HVAC MONITORING (TEMPERATURE) AND CONTROLLING (VALVE/DAMPER) SYSTEM

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Tajuk Projek : .HVAC MONITORING AND CONTROLLING SYSTEM

Sesi Pengajian :

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Date : 15 / 6 / 2016

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ABSTRACT

"Design of HVAC monitoring and controlling system to control the air flow with controllable damper and monitoring temperature"

Abstract of Project:

HVAC monitoring and controlling systems are small but significant part in any industrial application. Increase demand of HVAC usage is main motivation behind this project beside the way they use the HVAC not suitable way that make the people not comfort. The main feature of this project is all about a designing the HVAC prototype with monitoring and controlling system with effective cost and reliable valve to control the air flow.

There will be three main module of the project. First is about control the valve/damper (motor) consisted of a servo motor fitted on valve, its required position and the valve open percentage is shown on PC. Second is about monitoring HVAC temperature consisted of temperature sensor LM35 to sense the temperature and send the reading to computer. And the third is about the HVAC monitoring and controlling system can control and monitor by smartphone by using Ethernet shield. Ethernet shield act as connector between circuit and smartphone. When the HVAC control by smartphone it will update as well in PC and vice-versa.

ABSTRAK

"Rekaan pemantauan HVAC dan sistem kawalan untuk mengawal aliran udara dengan penampan boleh dikawal dan memantau suhu"

Abstrak Projek

Pemantauan HVAC dan sistem kawalan adalah kecil tetapi penting dalam apa-apa bahagian didalam kegiatan industri. Peningkatan permintaan penggunaan HVAC adalah motivasi utama di sebalik projek ini di samping cara mereka menggunakan HVAC secara yang tidak sesuai yang membuat orang tidak selesa. Ciri utama projek ini adalah tentang mereka satu bentuk prototaip HVAC dengan system pemantau dan pengawalan dengan kos efektif dan injap dipercayai untuk mengawal aliran udara.

Terdapat tiga modul utama projek ini, pertama adalah pengawalan injap / peredam (motor) terdiri daripada motor servo dipasang pada injap, ia memerlukan kedudukan dan peratusan injap terbuka ditunjukkan pada computer persendirian. Kedua ialah mengenai memantau suhu HAVC terdiri daripada sensor suhu lm35 untuk mengesan suhu dan menghantar bacaan ke komputer. Dan yang ketiga ialah tentang system pemantauan hvac dan mengawal suhu boleh dikawal dan dipantau dengan telefon pintar dengan menggunakan perisai ethernet. Perisai Ethernet bertindak sebagai penyambung antara litar dan telefon pintar. apabila HVAC berjaya dikawal dengan telefon pintar ia akan bacaan sudut dan suhu akan dikemas kini didalam Komputer persendirian mahupun sebaliknya.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

1 INTRODUCTION

1.1 PROJECT BACKGROUND

HVAC is short for heating, ventilation, and air conditioning. The system is used to provide heating and cooling services to buildings. HVAC systems have become the required industry standard for construction of new buildings. Before the creation of this system, the three elements were usually split between three or more devices.

Control system is a system, gadget or set of gadget that manages, aim, coordinates or directs the conduct of different gadgets that we can control its conduct or attributes by utilizing different gadgets or systems. Mastascusa (1999) said that while controlling a system, the main thing to know is the thing that the system itself need to control and how well it is getting along. [1]

The control valve/damper is one of the important part in control the airflow of HVAC. The control valve (damper) is something that we can adjust to get the airflow that we desired. In this case the valve area that we must change to get the appropriate airflow. So, the accurate airflow must be adjust using the valve (damper) to make sure the airflow in the valve will be accurate.

A monitoring system can be described as an arrangement of strategies controlling the data courses through an association to various administration levels with a specific end goal to bolster basic leadership and learning. The system needs to

empower the following of obvious subjective and quantitative information and makes an interpretation of it into profitable administration data. The system needs to in this manner be available, guaranteeing straightforwardness and advance the sharing and trading of encounters and lessons learned and make an interpretation of this into restorative activity.

The monitoring system is important for decrease electrical usage. Most people want to decrease something firstly they must monitor what the problem. In HVAC the monitoring system, it only can use temperature monitoring system because HVAC is about air conditioning. If people work during evening they not need temperature too low from HVAC like people that work at the morning. So they can decrease the electrical usage because more HVAC temperature increase more energy used.

