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COMPREHENSIVE REVIEW OF MOTOR DRIVE FOR FEED DRIVES USED IN CNC MACHINE

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Abstract : - The integration of advanced motor drive systems is pivotal in enhancing the performance and precision of Computer Numerical Control (CNC) machines, particularly in feed drives responsible for controlling the movement of critical machine components. This research focuses on a comprehensive performance analysis of motor drives in CNC machines, with a specific emphasis on feed drives. The study explores various aspects including speed and acceleration profiles, positional accuracy, dynamic response, energy efficiency, and reliability.

The investigation begins by examining the speed and acceleration profiles of motor drives to understand their ability to achieve and sustain desired speeds. Positional accuracy is then scrutinized, with a focus on minimizing errors and backlash, ensuring the CNC machineonsistently produces components adhering to specified dimensions. The dynamic response of the motor drives is assessed to ascertain their capability to handle rapid changes in motion, contributing to enhanced cutting efficiency and reduced cycle times.

Index Terms **– Introduction, Related Work**

I. INTRODUCTION

In the Real of modern manufacturing, Computer Numerical Control (CNC) machines play a pivotal role in achieving precision and efficiency. These machines rely on sophisticated motor drives to control the movement of various components, such as the cutting tool or workpiece. The performance analysis of motor drives in CNC machines is a critical aspect, as it directly influences the overall efficiency, accuracy, and reliability of the manufacturing process.

Motor drives in CNC machines are responsible for converting electrical energy into mechanical motion, enabling precise control over the machine's axes. The feed drives, a subset of motor drives, are particularly crucial as they dictate the speed and accuracy with which the cutting tool or workpiece is moved during machining operations. Analyzing the performance of these motor drives is essential for ensuring optimal machine functionality and meeting the stringent demands of modern manufacturing.

2. Related Work

In [1] Article presents an analysis of speed control of Brushless DC (BLDC) motor for feed drives. The feed drives play a crucial role in CNC machines. BLDC motor has been progressively replacing conventional DC drives in various applications due to its brushless and low power-loss operation. In this paper three phase voltage source inverter fed BLDC motor control is analysed. The proposed model has been developedusing Simulink/MATLAB and also their speed and torque performance for various load conditions using PI Controller. Are analysed.

The performance of feed drives is essential in CNC machine which decides the accuracy and repeatability. In this artical, BLDC motor is proposed for feed drive. The essential characteristic of feed drive of less waviness in speed is analysed in this paper using PI controller. Performance is analysed for wide speed and various loads. Wide speed states that analysis covers over rated speed, over rated speed and under rated speed. In all speeds not only the steady state error is minimum the peak overshoot is also less than

2%. From the reproduction results, it is obvious that the future system produces less steady state error which meets the requirement of feed drive.

In [2] The Brushless DC Motor (BLDC) is one of the best electrical drives that have increasing popularity, due to their high efficiency, reliability, good dynamic response and very low maintenance. Due to the increasing demand for compact & reliable motors and the evolution of low-cost power semiconductor switches and permanent magnet (PM) materials, brushless DC motors become popular in every application from home appliances to aerospace industry. The conventional techniques for controlling the stator phase current in a brushless DC drive are practically effective in low speed and cannot reduce the commutation torque ripple in highspeed range. This paper presents the PI controller for speed control of BLDC motor. The output of the PI controllers is summed and is given as the input to the current controller. The mathematical modeling of BLDC motor is also presented. The BLDC motor is fed from the inverter where the rotor position and current controller is the input. The complete mathematical model of the proposed drive system is developed and simulated using MATLAB/Simulink software. The operation principle of using component is analysed and the simulation results are presented in this to verify the theoretical analysis.

In this thesis, a mathematical model of brushless DC motor is developed. The simulation of the brushless DC motor was done using the software package MATLAB/SIMULINK. In this thesis a review of position control using Hall sensor methods for BLDC motors has been presented. It is obvious that the control for BLDC motors using position sensors, such as shaft encoders, resolvers or Hall- effect probes, can be improved by means of the elimination of these sensors to further reduce cost and increase reliability. In this thesis we have done result analysis and found results in different load conditions. We have also analyzed the steady state condition and transient condition. The steady state condition was found to be very close to the transient condition.

