Capturing & Quantifying Tacit Knife Grinding & Sharpening Knowledge

Dhvani AI Research Team

In collaboration with Fukabe Kaji Knife Company

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Outline

Objectives

- Capture tacit grinding & sharpening expertise from master craftsmen
- Quantify process parameters and outcome metrics
- Prototype AI-driven automation and closed-loop control
- Define industry-wide training and certification standards

Methodology Overview

1. **Multimodal Sensing**: Video, motion capture, audio, force sensors
2. **Data Annotation**: Expert labeling of quality outcomes
3. **Modeling**: Process-to-quality mapping & anomaly detection
4. **Automation**: Robotic grinding assist with adaptive control
5. **Training System**: Sensor-based feedback for trainees

Sensor Configuration

- High-speed cameras for stroke analysis (FPS > 300)
- Optical/inertial trackers on tool handle
- Load cells for force/torque measurement
- Directional microphones for acoustic signature

Data Collection & Annotation

- Record $\sim$30 knives per craftsman with diverse geometries
- Annotate key decision points and quality labels (good/bad)
- Measure surface finish (profilometry) and edge sharpness tests

Modeling & Automation

- **Process Modeling**: Map motion/force/audio to quality outcomes
- **Vision Inspection**: CNN classification of finish defects
- **Closed-loop Control**: AI agent adjusts parameters in real time
- **Prototype**: Robotic arm executes expert-like strokes

Training & Certification

- Sensor-assisted training modules with live feedback
- Standardized test pieces and automated evaluation
- Digital badge certification based on AI-validated metrics

Project Plan & Timeline

Phase	**Deliverables**
Pilot	Data rig, pilot dataset
POC	Models, prototype grinder
Training	Curriculum, software platform