Experimental Performance Analysis of Heat Processing of Drive Motor in CNC Machine

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Abstract: CNC Machines are preferred in many industries because of its advantage over other machine. This paper is focused about Designing of CNC machine to reduce the heat when the machine is working long period are done with help of SIMULINK/MATLAB. The On-Off and PID controller are used to reduce the fluctuation and to monitor power consumption. The parameter such as thermal resistance, thermal capacity and set points were studied. On-Off controller is used because of simplicity, lower cost and energy saving capability and it reduce the oscillation. PID controller employed in this project to boost the overshoot and setting time reduction and to reduce the effect of external heat disturbance.

Introduction

The computer programming is fed into the system to run the machine. It acts as total controlling unit of the machine. Computer Numerical Control operates based on the program instructions. It is otherwise called CNC [1]. In older NC machine the program is fed into punched card. The punched card is a piece of paper contains holes to represent the digital information. But in CNC machine the program instructions are directly fed into the computer through small board to perform the operation of the machine [2]. The CNC programs are stored in the system memory. It is rewritable. Therefore the programmers can easily change the instruction based on their requirement. The advantages of CNC machine are user friendly, greater flexibility, compatibility and computational capability etc. It is otherwise called as "soft-wired" Numerical control [3]. CNC machine now a day commonly used in precision engineering. There are still advance in CNC every day.

CNC machine is mainly used for the cutting of metal based on user's requirement. The dimensions, cutting process are carried into the system via program. The machine acts as a ROBOT to perform the action. The applications of CNC machines are milling, micro control drilling, lathe etc [4]. The important purpose of the machine is to take away the unwanted metal to provide correct shape of the metal. In olden days this operation is performed by the experts in the field. But now it can operated using CNC machine. Therefore the operation is reduced [5]. Advantage of using CNC machines are which are reduce time consumption, accuracy, simplicity, cost, errors, simplification of flexible automation greater flexibility, complex machining operations and repeatability are also performed easily. In the CNC machine the instructions will be issues to perform the operation [6]. Therefore the rest of the work runs automatically. CNC motors are the main origin of the CNC machine. The router precision, speed and efficiency are defined by the size and the type of motor.

Literature Review

The first milling machine was called as Numerical control (NC), Mr. John T. Parsons was designed the machine which was around 1940 to 1950s. He was worked and attached servomotors to this numerical control milling machine. Punch cards are used to give the instructions by the presence and absence of holes. By using the manual milling machine, system devising some complex shapes such as arcs, round and cylindrical etc [7]. By using the NC milling machine, such complex shapes are cut easily. Servomotor is also called linear actuator [8]. It allows for the exact control of velocity, velocity and linear position. It requires proper controller and suitable sensor. It is mainly used in robotics and automated manufacturing (CNC machinery). Nowadays, Computer Numeric Control (CNC) milling machines is used. In each and every machines to read G-Code program. For such programmed operations are creates and performs by the users. Parts are designed by using the personal computers. The programs are typed manually of G-code or else Computer Aided Manufacturing in personal computers. The G-code outputs are displayed from the input of cutter and tool path.

Computer Numerical Control is an automated Numerical control system. It is used for a single machine. The single machine tool includes a minicomputer control [9]. It is used to perform the numerical control functions and an instruction is
stored. By using the proper software, to replace the functions such as interpretation and interpolation. Hardware should be includes a servo amplifiers, interface components and transducer circuits [10]. Three major programs consist in the software portion of a CNC system such as a service program, a control program and a part program [11]. To edit, correct and check the part program by using the service program. The service program has a user interface; it is used to operate the machine easily by the user. Control program is used to accept program of the part as input data and it produces the output signals. The signals are used to drive the axes motion [12].

Methodology

In every CNC machine tool depends on the feed drive characteristics. [13] The aim of the feed drive is to move the running parts of the system include tool table, unit and spindle etc. It has a simple kinematics structure. But its optimal design is quite a problem. It consist of actuators, tuning current, position controller elements etc. The transmission elements consist of the machine parts. Mechanical transmission elements are most frequently used in lead screw, nut units, rack, pinion units, gear box, clutches etc. The systems have many subsystems which are outdoor temperature, heater and house. When cold air enters into the system which is heated and sent to the conditioned space. They are two controllers are used in this system which are, On-Off controller /PID controller. PID controller is one of the controller which is used to switch the output. It is used to control the error signal to modify the output of the heater. On-Off controller is mainly used in various applications. In the CNC machine, it is used for simplicity and switching function. To calculate a problem, many assumptions were made. The temperature is kept as constant so that capacitance can be applied. The pressure loss is neglected from the system. It is also called as feedback controller. In a domestic heating system, temperature control for the common example of the on-off controller. During the calculation outdoor temperature are kept at 25 C. The gain values are assumed as constants such as proportional, integral and derivative. The indoor temperature and set point are kept at constant values which are 20C and 24C. The changes in temperature are simulated by sine wave form. The thermostat was set to the limit of 10 degrees. There are two control strategies which have been implemented in the model of CNC machine to control the heat in machine are Simulink of House model/ Simulink of Heat model. In heat model the temperature of air and heat flow are being monitor and in house model heat loss, outdoor temperature and room temperature are being monitored. From these two models we are going to see how to reduce heat in CNC machine.

![Simulink model of CNC machine to reduce or control heat](image1.png)

**Figure 1 Simulink model of CNC machine to reduce or control heat**

The thermal characteristics are used to calculate the thermal resistance of the house. The hot air from the heater provides temperature and flow rate to the On-Off controller. The energy obtained is integrated to give consumption of energy. The fan heat controls heat flow.

Subsystem of the system is,

![Simulink Model of House](image2.png)

**Figure 2 Simulink Model of House**

Here the Fahrenheit are converted into Celsius in the temperature conversion block.

Subsystem of the subsystem1 is,

![Simulink model of Heater](image3.png)

**Figure 3 Simulink model of Heater**

Subsystem of the subsystem2 is,

![Simulink Model of Outdoor Temperature](image4.png)

**Figure 4 Simulink Model of Outdoor Temperature**

Simulink is divided into five groups (subsystems), the Outdoor temperature model, the Thermostat model, the Heater model, the House model and the Output display model. By combining the various subsystems, the overall model appears as Figure 1. Output of the system,
Conclusion

The method of modelling and simulation of the heat control of CNC machine are modelled, analyzed, tested and designed using Simulink/Matlab. An analysis of On-Off and PID controller was conducted. The model developed was used to investigate the effect of many parameters on system performance and energy efficiency. The result shows PID controller effects on outdoor disturbance. The fluctuation caused by On-Off controller influences significantly the state of comfort. The On-Off controller controls an increase in thermal capacity of the system and reducing the fluctuations. It was found that there is no difference in the energy consumed between the two controllers, but the state of comfort is significantly improved in the case of PID controller. This model reduces time to develop and design of different feed drive system of the CNC machine is very useful for design and manufacturing engineers to study and evaluate about CNC machine.

References