

Simulation of Thermistor Controlled Fan using MATLAB

Neha Kumari
UG –student

IV Year EEE-Department
Gandhi Institute of Engineering and Technology
Gunupur-765022, India

Amisha Sinha
UG – Student

IV Year EEE-Department
Gandhi Institute of Engineering and Technology
GUNUPUR-765022, India

Smruti Ranjan Pradhan
Asst Professor
EEE-Department

Gandhi Institute of Engineering and Technology
Gunupur-765022, India

Ankita Das
UG – Student

IV Year EEE-Department
Gandhi Institute of Engineering and Technology
Gunupur-765022 India

Abstract: The model shows the use of thermal, mechanical and electrical components to model a thermistor-controlled fan. The heat-generating device starts producing 10 watts at time zero, and then at 20 seconds this increases to 100 watts. The thermistor hence heats up, and its resistance decreases causing the increase in the voltage across the PWM reference pins. This increases the PWM frequency which in turn increases average motor current, and the fan speeds up. The additional fan speed increases the convective cooling of the device, moderating the temperature increase of the device. The Controlled PWM Voltage and H-Bridge blocks have two modes of operation, namely Averaged and PWM. As this is a software based model, and the thermal time constants are measured in seconds, the Averaged mode of operation is used. The PWM mode replicates the PWM control signal which would typically operate at a few kilohertz.

Keywords: MATLAB, PS-Simulink, Thermistor, H-Bridge, Aerodynamic Drag, Solver Configuration

I. INTRODUCTION

This is a system-level model which might be used for selecting an appropriate thermistor characteristic. The convective heat transfer coefficient used to model nominal cooling (i.e. when the fan isn't running) would typically be determined by experiment.[1]

Knowing the temperature difference and having an estimate of the device area, the heat transfer coefficient assisted cooling could then be estimated by running the motor at maximum RPM, and again measuring the temperature difference. The nominal cooling term also be taken into account when calculating the fan-cooling coefficient.

II. OBJECTIVE OF PROJECT

A. Using software MATLAB for numerical computation and in particularly familiarizing with MATLAB Desktop.

B. Block by block elaborative study of each unit along with heat generating device with their direction of working.

C. Implementation in practical world with various suitable working characteristics of thermistor and adaptability in various conditions.

D. Automatic control of speed of fan based on temperature sensor and study of energy saving by using this sensor.

A. Using software MATLAB for numerical computation: It is a multi-paradigm numerical solving environment and a fourth-generation programming language. This programming language was developed by MathWorks. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. MATLAB users include various backgrounds of engineering, science, and economics. Along with MATLAB there are several other Commercial competitors like Mathematica, TK Solver, Maple, and IDL. There are also free open source alternatives to MATLAB, in particular GNU Octave, Scilab, FreeMat, Julia, and SageMath which are intended to be mostly compatible with the MATLAB language.

B Block by block elaborative study: Application of various blocks such as heat generation unit, pwm unit, H Bridge, DC fan, rotational sensors and simulink converters shows us the complete flow of energy and its conversion. Each block has different set-off values to be set and the output varies accordingly. Such as value at heat generation unit can be set at various values and thermistor senses this change. Now thermistor has its own specification of resistance, reference temperature and temperature coefficient. All these values are varied within range and speed of fan.

C. Implementation in practical world with various suitable working characteristics: MATLAB supports developing applications with graphical user interface (GUI) features. MATLAB includes GUIDE (GUI development environment) for graphically designing GUIs. It also has tightly integrated graph-plotting features.

Hence different characteristic curve of thermistors at different input values of temperature shows us the practical usage and feasibility of such device. One can also conclude the value at which higher efficiency is obtained for such devices. This implies that various output curve can be analyzed with utmost ease and flexibility giving wide scope of experimenting.

D. Automatic control of speed of fan based on temperature sensor and study of energy saving by using this sensor: With latest improvement in science and technology it is necessary to bring out new innovation in existing technology to thrive in society. In this system speed of the fan depends on temperature of the room and manual regulation of speed of fan is not required. Hence useless power wastage is limited as fan working at higher speed during cooler condition can be cause for such losses where manual intervention is required for controlling.

