

A MACHINE LEARNING STRATEGY TO PREDICT DRY FRICTION FROM THIRD BODY MORPHOLOGY

A. Bouchot ^{a,b}, A.Ferrieux ^b, J.Debayle ^c, G.Mollon ^b, S.Descartes ^{b*}

*sylvie.descartes@insa-lyon.fr

^a Univ Lyon, ECAM LaSalle, LabECAM, 40 Montée Saint Barthélémy, Lyon Cedex 05, 69321, France,

^b INSA Lyon, CNRS, LaMCoS, UMR5259, 69621 Villeurbanne, France

^c Mines Saint-Etienne, CNRS, UMR 5307 LGF, Centre SPIN, Saint-Etienne F-42023, France

KEYWORDS

Friction, Tribofilm and 3rd bodies, Machine learning / AI.

ABSTRACT

There is no pre-established model in tribology for predicting dry friction. This work proposes to lay the foundations for building an efficient database that is representative of the morphology of the third body, with the aim of understanding whether it is possible to predict the local friction coefficient from the latter, using machine learning. Its use requires to build a quality database [1]. Indeed, databases are one of the critical elements in machine learning as they allow to train artificial intelligence algorithms and as consequence to build models. It was with this in mind that this study was developed. The aim of the study is to seek to predict dry coefficient of friction, by means of a quantitative description of the frictional interface, known as the third body.

For that purpose, the work is divided into four stages. Firstly, tribological experiments, carried out on a pin on disk tribometer, enable the acquisition of temporal signals of the tangential force, for several test conditions. The second stage consists of analysing the experimental data, i.e. the evolution of the friction coefficient and the analysis of the rubbed surfaces using a scanning electron microscope (SEM). The third stage involves processing and analysing the SEM images [2]. Finally, the last stage consists of finding correlations between the characteristic morphology of the third body and rheological data. To do this, five different databases are constructed, and a Random Forest (RF) machine learning algorithm is implemented.

A critical study of the various databases used is carried out to highlight the impact of datasets configurations on friction prediction results. Results show that an algorithm trained on third body morphological features can provide a fairly accurate prediction of the local value of the friction coefficient in a variety of tribological situations, with an average error close to 0.14 (Table 1). An illustration of prediction is given on Figure 1 for the training set, the test set, and the generalization test. Bold dotted lines correspond to measure = prediction, grey areas correspond to a prediction error lower than 0.2.

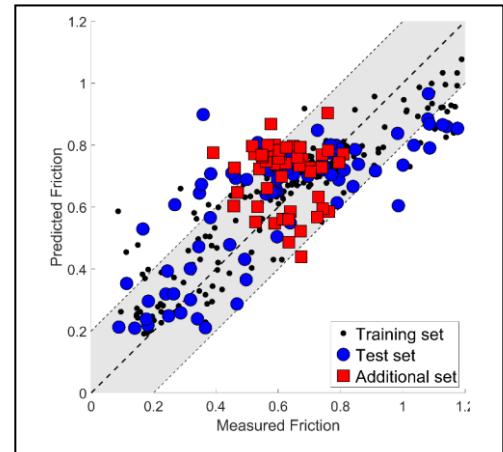


Figure 1: Comparison of measured and predicted COF values from selected database.

Table 1 Model performance.

| | |
|-------------------------------|-----------------|
| Average Error | 0.1438 |
| Cross Validation Error | 0.0882 ± 0.0371 |

ACKNOWLEDGMENTS

This work has been funded by a public grant from the French National Research Agency (ANR) under the “France 2030” investment plan, which has the reference EUR MANUTECH SLEIGHT - ANR-17-EURE-0026

REFERENCES

- [1] A.Bouchot., A.Ferrieux., J.Debayle., G.Mollon., & S.Descartes. (2024). Can Machine Learning Predict Friction from Third Body Morphology?. *Tribology International*, 109361.
- [2] A.Bouchot., A.Ferrieux-Paquet, G.Mollon., S.Descartes, & J.Debayle. (2022). Segmentation and morphological analysis of wear track/particles images using machine learning. *Journal of Electronic Imaging*, 31(5), 051605-051605.