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PLC Based Servo Motor Control of Vertical Turret Lathe Machine

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ABSTRACT

The conventional vertical turret lathe machine has frequent breakdown problem due to DC shunt motor and clutch system. Failure of clutches causes frequent breakdown and needs replacements. This hamper the production and increases maintenance cost. This reduces the profit. This raises the need to find the replacement for conventional DC motor and clutch system. AC servo motor controlled through PLC provides the efficient system with precise control. Replacement of conventional system with PLC based servo motor system breakdown of the system will reduce which will reduce the maintenance cost. Productivity will increase and overall profit will also increase.

Keyword- servo motor, plc, maintenance

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I. INTRODUCTION

The turret lathe is a metalworking lathe. It is used for repetitive production of metal parts. Turret is a tool holder which allows multiple cutting operations to be performed. It performs operation in rapid succession. There is no need for operator to perform set up tasks such as installing or uninstalling the tool. There is also no need to control tool path. Tool path is controlled by servomechanism.

Turret lathe can be classified as follows

Size

- Small
- Medium
- Large

Method of control

- Manual
- Automated Mechanically
- Automated via CNC

Bed orientation

- Horizontal
- Vertical

Vertical Turret Lathe

The vertical orientation allows the headstock to sit on the floor and faceplate become a horizontal rotating table. This is useful in handling very large and heavy work pieces. Vertical turret lathes in general are also called as vertical boring mills or often simply boring mills, therefore vertical turret lathe is a vertical boring mill equipped with a turret.

Main Components Used

I. AC Servo Motor
II. Programmable Logic Controller

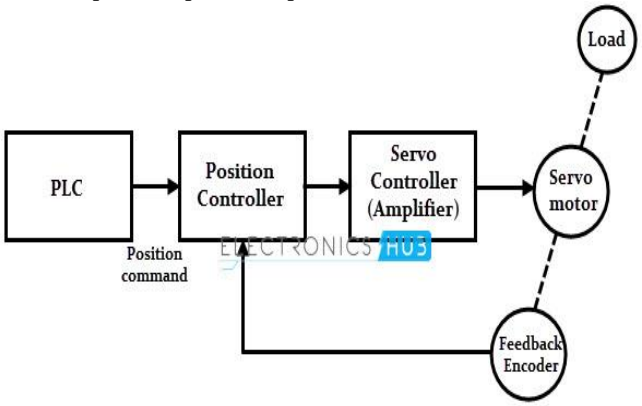
i. AC Servo motor

A servo motor is used widely for variable speed drives in industrial production, process automation and building technology. Servo Motors are designed to use in motion control applications which require high precision in positioning, quick reversing.

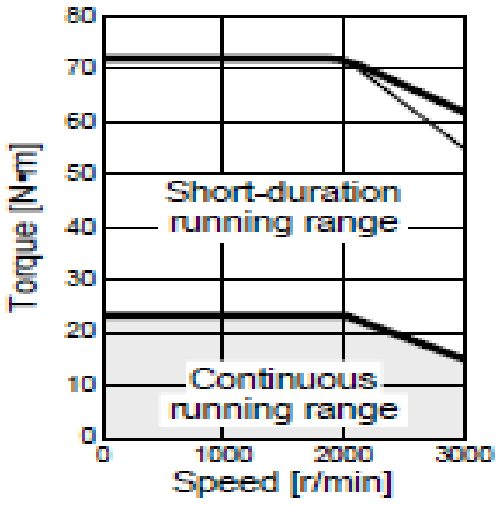
A Servomotor is a close loop servomechanism. It uses position feedback to control its motion. Servo motor is a combination of a motor, feedback sensor, servo controller and other electronic circuit. A encoder is used to provide speed feedback and position feedback. The feedback signal is compared with input reference signal using a comparator. The error signal available at the output of comparator is amplified using a amplifier raises the voltage and power level of the error signal which is then provided to the motor. The whole assembly of comparator and amplifier is combined in servo controller.