This project system is run circuit that can control the temperature reading and collect the data in real time which using software that can analyze the data in real time. Before the software can analyze the data, must have some circuit can control the air flow out and device that can grab the data from sensor and convert into a data that PC (Personal Computer) can understand or read which, the device is Arduino Uno. Function of Arduino Uno is to convert the analogue signal to digital signal (which can understand by PC)

The aim of this project is to made HVAC system that know how to control and monitor temperature change progressively. To perform persist monitoring, MATLAB programming is use in this anticipate and other programming can be utilizing, for example, LabVIEW. MATLAB and LabVIEW have same function which can use to control the HVAC damper and to show the output or key-in input value or parameter. This product still has contrasts between each other which is in LabVIEW, the block diagram is linked with GUI model and it also compatible with National Instruments (NI) device. While in MATLAB, Simulink block diagram and GUI model is two different ways in utilizing programming and not interface each other.

1.2 PROBLEM STATEMENT

The problem statement in this project is the controlling and monitoring of HVAC temperature in university is very important because it can affect the mood student for study. Student need comfort place to study, if the place very hot or too cool, it makes the place be not comfort for student to study. The Graphical User Interface (GUI) is developing using MATLAB. With this GUI, user can control and monitor the change of temperature through user own personal computer (PC).

1.3 OBJECTIVES

This document proposed a design of low cost monitoring and controlling HVAC. I have identified 4 major objectives must meet in development this system.

1. To model the prototype of HVAC.
2. To design GUI using MATLAB for monitoring the change of temperature.
3. To developed HVAC temperature controlling system using low cost.
4. To develop sensor system which capable to monitoring temperature in real-time

1.4 SCOPE OF PROJECT

Several scope of project is:

1. The hardware part of controlling HVAC temperature system will be designed and development.
2. The software for GUI and data analysis will be develop using MATLAB.

3. The sensor part should capable to monitor temperature in real time.
4. The working controlling and monitoring HVAC system will be tested in related industrial application.

1.5 OVERVIEW OF REPORT

This thesis consists of five chapters which is the first chapter is the Introduction that discuss about the background of this project, objectives, scope of this project which are for the overall summary of works. The second chapter will discuss about several theory and literature reviews that had been done in this project. In this chapter, the basic theory of control, basic theory of sensor, type of sensor and the function of Arduino Uno had been discussed. The process flow of the project will be discussed in Chapter 3 which is the methodology part. The second last chapter is the results and discussions part which consists of data from GUI. Finally, the last chapter which is Chapter 5 will conclude overall of the project and future recommendation that can improve this project.

CHAPTER 2

2 LITERATURE REVIEW

2.1 THE THEORY OF CONTROL SYSTEM

Control systems are a basic piece of present day society. Various applications are surrounding us: The rockets fire, and the space transport lifts off to earth circle; in sprinkling cooling water, a metallic part is consequently machined; an independently directed vehicle conveying material to workstations in an aviation get together plant skims along the floor looking for its destination. These are only a couple of illustrations of the naturally controlled systems that we can make. [2]

We are by all account not the only makers of naturally controlled systems; these systems likewise exist in nature. Inside of our own bodies are various control systems, for example, the pancreas, which directs our glucose. In time of "battle or flight," our adrenaline increments alongside our heart rate, creating more oxygen to be conveyed to our cells.

Our eyes take after a moving article to keep it in perspective; our hands get a handle on the item and place it definitely at a foreordained area. Indeed, even the nonphysical world has all the earmarks of being naturally directed(Nise, 2011).

Control System Definition

A control system consists of subsystems and processes (or plants) assembled for the purpose of obtaining a desired output with desired performance, given a specified input. Figure 1 shows a control system in its simplest form, where the input represents a desired output(Nise, 2011).

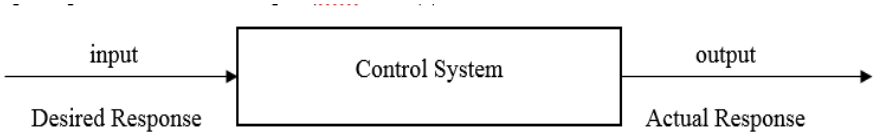

Figure 2.1.1: Control System

2.2 FEEDBACK CONTROL SYSTEM (Closed loop)

By using the closed-loop system, those errors made by the disturbances can be overcome(Nise, 2011). This also is an advantage of close-loop system compare to open-loop system which can't correct the errors made by the disturbance and directly only take command from the input we enter. The best example of the open-loop system is on the washing machine application. Maybe we can set how long the operation and what type of fabrics we want to clean, but the output which is the cleanliness of the clothes, we can't measure it. The term of 'closed-loop' also is referred as the feedback control action in order to decrease the error of the system (Ogata, 2010).

