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Autonomous Robotic Tribology Testing System for Lubricated Hot Aluminum Blanks

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This study reports an autonomous experimental setup designed to perform multi-cycle tribological characterization on heated metallic blanks by integrating a UR10 robotic arm. The system incorporates a custom-designed pin holder mounted on the robotic arm to securely hold the die material pin [1], enabling tribological evaluation across a wide range of applied normal loads and sliding velocities against the heated blank strip. Prior to testing, liquid lubricants are uniformly applied onto the heated blanks utilizing an automated spray gun apparatus. The robotic manipulator is seamlessly integrated with the Robot Operating System (ROS) framework [2], facilitating autonomous control of the arm kinematics and synchronized data acquisition via the UR ROS Driver interface [3].

Upon completion of each tribological cycle, the friction data is automatically recorded, processed, and visualized through the implementation of advanced algorithmic routines developed in Python, significantly reducing the requirement for manual data handling by the researcher. Results are presented elucidating the coefficients of friction (COF) obtained during sliding tests performed on 2 mm thick aluminum alloy AA6111 blanks at elevated temperatures of 300°C and 350°C. The autonomous nature of this experimental setup streamlines the overall workflow, promoting systematic and efficient data collection, processing, and characterization procedures. Highlighting the benefits of robotic process automation and integrated software paradigms within the domain of tribological research, this system notably enhances experimental throughput. The study comprehensively details the system architecture, experimental methodology, and showcases salient results acquired from the autonomous tribological evaluation of lubricated hot aluminum blanks.

[1] Yang, X. et al. (2021). Experimental and modelling studies of the transient tribological behaviour of a two-phase lubricant under complex loading conditions. Friction.

[2] Quigley, M. et al. (2009). ROS: an open-source Robot Operating System. IEEE International Conference on Robotics and Automation.

[3] UniversalRobots/Universal_Robots_ROS_Driver. (2024). GitHub repository. https://github.com/UniversalRobots/Universal_Robots_ROS_Driver