Servo Motor

Two-phase squirrel cage induction motors are generally used as AC servo motors for low power applications. Three phase squirrel cage induction motors have been modified so that they can be used in high power applications. Difference between a induction motor and AC servo motor is that the rotor of a servo motor is made of thinner conducting bars, so as to increase the rotor resistance. When the stator winding is excited rotor follows the rotating magnetic field of the stator. With this permanent magnet rotor, no rotor current is needed and hence less heat is produced. Efficiency of these motors is high due to the absence of rotor current. An encoder is placed on the rotor to know the rotor position with respect to stator field and acts as a feedback sensor to provide feedback to the servo controller. The working principle of AC servo motor is similar to the conventional induction motor only difference is the ue of servo controller to know the exact position of rotor for precise speed and position control.



Block diagram of AC servo motor



Torque characteristics

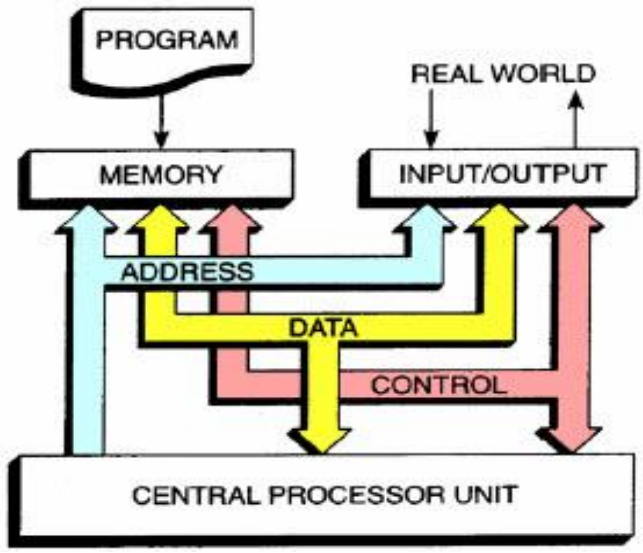
ii. Programmable Logic Controller (PLC)

It is major component in the industrial automation sector due to its robust construction, exceptional functional features such as sequential control, timers and counters, easy programming, reliable controlling capabilities. PLC is a special-purpose digital computer. Different types of PLCs from vast number of manufacturers are available.

PLC is capable to continuously monitor the inputs from sensor and produces the output to operate the actuators based on the program stored.

PLC system has these three basic modules:

i. Power Supply Module
ii. CPU Module
iii. I/O Module



Architecture of PLC

i. Power Supply Module

Power supply module supplies the power requirement of the whole system. It converts the available AC power to DC power for CPU and I/O modules. The output is either 5V DC or 24DC.

ii. CPU Module

CPU is a central processing unit. The CPU accepts all inputs and performs all the necessary computations and data processing to produce output. It include ROM and RAM. ROM contains the operating system and application programs, whereas RAM stores user programs and data. a keyboard or monitor is used for programming the processor.

iii. I/O Module

Input and output modules of the PLC are used to interface input and output devices to CPU. These I/O modules vary in type, range, and capabilities. I/O modules can be analog or digital.

Digital I/O module:

These modules are used to connect the input and output devices which are digital i.e., only have two states ON and OFF states. These modules can be AC and DC modules with variable number of inputs and outputs.

Analog I/O modules:

Analog modules are used to provide the analog electric signals. It uses a analog to digital converter to convert the analog data to digital data.

III. MECHANISM

A servo motor uses position signal from position sensor to control its motion and position. An encoder is placed in rotor circuit of motor to sense the shaft position. The sensed signal of position is given to servo controller. The servo controller also receives the reference signal from PLC.

Reference signal from PLC is used to decide the direction of rotation of motor, speed of rotation. The servo controller compares the two signal at its input to produce output to the motor. The output signal of controller is proportional to error between the two input signals. A amplifier amplifies the output signal so that it can be feed to the motor. As per input received from the controller motor starts to rotate in forward or reverse direction at particular speed.

As motor reaches close to the final position error signal produced reduces. The output of controller reduces and motor stops when error signal produced is reduced to zero indicating that motor is reached to final position. This motor rotates only at full speed. It forms the basis of simple servo system.

IV. CONCLUSION

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By replacing the conventional system by highly efficient and accurate system of PLC controlled servo motor downtime of machine is reduced. Positive effect of this is seen in increased productivity and overall profit.

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