 m / s. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The image below in the top of the roof-floor piece describes X Z axis to the Y axis Time to explain the spread of the afternoon on the room temperature 20°C-40°C environmental temperature (ambient) 32°C, the roof temperature of 34.3°C, floor temperature 33°C, the broiler temperature of 40°C, left and right wall temperature 33°C, the temperature of the evaporating cooling 20°C -20.6°C, fan power 8800 watt, lamps 18 watt and wind speed 1.6 m / s. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The picture above is viewed from the roof-floor piece describes the X Z axis to the Y axis.

Scenario 3 in the morning above the room temperature to explain the spread of 20°C-40°C environmental temperature (ambient temperature) 31°C, the roof temperature of 30°C, the floor temperature of 32°C, the broiler temperature of 40°C, wall temperature left and right 34.5°C, temperature cooling evaporating 20°C -20.6°C, the fan power an 8800 Watt, lamps 18 watt and wind speed 1.6 m / s. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The figure above is viewed from the roof-floor piece describes the X Y axis to the Y axis Time for lunch at the top explaining the spread of the room temperature 10°C-38°C environmental temperature (ambient)

32°C, the roof temperature of 35°C, floor temperature 35°C, the broiler temperature of 40°C, wall temperature left and right 33°C, the cooling evaporating temperature 20°C -20.6°C, irradiation of 386 W/m² fan power 8800 Watt, lamp 18 watt and wind speed 1.6 m/s. Room temperature is low compared to morning and afternoon due to measurement data in the rain and the temperature of the floor as influenced by rice husk and broiler chickens. The image below in the top of the roof-floor piece describes X Y axis to the Y axis Time to explain the spread of the afternoon on the room temperature 20°C-40°C, ambient temperature 31.4°C, the roof temperature of 33.3°C, the floor temperature 34°C, the broiler temperature 40°C, wall temperature left and right 34°C, the cooling evaporating temperature 20°C -20.6°C, Irradiation 308 W/m², the fan power 8800 Watt, lamps 18 watt and wind speed 1.5 m/s. Room temperature the heat contained in the middle and floor temperature as influenced by rice husk and broiler chickens. The figure above is viewed from the roof-floor piece describes the X Z axis to the Y axis. The model has been tested with data compiled experiments conducted. The output of the model is the change in room temperature, floor temperature, roof temperature, while the temperature of the fan, chicken temperature, temperature of cooling evaporation constant. Simulation models to predict changes in room temperature can already be seen in general represent the simulated measurements with coefficients of determination (R²) 92%, the standard deviation of 0.0916 and humidity also can represent the data with coefficients of determination (R²) 91% standard deviation of 0.065.

Supervisory control system in broiler house which is influenced by convection and conduction, irradiation by using the mode control that adjusts the climatic and environmental conditions that exist. For one variable using PI control mode, the PD and PID with one of the controlled temperature, humidity. The temperature is controlled in the morning using a PD, PID daytime, evening PD of starter, grower and finisher. Humidity is controlled in the morning using the PI, PID daytime, evening PD of starter, grower and finisher. Simulation supervisory control on a broiler house in this study was its use of the broiler house made divided into 3 scenarios hours during starter, grower and finisher and subsequent studies use some of the broiler house. To set point 30°C is a starter, set points 29°C is the grower, the set point 28°C is a finisher. Controlling temperature and humidity in a closed cage in broiler chickens using the method of self tuning PID control. Testing is done by testing the response variable input, set point tracking test. Response testing performed on the machine control that is modeled in the form of transfer function with input-an of Constanta in Matlab simulink. Testing the first tracking point on the temperature setting is done by changing the input value of 30°C, 29°C, 28°C for PI and PID control. Then in the second set point humidity will change the input value by 70%, 60%, 50% for PD and PID control. From the results will be searched testing rise time (rise time) with the criterion of 10% to 90%, when settlers (settling time) that indicates that the response has been entered ± 5% of steady state response, delay time, and recovery time.

which then compares the results obtained on the method of self-tuning PID control. To study the response of PID control, PD and PI on the temperature and humidity based on the parameters below.

PID Control Response Temperature

Table 1 set point 30⁰ temperature

Characteristic	Criteria
Time rise (<i>Tr</i>)	0,2343 detik
Maximum peak (<i>Mp</i>)	2,7777 %
Time settling (<i>Ts</i>)	6,4843 detik
Error steady state(<i>Ess</i>)	1,3889 %
Time delay (<i>Td</i>)	0,078125 detik

