Smart Control Motor Compressor Cooling System For Improving The Efficiency Of Energy Usage Method Of Fuzzy-PID

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Abstract. Research on the cooling system becomes the concentration that will be carried out, more than 60% of the biggest electricity usage of a building is Air Conditioner (AC). Actually the AC performance itself is set when the room temperature matches the target, the performance of the compressor motor will be turned off. The system to be studied is how to make the AC performance always reach its maximum set point temperature for the room. In this study an automatic temperature measurement system will be created which will read temperature data continuously in real time and read the power on the Compressor to make a control system so that the use of the Compressor becomes efficient. The reading of temperature data can be seen through mobile devices and via Internet of Things (IoT) technology. This system will automatically calculate the setpoint to get the most optimal energy consumption value. The system will read temperature data on a certain time to monitor AC performance. If it never reach the set point, the system will be taken over to make energy efficiency decisions. This system optimizes AC energy so become one of the energy saving models.

1. Introduction

The current use of electricity can be said to be a basic need, and efforts to develop alternative energy sources have been urgently needed. Various efforts have been made from alternative energy searches to the efficiency of electricity use. The use of electricity in a building, factory, school and others is greatest in refrigeration machines, especially Air Conditioner (AC) around 55-70%[1]. Most humans set the remote at a temperature of 18 °C where this condition will cause the AC to live non-stop without stopping because it never reaches the set point.

This Smart Control will monitor the AC performance if in a certain time in a certain room it will never reach the set point so this tool will turn off the AC motor performance so that it happens like a set point on the AC engine, if the temperature increases 1 degree then the Compressor Motor will be turned on again until set point that has been determined by the system. This technique has been able to save the use of electrical power in the AC, so that the more efficient the behavior of on off motor compressor will partially follow the presentation from 10% to 100% using the PID method. In the end there will be two savings on the Air Conditioner system.

This research develops Fuzzy PID system to control FOPDT system where the result are better than the system Conventional PID[2].
This fuzzy system focuses on low temperature controllers such as ovens or incubator, Fuzzy logic planted on the microcontroller makes performance faster, result obtained due to low temperature then this fuzzy system is better than PID[3].

Monitoring and efficiency of energi servers is of particular concern lately the method used by this researcher is by way of server load allocation combined with an Air Conditioner control system[4].

This study uses MATLAB as a PID Selef-tuning system design and compared with traditional PID system, the result can overcome the problem of VFD (Variable Frequency Drive) so that it has a constal temperature from the Fuzzy PID Algorithm[5].

The variable refrigerant volume (VRV) air conditioning systems have been employed in small and medium sized buildings recently for its advantages of comfort, energy conservation and easy maintenance. However, the optimal control of VRV air conditioning systems is very difficult due to cross-coupling system parameters and time-variant operating conditions[6].

The ideal temperature for orchids is: daytime temperature between 27-30 degrees Celsius and night temperature between 21-24 degrees Celsius. Based on these problems, the Moisture Monitoring System, Temperature, Light Intensity on Orchid Plant using ESP8266 and Arduino Nano are designed. In this design, the result of sensor readings will be displayed in graphical form and Chart on IoT Thingsboard. To reading moisture, temperature, light intensity used several sensors they are: LDR, Soil Sensor and DHT-11[7].

This system regulates the temperature and humidity of the server room using the ESP8266 Microcontroller type Wemos D1 where already has a WIFI chip, the method used uses Fuzzy Logic with the help of Infra Red to regulate the air conditioner[8].

The researchers gave the solution by creating a tool that able to work automatically to monitor and control the temperature and humidity in oyster mushroom cultivation problem based on microcontroller[9].

This system monitors remotely and uses the CPU to concentrate on cooling the air before entering the compressor, because this performance affects the efficiency and quality of compressed air[10].

Many techniques have been carried out to examine the safety of PWR power reactors. The most appropriate control method is to use PID to produce a reliable and uncomplicated system[11].

The case study on a temperature model of a heating furnace demonstrates the effectiveness of the proposed PID control scheme in comparison with the conventional PID control and the fuzzy self-adaptive PID control[12].

Energy saving in a building is very necessary so that the use of electric power becomes more efficient, energy conservation is one of the methods carried out[13].

The Indonesian Nasional Standard (SNI) in temperature and humidity is a workspace with temperatures ranging from 24 °C to 27 °C with relative humidity between 55% Rh to 65%. Transit space (Lobby, corridor) with temperatures ranging from 27 °C to 30 °C with humidity of 50% RH to 70% RH[14].

Energy Audit is carried out as an evaluation process where buildings or factories use energy and are explored for energy consumption savings opportunities so as to produce electrical power efficiency[15].

2. Methodology

This system uses temperature sensors, IoT-based controllers and AC motor drivers that are driven by the PID method, making it more efficient because the controller functions in addition to regulating the AC performance also regulates the performance of the VSD motor compressor. The use of IoT so that the system becomes the industry standard 4.0 so that remote monitoring of the performance and efficiency of electrical power can be seen directly, and quickly make decisions when problems occur with the system. So that this system becomes much better compared to other savings method systems such as AC inverters or calculating the presence or absence of a person in a room[16]. In order for this research to be done, the following data are needed: Room temperature, Power Air Conditioner, Motor Compressor When On / Off while the AC is on. Thus the comparison between the AC power as long as it is turned on with or without the system installed will clearly see the difference.
The end result can be seen how much efficiency is happening to the temperature that is obtained. The target is the same room temperature but the power is more efficient. So there are 2 things the method that is done first is the controller reads the room and makes a second setpoint decision on the performance of the compressor motor using the PID method so that the savings occur 2 times.