In [3] The BLDC motor is an electronically commutated dc motor becoming very popular in many applications. There are various speed control methods used for BLDC motor. The performance of BLDC motor drives can be improved using sensored control techniques over sensorless technology. This paper presents Brushless Direct Current motor drive system and its sensored speed control technique with PWM. Advantages and limitations of sensorless techniques are reviewed and then, sensored speed control technique is introduced with their advantages, performance analysis, practical implementation and applications. Torque and speed behavior during clockwise and anticlockwise motion, use of hall sensors to detect rotor position, speed control technique using PWM method are discussed in detail. Detailed hardware design its implementation and experimental results covered.

This paper also covers performance analysis of BLDC motor using experimental results. BLDC motors have several advantages over brushed DC motors and induction motors. It provides highly efficient and noiseless operation. With these advantages, BLDC motors can be used in all applications wherever brushed dc motor and induction motor used. The sensored PWM control scheme proposed for BLDC motor to vary the speed of motor worked well as expected. It provides wide speed control range with high torque. Test results are verified for both CW to CCW direction. The significant advantages of the proposed work are: simple hardware circuit, reliability of the control algorithm, excellent speed control with and without load conditions. The sensored control algorithm is very simple to implement using PIC microcontroller. The designed and implemented prototype model may be implemented even for higher rated motors.

In [4] wide applications such as in battery operated vehicles, wheel chairs, automotive fuel pumps, robotics, machine tools, aerospace and in many industrial applications due to their superior electrical and mechanical characteristics and its capability to operate in hazardous environment. Conventional controllers fail to yield desired performance in BLDC motor control systems due to the non-linearity arising out of variation in the system parameters and change in load. The main focus is now on the application of artificial intelligent techniques such as fuzzy logic to solve this problem. Another great challenge is to reduce the size and cost of the drive system without compromising the performance. In this paper, the design and digital implementation of fuzzy logic controller using a versatile ADUC812 microcontroller, and low- cost, compact, superior performance components are used in order to reduce the cost and size of the drive system. The experimental results are presented to prove the flexibility of the control scheme in real time.

The proposed low cost, compact, robust, fuzzy logic speed controller for BLDC motor using a versatile Aduc812 microcontroller is designed, implemented and tested. The set speed is varied and the variation in the motor speed is measured and the performance of drive is found to be excellent. The motor is subjected to disturbances by changing the load and the transient and steady-state behavior of the system is studied. It is found that the system responds faster with no overshoot and the actual speed matches with the set speed under different load conditions. It is also found that this drive less is affected by electromagnetic interference and noise signals. Several protective functions like over current protection, over voltage, and thermal protection to protect the BLDC drive can also be implemented in the Aduc812 microcontroller. This entire drive can be put in a compact module and it can be used for speed control applications.

In [5] general overview of BLDC motors, including their advantages against other commonly-used motors, structure, electromagnetic principles, and mode of operation. This document also examines control principles using Hall sensors for both single-phase and three-phase BLDC motors, and a brief introduction to sensorless control methods using BEMF for a three-phase BLDC motor.

This application note introduces the motor fundamentals, with special attention to BLDC motors. As described in this document, a BLDC motor has many advantages over a brushed DC motor and an AC induction motor: It is easily controlled with position feedback sensors and generally performs well, especially in speed/torque. With these advantages, BLDC motor will spread to more

applications. Moreover, with the development of sensorless technology, BLDC motor will become convenient or indispensable in applications with environmental limitations.

3. CONCLUSIONS

After a thorough analysis of the above papers under consideration, it is evident that [1] emerges as the most compelling and noteworthy. This paper provides a comprehensive analysis of the performance of PV module positions under partial shading conditions, offering valuable insights into the impact of module positioning on energy output. It also discusses the use of bypass diodes and maximum power point tracking (MPPT) techniques to mitigate the effects of partial shading on PV systems. Additionally, the study introduces a reference model developed using artificial neural networks (ANN) to estimate the power output of the PV system under various conditions, providing practical recommendations for improved energy production. Overall, the paper presents significant contributions to the understanding of PV system performance under partial shading conditions and offers valuable insights for future research and practical applications in the field of solar energy.

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