The figure 2 below shows how the sensor reacted as the feedback action as its measure the output value. (Ogata, 2010) also said but their certain case whereas there is no disturbance and using time as its base, it's more reliable to use open-loop system. We can see this application on traffic light system as example. In traffic lights system, actually the computer will control the sequences of lights displayed at a cross-road to ensure that cars do not crash. Additionally, the computer operates a pedestrian crossing to let pedestrians cross the road when a button is pressed. [3]

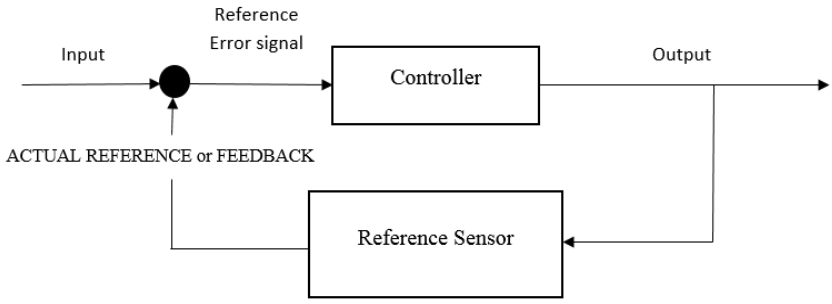

Figure 2.2.1: Feedback Control System Diagram

2.3 SERVO MOTOR

Servo is a term which applies to capacity or task. The function, or errand, of servo can be described as follows. A command signal which issued from the client interface panel comes into the servo's "positioning controller". The positioning controller is the gadget which stores data about different jobs or assignments. It has been modified to active the motor/load (change speed/position)

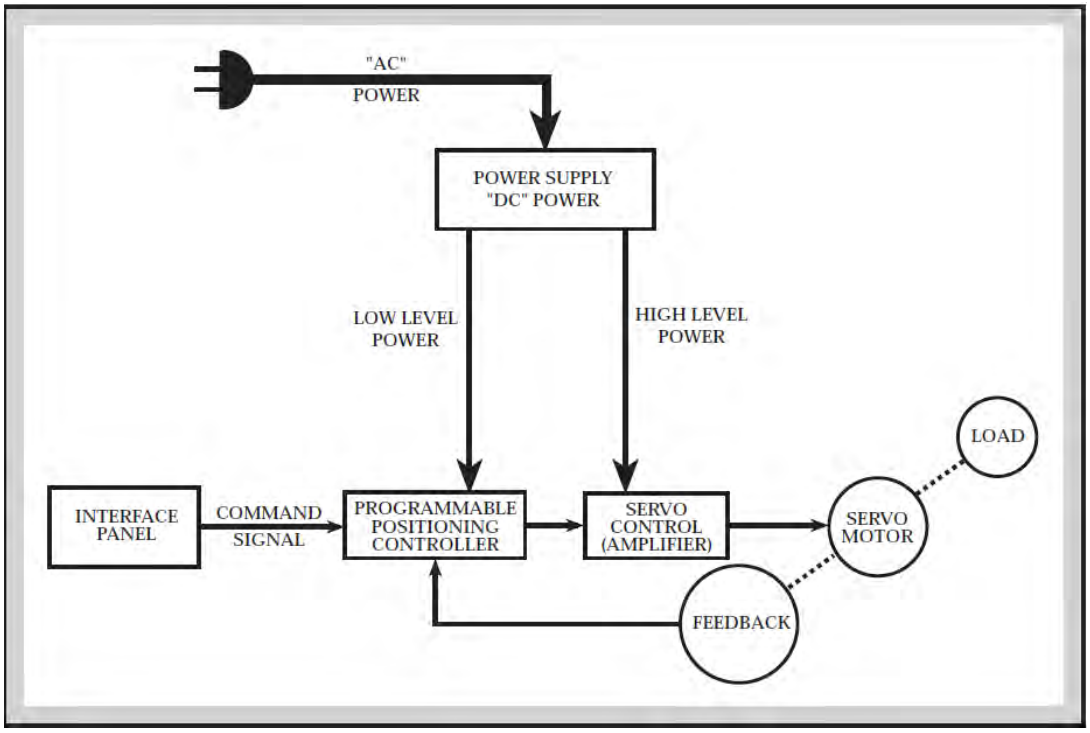

Figure 2.3.1: The concept of Servo System

The command signal then goes into the servo control area. The servo control takes this low level power signal and increases, or amplifies, the power up to certain levels to actually result in movement of the servo motor/load.