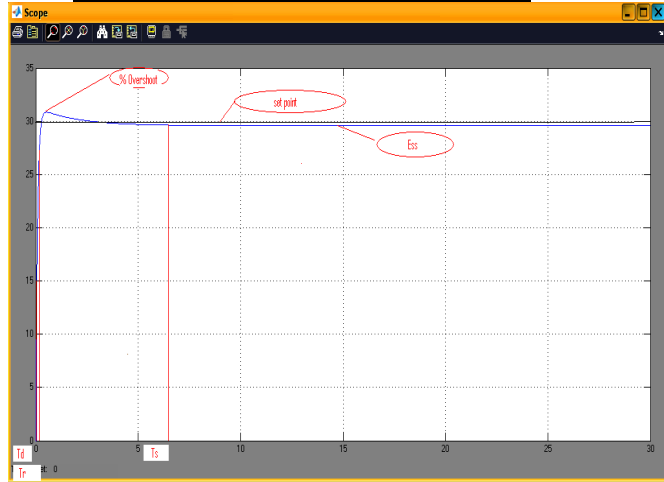


Figure 7. Graph PID control temperature set point 30⁰C

Table 2 set point 28⁰ temperature

Characteristic	Criteria
Time rise (<i>Tr</i>)	0,45875 detik
Maximum peak (<i>Mp</i>)	4,464285714 %
Time settling (<i>Ts</i>)	6,1719 detik
Error steady state(<i>Ess</i>)	1,4881 %
Time delay (<i>Td</i>)	0,078125 detik

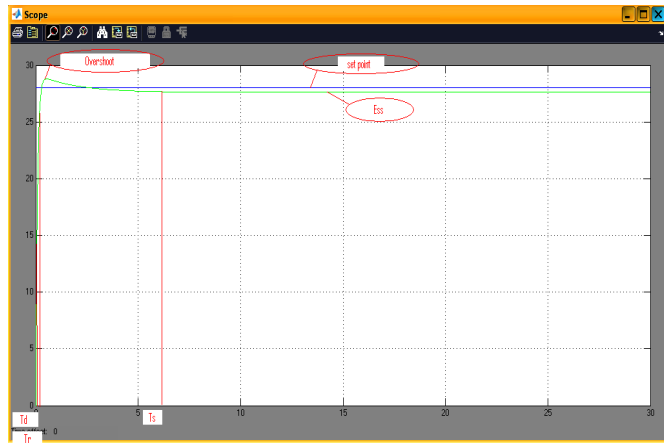


Figure 8. Graph PID control temperature set point 28⁰C

Table 3 set point 29⁰ temperature

Characteristic	Criteria
Time rise (<i>Tr</i>)	0,3125 detik
Maximum peak (<i>Mp</i>)	5,0288 %

Time settling (<i>Ts</i>)	6,5937 detik
Error steady state(<i>Ess</i>)	1,7241 %
Time delay (<i>Td</i>)	0,15625 detik

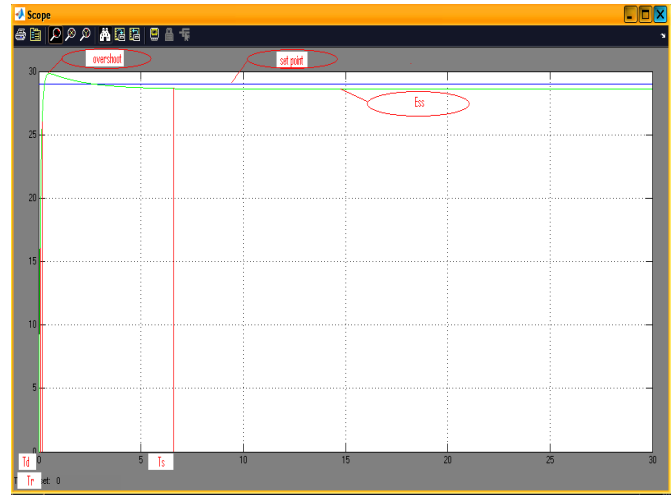


Figure 9. Graph PID control temperature set point 29⁰C

PD Control Response for Humidity

Table 4 set point 70 % humidity

Characteristic	Criteria
Time rise (<i>Tr</i>)	0,8125 detik
Maximum peak (<i>Mp</i>)	0 %
Time settling (<i>Ts</i>)	4,15625 detik
Error steady state(<i>Ess</i>)	1,098901 %
Time delay (<i>Td</i>)	0,34375 detik

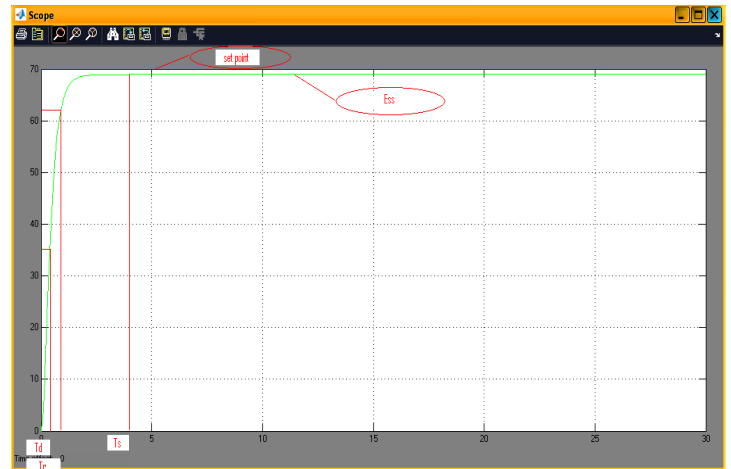


Figure 10. graph PD control humidity set point 70 %

Table 5 set point 60 % humidity

Characteristic	Criteria
Time rise (<i>Tr</i>)	0,78125 detik
Maximum peak (<i>Mp</i>)	0 %
Time settling (<i>Ts</i>)	4,1875 detik
Error steady state(<i>Ess</i>)	1,111111 %
Time delay (<i>Td</i>)	0,3125 detik

