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Novel and Efficient Thermal Error Reduction Strategy For Machine Tool Performance Improvement

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1. INTRODUCTION

CNC Machine tool
- Massive production
- Reduced timescales
- Accuracy

Customer satisfaction

2. THE PROBLEM

Volumetric error = $e_T + e_G + e_{NR}$

Scrap
Rework
Time waste

CNC Machine tool

Thermal error represents 70% of the total volumetric error

3. OBJECTIVES AND METHODOLOGY

- Prediction of Thermal behaviour
- Machine CAD simplifications

4. THERMAL ANALYSIS

4.1 EXPERIMENTAL MACHINE TESTING - ONLINE ANALYSIS

- Thermal Sensors
- Displacement Transducers
- Thermal Imaging

4.2 FINITE ELEMENT ANALYSIS (FEA) - OFFLINE ANALYSIS

- Experimental temperature and displacement profiles
- Simulated temperature and displacement profiles

Machine head
Tool
Machine's front view

70% to 86% correlation achieved in experimental and FEA simulated displacement results

5. RESULTS

Experimental temperature and displacement profiles

Simulated temperature and displacement profiles

6. NOVELTY

- Simplified machine CAD
- Accurate thermal coefficients
- FEA offline thermal assessment
- Quickly applicable to machines
- Reduce machine downtime
- Internal heating and varying Environment modelling
- Robust machine thermal assessment
- Long term ambient FEA models
- Long term stability

Thermal condition assessment
- Thermal imaging/Sensors
- Parameter correlation between
- FEA estimations/Actual temperature comparison
- FEA results/Actual machine data obtaining
- Thermal algorithms using existing approaches