Teaching materials
Deliverable 2. Dynamic Burnishing Analysis

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Mechanical systems

Workgroup: RzuT, UNICA, UCLM, UNICAS

This document corresponds to the first burnishing exercise for the competence 'Mechanical Systems'. ‘ Exercise 2 - Dynamic Burnishing Analysis’

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1 Dynamic Burnishing of a Shaft for Two Indentation Patterns

1.1 Objective of the Exercise

- Analyse the impact of dynamic indentation on the depth and distribution of indentations on the shaft surface.
- Compare two different indentation patterns produced during dynamic indentation.

1.2 Task Description

1. Move the tip of the burnisher towards the workpiece until it makes contact. Read the value of force F (or spring deformation Δ) when the mechanism's arms are fully extended (this represents the additional static force applied to the workpiece by inner spring compression).
2. Set the servo angular velocity to, for example, 500 rpm
    a. On the HMI, select the Dynamic option (Fig. 1, 1) to initialize the Dynamic burnishing process.
    b. Enable the motor by ticking the Enable Motor checkbox (Fig. 2, 1).
    c. Use the slider (Fig. 2, 2) to set the maximum Burnisher servo angular velocity.
    d. Alternatively, input the angular velocity value manually in the text box (Fig. 2, 3).
3. Start the shaft rotation (n) and engage the lathe feed (t).
4. The dynamic indentation process is conducted in two variants. Pointwise indentation at specified intervals along the shaft axis, producing indentations with different spacing.

- **Pattern 1:** n = 1rev/3mm, ω = 300 rev/min, t = 0.5 mm
- **Pattern 2:** n = 1rev/3mm, ω = 500 rev/min, t = 0.5 mm
    - Burnisher servo angular velocity (ω),
    - Rotational speed of the shaft (n),
    - Burnisher head pressing depth (t).

5. Perform two experiments over one full rotation of the shaft:
    - To stop the experiment, set the angular velocity to 0 and disable the motor using Enable Motor checkbox.

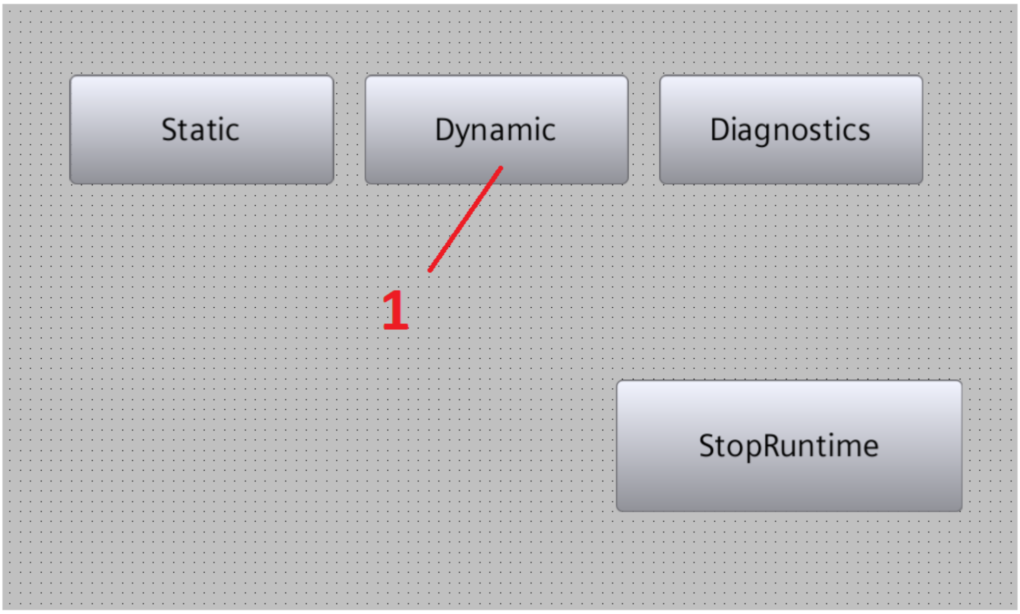

Fig. 1 Main menu

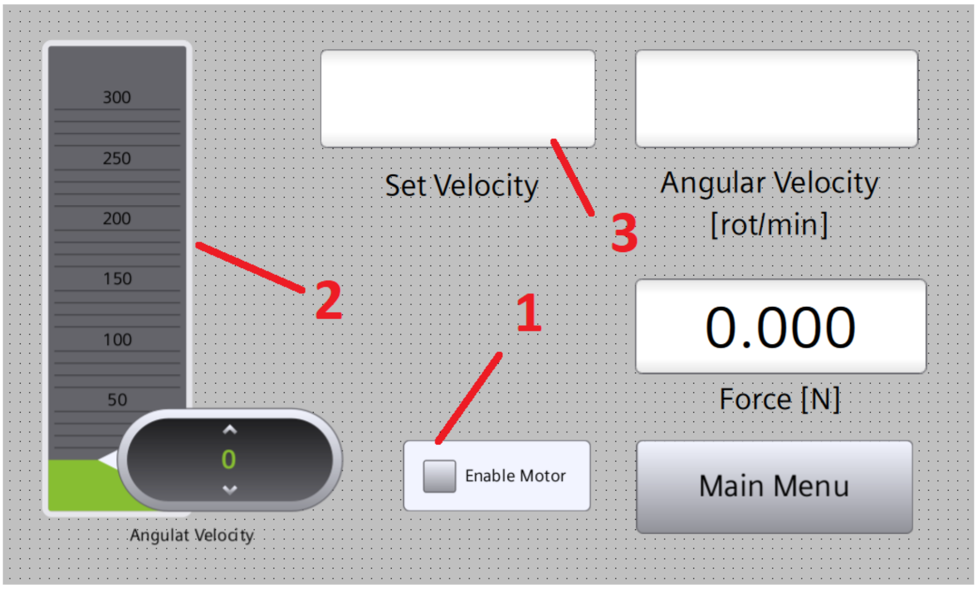

Fig. 2 Dynamic burnishing menu

6. Measure the depth of the indentations (δ) and their distribution on the shaft.
7. Perform theoretical calculations according to the previously presented theory:
   - Depth of indentation:

$$\delta = \sqrt{\frac{mv_d^2}{2\pi RH}},$$

   - Maximum force:

$$F_{\text{max}} = v_d\sqrt{2\pi RHm}.$$

The velocity v_d is calculated based on the burnisher's geometry and the burnisher servo's rotational velocity ω, using the equation:

$$v_D(\varphi) = \omega\left[-a\sin(\varphi) - \frac{a^2\sin(\varphi)\cos(\varphi)}{\sqrt{b^2 - a^2\sin^2(\varphi)}}\right]$$

8. The results of the calculations are compared with the experimental results, considering differences in the indentation depth and distribution for both patterns.

1.3 Expected Results

- Comparison of the depth and distribution of the indentation for both dynamic indentation patterns.
- Graphs showing the relationship between indentation depth and process parameters (ω, n, δ).
- Assessment of which indentation pattern provides better surface quality and uniformity of the shaft using a profilometer.