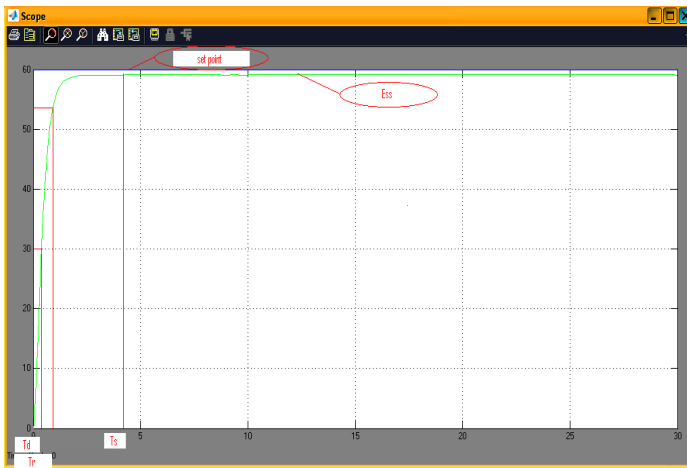


Figure 11. graph PD control humidity set point 60 %

Table 6 set point 50 % humidity

Characteristic	Criteria
Time rise (T_r)	0,820313 detik
Maximum peak (M_p)	0 %
Time settling (T_s)	4,21875 detik
Error steady state (E_{ss})	1,111111 %
Time delay (T_d)	0,3125 detik

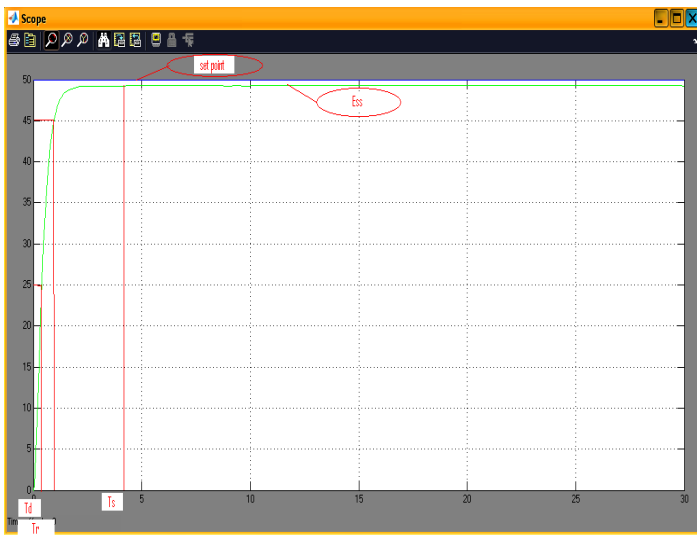


Figure 12. graph PD control humidity set point 50 %

To set the heater and the fan outlet using the method of PI controller, PD and PID to raise the temperature in a broiler house room as desired with humidity down. Starter requires heating period. To heat the room requires a 60 watt heater power used to raise the room temperature becomes a broiler house 4°C to achieve optimal temperature 32°C initial temperature of the starter with 28°C with initial moisture of 60%. With fan assisted air flow outlet (outlet) makes the hot air evenly throughout the room with a ceiling fan power 1800 watts /2.8 amper. Heating load accumulation of heating with the fan drive controller at 5460 watts with evaporating cooling in off. During the grower and finisher on the optimal temperature of the broiler house below 32 ° C with initial moisture of 60% then the fan is switched on as many as 3 of 8 fan alternately with evaporating cooling in off so that the

heater 5400 watt.

V. CONCLUSION

Model control system controls the temperature and humidity supervisory sealed enclosure has been developed and the validation results indicate a significant correlation to the temperature coefficient of determination (R^2) 92%, the standard deviation of 0.0916, and the humidity coefficient of determination (R^2) 91% standard deviation of 0.065. Response control of PD, PI and PID yield rise time, spike, resident time, steady state error, the response delay time corresponding PID parameters. The results of testing both on the model of the desired temperature and humidity within the maintenance period in the three scenarios starter, grower and finisher can be obtained with good insulation without significant disruption. Heater power the starter broiler house require 5460 watt and the grower, finisher requires 5400 watts.

ADVICE

Supervisory control system the temperature and humidity broiler house can be used to support farm businesses in broiler. In addition, control of process variables in order to accommodate more, the necessary facilities and interfaces that suit the needs of expected development in the next study adds artificial intelligent-based control mode (control Fuzzy logic and control of artificial neural networks) as well as broiler house used more than one.

ACKNOWLEDGMENT

I thank you very much for sponsor contribution in funding from the national education ministry Indonesia provides grants to the author's doctoral study and research program in Engineering at Tsukuba sandwich Japan.

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