3. Result and Discussion
   a. Smart Control Motor Compressor Cooling System Equipment
      This Air Conditioner saver consists of an ARM type architecture controller as from the whole brain of the system, this tool consists of two first pcb parts containing temperature sensors, microcontrollers and communication lines to other devices using esp8266 chip as WIFI to connect with industrial 4.0, the second pcb is an air conditioner motor driver that can be passed by a current of 5 Ampere, using TRIAC so that the microcontroller can provide PWM signal so that the motor rotation can vary from 0 to 100%. This is intended with the PID formula so that the motor rotation becomes more efficient.

b. Wiring Sensor Diagram AC
   The relationship between indoor and outdoor using the OUTDOOR UNIT RELAY, this AC saver is installed in series on the relay line, so that if the temperature is never reached then the system will automatically take over and start working according to the program rules that have been designed,
so the setpoint will always occur under any conditions (the remote in the setting is smaller than the temperature of the AC capability achieved).

c. Display HMI

![Figure 3. HMI Android Display](image)

The display shows the temperature of the environment and there is a notification on the android screen and email when there is an error or system failure. That is one of the advantages of IoT, monitoring is easier.

d. PID Motor Compressor Method

![Figure 4. Fuzzy Pid Block Diagram System](image)

First of all, the ambient temperature is read by the Sensor within a certain time, when the ambient temperature does not change again, the Controller does its job to make this condition setpoint, and gives pwm data for the motor so that savings occur. When the temperature starts to rise 1C from the new setpoint (the controller is determined), the PWM motor will rise so that the cooling performance occurs faster, when it reaches its setpoint, the motor performance is lowered again.

e. Experimental System Tools

In this experiment the data is taken when the device has not been activated, the AC works normally from the manufacturer (not upgraded with the system) and uses the system. This data is taken for 8 hours from 09:00 to 17:00.
Table 1. Data Monitor Cooling System (AC) normal operation

| No. | Time  | Temp | Voltage | Current | Power | Motor  |
|-----|-------|------|---------|---------|-------|--------|
| 1   | 09.00 | 27   | 226     | 3.7     | 836.2 | ON     |
| 2   | 09.30 | 27   | 225     | 3.8     | 855   | ON     |
| 3   | 10.00 | 27   | 225     | 3.8     | 855   | ON     |
| 4   | 10.30 | 27   | 225     | 3.8     | 855   | ON     |
| 5   | 11.00 | 27   | 225     | 3.8     | 855   | ON     |
| 6   | 11.30 | 28   | 225     | 3.8     | 855   | ON     |
| 7   | 12.00 | 28   | 225     | 3.8     | 855   | ON     |
| 8   | 12.30 | 28   | 225     | 3.8     | 855   | ON     |
| 9   | 13.00 | 28   | 225     | 3.8     | 855   | ON     |
| 10  | 13.30 | 28   | 225     | 3.8     | 855   | ON     |
| 11  | 14.00 | 28   | 225     | 3.8     | 855   | ON     |
| 12  | 14.30 | 27   | 225     | 3.8     | 855   | ON     |
| 13  | 15.00 | 27   | 225     | 3.8     | 855   | ON     |
| 14  | 15.30 | 27   | 225     | 3.8     | 855   | ON     |
| 15  | 16.00 | 27   | 225     | 3.8     | 855   | ON     |
| 16  | 16.30 | 27   | 223     | 3.8     | 847.4 | ON     |
| 17  | 17.00 | 27   | 218     | 3.9     | 850.2 | ON     |

| No. | Time  | Temp | Voltage | Current | Power | Motor  |
|-----|-------|------|---------|---------|-------|--------|
|     |       |      |         |         |       |        |

Total Daya / 8 hours = 855 Watt 8 6840 Kwh

Table 2. Data monitoring using system control

| No. | Time  | Temp | Voltage | Current | Power | Motor  |
|-----|-------|------|---------|---------|-------|--------|
| 1   | 09.00 | 27   | 226     | 3.7     | 836.2 | ON     |
| 2   | 09.30 | 27   | 225     | 1.11    | 249.75| 5%     |
| 3   | 09.35 | 27   | 225     | 3.8     | 855   | ON     |
| 4   | 09.40 | 27   | 225     | 1.12    | 252   | 5%     |
| 5   | 09.45 | 27   | 225     | 3.8     | 855   | ON     |
| 6   | 09.50 | 28   | 225     | 3.8     | 855   | ON     |
| 7   | 10.00 | 28   | 225     | 1.11    | 249.75| 5%     |

It can be seen that when using the system, within 1 hour there is a 15 minute reduction in ac power from 836Watt to around 250W, meaning that there is savings in one hour 836-250 = 586 Watts for 15 minutes.

Variable Input Fuzzy

- Time: Little, Medium, Many; <10 minutes, 20 to 30 minutes,> 30 minutes
- Temperature: Hot, Medium, Cold; <1 Setpoint, Temperature = Setpoint,> 3 Setpoint
Variable Output:
- Set Point Temperature

**Figure 5.** Road map for research from 2018-2019

4. **Conclusion**

From the results of testing the smart controller cooling system, it can save electrical power consumption in an apartment, a building that has split air conditioner (there is an outdoor unit), savings will be felt when installed on all air conditioners in the building, research will be expected to reach 30% until with 50%, the use of IoT is enabled in addition to analyzing the performance of electrical power for savings as well as routine maintenance of AC performance so that it can be quickly acted upon if the AC experiences a system failure or is damaged.

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