These low level power signals must be amplified. The higher voltage levels are needed to turn the servo motor at certain higher current and higher speed levels are required to provide torque to move heavier loads.

This power is supplied to the servo control from the "power supply" which simply converts AC power into the required DC level. It also supplies any low level voltage required for operation of integrated circuits.

As power is connected onto the servo motor, the load starts to move . . . speed and position changes. As the load moves, so does some other "device" move. This other "device" is either a tachometer, resolver or encoder (giving a signal which is "sent back" to the controller). This "feedback" signal is informing the positioning controller whether the motor is doing the proper job.

The positioning controller looks at this feedback signal and figure out if the load is being moved properly by the servo motor; and if not, then the controller makes appropriate corrections. The controller then outputs a signal to apply more voltage onto the servo motor to increase speed until the feedback signal equals the command signal.

Therefore, a servo involves several devices. It is a system of devices for controlling some item (load). The item (load) which is controlled (regulated) can be controlled in any manner, i.e. position, direction, speed. The speed or position is controlled in relation to a reference (command signal), as long as the proper feedback device (error detection device) is used. The feedback and command signals are compared, and the corrections made. Thus, the definition of a servo system is, that it consists of several devices which control or regulate speed/position of a load. [4]

TowerPro MG995 servo motor

The unit comes complete with 30cm wire and 3 pin 'S' type female header connector that fits most receivers, including Futaba, JR, GWS, Cirrus, Blue Bird, Blue Arrow, Corona, Berg, Spektrum and Hitec

This high-speed standard servo can rotate approximately 120 degrees (60 in each direction). User can use any servo code, hardware or library to control these servos, so it's great for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. The MG995 Metal Gear Servo also comes with a selection of arms and hardware to get you set up nice and fast. [5]

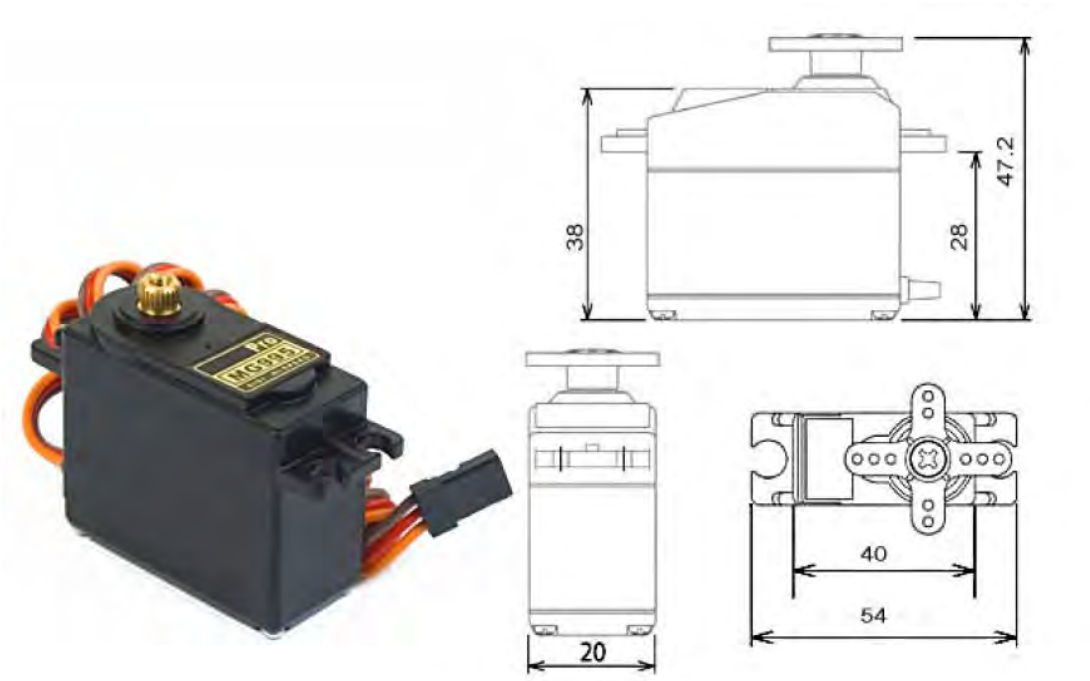

Figure 2.3.2: Servo motor diagram

Specification

Table 1: Servo motor specification

Weight	55 g
Dimension	40.7 x 19.7 x 42.9 mm approx..
Stall torque	8.5 kgf cm (4.8 V), 10 kgf cm (6V)
Operating speed	0.2 s/60° (4.8 V), 0.16 s/60° (6V)
Operating voltage	4.8V a 7.2V
Dead bandwidth	5µs
Temperature range	0°C - 55°C

