
Conversational Intelligence for Industrial Quality Control: AI-Driven Defect Classification in Wood Edgebanding

Master's Thesis

This thesis explores how an AI-driven conversational agent can replace expensive hardware sensors by guiding operators through the process of classifying product defects. The work focuses on translating human visual observation into structured data that can be used for automated machine adjustment.

Motivation

In the wood manufacturing industry, specifically within the edgebanding process, maintaining high quality requires a deep understanding of complex machine interactions. When a defect occurs, it currently takes a highly experienced operator to diagnose the root cause and adjust the machine parameters correctly. However, such qualified personnel are becoming increasingly scarce, and the "trial-and-error" method used to find optimal parameters is costly in terms of both time and material. While high-end automated sensor systems can solve this, they are often too expensive for manufacturers. A promising alternative is a "Human-in-the-Loop" approach: using an AI agent to act as a digital expert, leading the operator through a diagnostic conversation to accurately identify the defect. This creates a scalable way to achieve high-quality production without the need for prohibitive hardware investments.



Abbildung 1: Edgebanding Maschine

Objectives

This thesis involves designing a system where an AI agent guides operators through structured interactions to diagnose production defects. You will leverage a knowledge base of defects, attributes, and visual aids to enable high-certainty classification of defect type, position, and dimensions. The work requires analyzing industrial quality assurance needs and developing conversational logic—comparing AI architectures to identify the most reliable and efficient method for data extraction. The outcome is a prototype converting diagnostic conversations into structured technical reports.

Key tasks include:

- Analysis of the domain-specific "defect library" (attributes, types, and visual examples).
- Development of a conversational strategy/flow to guide non-expert users.
- Implementation of an AI agent prototype (e.g., utilizing LLMs, RAG, or decision-logic).
- Development of a method to calculate the certainty/confidence of the final classification.

Interests and Helpful Prior Knowledge

- 🔧 Experience with modern AI frameworks, Knowledge Graphs and information modeling.
- 👤 Comfortable working independently to design a software prototype.



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