Machine fault identification using Acoustic Imaging and Deep Convolutional Neural Networks

Kiran Anginthaya, Dragan Kostić, Faysal Boughorbel, Ines Lopez Arteaga

Objective

Apply acoustic imaging in combination with Convolutional Neural Networks (CNNs) to identify faults in commercial wirebonder machines.

Introduction

Prognostic Health Management (PHM) is an appealing approach to increase the manufacturing throughput in semiconductor industries. Acoustic imaging is a promising non-intrusive sensing technique for machine condition monitoring. In this research, we investigate whether acoustic imaging in combination with deep CNNs can identify the root-causes of performance degradation in the motion stages of ASM Pacific Technology wirebonder machines.

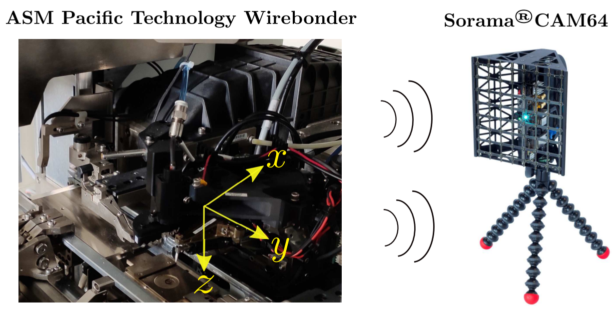

Figure 1: Schematic of the system.

Methodology and Results

Using the sound camera Sorama®CAM64, we obtain acoustic measurements in the form of spectrograms. After pre-processing the spectrograms, a MobileNet CNN [1] is trained on repetitive motion data. Prediction for a combination of different motions is achieved using a novel sliding window based algorithm illustrated in Figure 2.

Table 1: Classification accuracy (AUC values) for the faulty scenario under consideration.

Class	AUC
No motion	0.93
$x-$ motion	0.99
$y-$ motion	0.85
$xy-$ motion	0.99

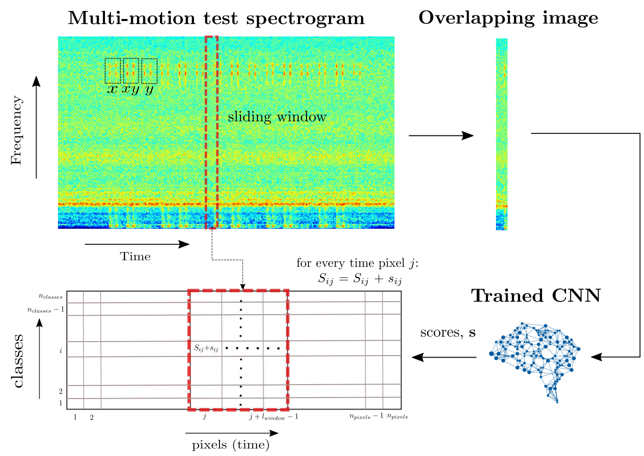

Figure 2: Proposed sliding window algorithm.

We test this algorithm under a representative faulty scenario, mimicking the excitation of undesired resonance frequencies as shown in Figure 3. The resulting Area under the curve (AUC) values for the above mentioned faulty scenario are tabulated in Table 1.

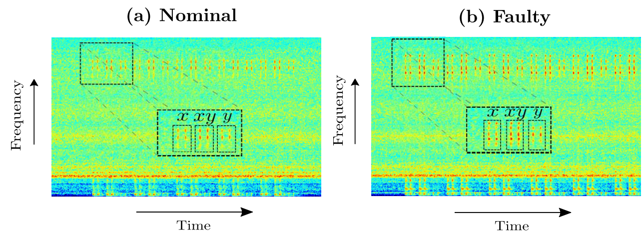

Figure 3: Spectrograms for nominal and faulty scenario.

Conclusions and Outlook

- The proposed framework is tested successfully when there are undesirable resonances in the wirebonder motion stages, since the AUC values are > 0.8 for all classes.
- The present approach can be further extended to identify other commonly occurring faults such as change in friction characteristics, motor force constant degradation and mechanical interaction between moving parts.

References

[1] Howard, A. G., Zhu, M., Chen, B., Kalenichenko, D., Wang, W., Weyand, T., Andreetto, M., & Adam, H. (2017). Mobilenets: Efficient convolutional neural networks for mobile vision applications. *arXiv preprint arXiv:1704.04861*.

Department of Mechanical Engineering