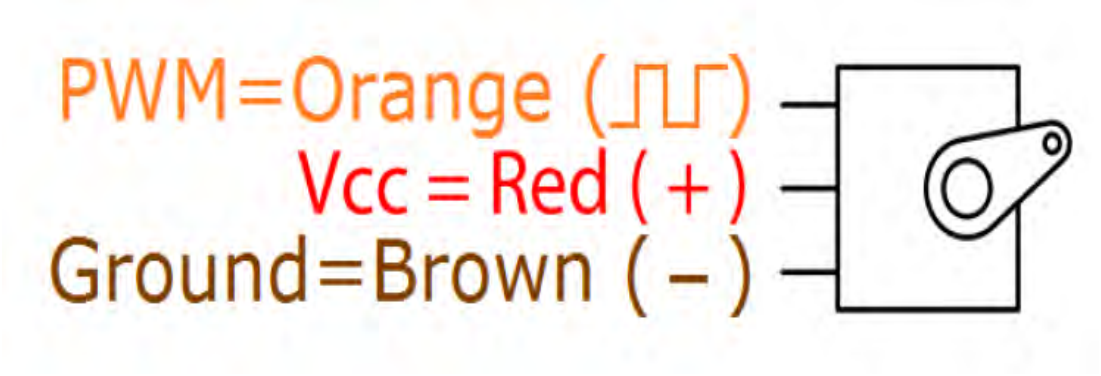

Figure 2.3.3: Servo motor connection

2.4 FUNDAMENTAL OF HVAC CONTROL

HVAC is short for heating, ventilation, and air conditioning. The system is used to provide heating and cooling services to buildings. HVAC systems have become the required industry standard for construction of new buildings. Before the creation of this system, the three elements were usually split between three or more devices. (business dictionary)

HVAC System

HVAC systems are delegated either independent unit bundles or as focal systems. Unit bundle depicts a solitary unit that changes over an essential vitality source (power or gas) and gives last warming and cooling to the space to be adapted. Illustrations of independent unit bundles are housetop HVAC systems, cooling units for rooms, and aerial warmth pumps. With focal systems, the essential transformation from fuel, for example, gas or power happens in a focal area, with some type of warm vitality dispersed all through the building or office. Focal systems are a mix of focal supply subsystem and numerous end use subsystems. There are numerous varieties of consolidated focal supply and end use zone systems.

The most every now and again utilized mix is focal hot and chilled water dispersed to numerous fan frameworks. The fan frameworks use water-to-air heat exchangers called loops to give hot and/or chilly air for the controlled spaces. End-use

subsystems can be fan frameworks or terminal units. On the off chance that the end use subsystems are fan frameworks, they can be single or numerous zone sort. The numerous end use zone frameworks are blending boxes, typically called VAV boxes.

Another combination central supply and end use zone system is a central chiller and boiler for the conversion of primary energy, as well as a central fan system to delivery hot and/or cold air. The typical uses of central systems are in larger, multi-storied buildings where access to outside air is more restricted. Typically, central systems have lower operating costs but have a complex control sequence. (A. Bhatia, Fundamental of HVAC)

How does central air-conditioning system work?

Cooling Cycle (chilled water system): The supply air, which is around 20° F cooler than the air in the adapted space, leaves the cooling loop through the supply air fan, down to the ventilation work and into the conditional space. The cool supply air grabs heat in the conditional space and the hotter air advances into the arrival air pipe back to the air taking care of unit. The arrival air blends with outside air in a blending chamber and experiences the channels and cooling loop. The blended air surrenders its warmth into the chilled water tubes in the cooling loop, which has balances connected to the tubes to encourage heat exchange. The cooled supply air leaves the cooling loop and the air cycle rehashes. The chilled water circling through the cooling curl tubes, in the wake of getting warmth from the blended air, leaves the cooling loop and experiences the chilled water return (CHWR) channel to the chiller's evaporator. Here it surrenders the warmth into the refrigeration framework. The recently "chilled" water leaves the evaporator and is pumped through the chilled water supply (CHWS) piping into the cooling loop consistently and the water cycle repeats.

The evaporator is a heat exchanger that allows heat from the CHWR to flow by conduction into the refrigerant tubes. The liquid refrigerant in the tubes "boils off" to a vapour removing heat from the water and conveying the heat to the compressor and then to the condenser. The heat from the condenser is conveyed to the cooling tower by the condenser water. Finally, outside air is drawn across the cooling tower, removing the heat from the water through the process of evaporation. The figure below