III. COMPONENTS USED

- [1] Heat Generating Device: System based heat generating unit is implemented to generate and vary the heat as per required for analyzing the speed of fan wrt to change in temperature.
- [2] Fan Induced And Nominal Convective Heat Transfer: The additional fan speed increases the cooling of the device using convection, reducing the temperature increase of the device.
- [3] Conductive Heat Transfer: This block is responsible for transferring the heat by conduction through a layer of material. This transfer is based on Fourier law and is directly proportional to the material thermal conductivity, area normal to the heat flow direction, temperature difference, and is inversely proportional to the thickness of the layer. Connections A and B are thermal conserving ports associated with material layers. The block positive direction is from port A to port B. This means heat flowing from A to B is taken positive.
- [4] Positive Supply Rail: This block represents an ideal positive supply rail. Value of this parameter is set to 12V wrt to Electrical Reference Block.
- [5] Thermistor: This block represents an NTC thermistor having B-parameter equation where temperature is governed by equation. $m \cdot c \cdot dT/dt = Q$ where Q is the net heat flow into port A, m is the mass and c is the lumped specific heat capacity. The resistance is established from equation $R(T) = R_0 \cdot \exp(B \cdot (1/T - 1/T_0))$. [2]
- [6] Resistor: The voltage-current (V-I) relationship for a linear resistor is in general represented as $V = I \cdot R$, where R is the constant resistance in ohms. The positive and negative terminals of the resistor are denoted by the + and - signs respectively.
- [7] Solver Configuration: This represents solver settings to be used for simulation. Various parameters involved in it are tolerance value, solver type and algebra to be used, iterations etc.
- [8] Controlled PWM Voltage: This block is a Pulse-Width Modulated (PWM) voltage source across its PWM and REF ports that depends on the reference voltage Vref across its +ref and -ref ports. The duty cycle in percent is given by $100 \cdot (V_{ref} - V_{min}) / (V_{max} - V_{min})$ where Vmin and Vmax are the minimum and maximum values for Vref. The output voltage amplitude is set by the Output voltage amplitude. At time zero, the pulse is initialized as high (unless the duty cycle is set to zero). The Simulation mode can be set to PWM or Averaged. [3]
- [9] H-Bridge: This block represents an H-bridge motor driver. This block can also be driven by the Controlled PWM Voltage block in PWM or Averaged mode. In PWM mode, the motor is under power if the PWM port voltage V is above the Enable threshold voltage. In Averaged mode, the output voltage magnitude is proportional to the PWM port voltage V, reaching to maximum when V is equal to the parameter PWM signal amplitude. Output is governed by formula $[(V_o \cdot V_{PWM}) / A_{PWM}] - I_{OUT} \cdot R_{ON}$. [4]
- [10] DC Motor: This block represents a DC motor having the electrical and torque characteristics with no electromagnetic energy are lost, and hence the back-emf and torque constants have the same numerical value when in SI units.
- [11] Aerodynamic Drag: The block represents an ideal source of torque generation at its terminals which is proportional to the input physical signal.
- [12] Rotational Motion Sensor: The block represents an ideal mechanical rotational motion sensor, that is, a device that converts variable measured between two mechanical rotational nodes into a control signal proportional to angular velocity or angle.
- [13] Fan Inertia: The block is an ideal mechanical rotational inertia which has one mechanical rotational conserving port.
- [14] PS- Simulink Converter: This block is converts the input Physical Signal to a unitless Simulink output signal. The unit expression in 'Output signal unit' parameter must match with the unit of the Physical Signal and determines the conversion from the Physical Signal to the unit less Simulink output signal.

IV. FLOWCHART OF SIMULATION:

The systematic flow of signal and working is explained logically by pictorially representation as following. [1]

1. Initially, when reference temperature is 23 degree Celsius, speed of fan is nearly 100 rpm.
2. When temperature increases to 27 degree Celsius speed of fan also increases to 900 rpm.
3. When temperature is maintained stable, speed of fan also remains constant.
4. When temperature steeply rises to 37 degree Celsius speed rises simultaneously to 2700 rpm.

