57th CIRP Conference on Manufacturing Systems 2024 (CMS 2024)

Digital Twin Based Online Material Defect Detection for CNC-Milled Workpieces

First Author[a,b], Second Author[a,*], Third Author[b]

aHochschule Reutlingen, ESB Business School, Alteburgstrae 150, 72762 Reutlingen, Germany
bDepartment of Industrial Engineering, Stellenbosch University, Joubert Street, Stellenbosch, 7600, South Africa

* Corresponding author. Tel.: +49-7121-271-5005; fax: +49-7121-271-90-5005. E-mail address: dominik.lucke@reutlingen-university.de

Abstract

Achieving reliable lot size one compatible and adaptable online quality monitoring for CNC-milled workpieces remains elusive yet. To address this challenge, our approach aims to bridge the current gap in research by developing a cost-effective and reference-independent monitoring concept for material defect detection in CNC-machined parts. This paper presents a novel digital twin-based method, utilizing machining vibrations and a g-code-based encoding of the cutting process. The objective is to detect material defects, such as blowholes, without the need for individual workpiece references. The proposed method aims to reduce barriers to entry, minimize waste, and enhance machine productivity by enabling automated early online quality control. To develop and validate the model, we generate a new dataset combining machining vibration with technological context data such as chip-shape. We demonstrate the feasibility and potential of the approach in a job shop setting on a 3-axis CNC mill.

1. Introduction

<div>

Nomenclature

A   radius of
B   position of
C   further nomenclature continues down the page inside the text box

</div>

1.1. Structure

2. Introduction

Moti(erste seite)

3. Related work

(state of the art) (1,5seiten)

4. Aproach

(vorgehen + prinzipielle aufbau/Konzept)

5. Implementation

(in python, auf emco, DoE...)

6. Validation

7. Conclusion

and futere recommendation (halbe seite)
Zitiertest...
[1]
[2]
[3]

[4]
[5]

References

[1] Y. M. Al-Naggar, N. Jamil, M. F. Hassan, A. R. Yusoff, Condition monitoring based on IoT for predictive maintenance of CNC machines, Procedia CIRP 102 (2021) 314–318. `doi:10.1016/j.procir.2021.09.054`.

[2] D. Axinte, N. Gindy, Assessment of the effectiveness of a spindle power signal for tool condition monitoring in machining processes, International Journal of Production Research 42 (13) (2004) 2679–2691. `doi:10.1080/00207540410001671642`.

[3] L. Ma, I. Howard, M. Pang, Z. Wang, S. Jianxiu, Experimental Investigation of Cutting Vibration during Micro-End-Milling of the Straight Groove, Micromachines 11 (2020) 494. `doi:10.3390/mi11050494`.

[4] D. Biermann, A. Zabel, T. Brüggemann, A. Barthelmey, A Comparison of Low Cost Structure-borne Sound Measurement and Acceleration Measurement for Detection of Workpiece Vibrations in 5-axis Simultaneous Machining, Procedia CIRP 12 (2013) 91–96. `doi:10.1016/j.procir.2013.09.017`.

[5] T. Chen, Y.-C. Lin, Feasibility Evaluation and Optimization of a Smart Manufacturing System Based on 3D Printing: A Review, International Journal of Intelligent Systems 32 (4) (2017) 394–413. `doi:10.1002/int.21866`.