Capstone Project

DDI Smart Diagnostics

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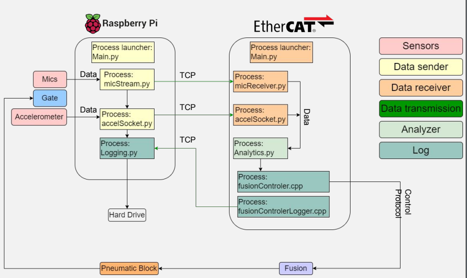
Abstract

DDI Smart Diagnostics is a solution to underutilization of the lifespan of wafer manufacturing vacuum gates. Detecting the level of degradation of vacuum gates would allow semiconductor manufacturers to schedule maintenance before gate failure, which would expand the lifespan of each gate and thus reduce the cost of production.

Approach

By monitoring the gate with microphones and an accelerometer as it runs, we collected data in order to see how these audio frequencies and accelerometer data changes over time in a high temperature environment.

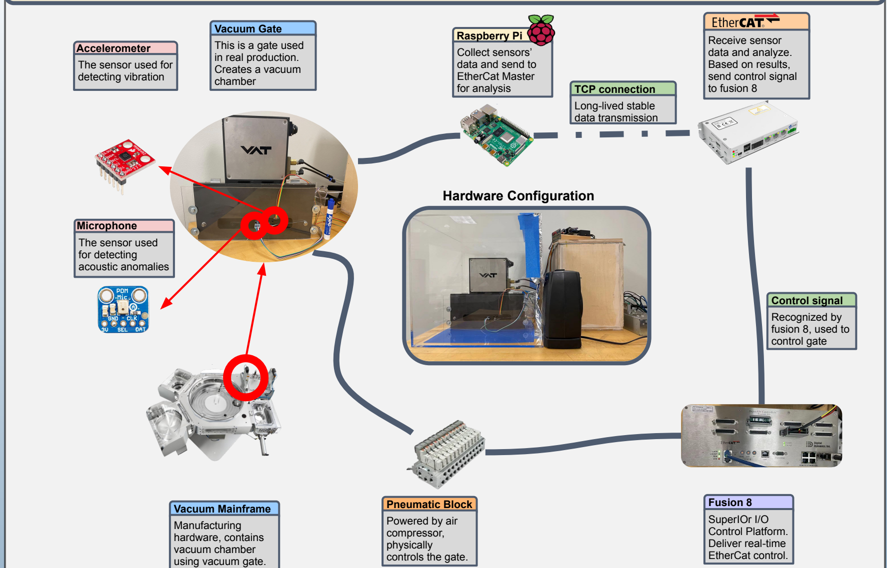
Processes on the EtherCat control the gate, record its operating status, and transfer status data back to the Raspberry Pi for Logging. Then, we accelerate wear by adding heat, to force gate failure.



Overview

During semiconductor manufacturing, one of the major points of failure is vacuum gate degradation which leads to wafer contamination. The current solution is to preemptively change the gate before it fails, which needlessly increases the down-time of the whole system. In order to increase its efficiency, the team developed a system to detect the onset of deterioration of the gate vacuum seal. This involved data collection via microphones and accelerometers, persistent storage of this data, signal processing, and analysis of the data for the detection of signatures indicating normal operations and identifying transitions to degraded material states.

Workflow



Acknowledgments

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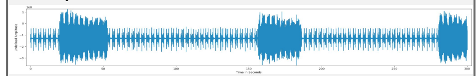
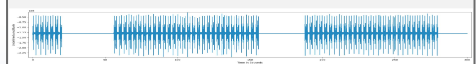
Results

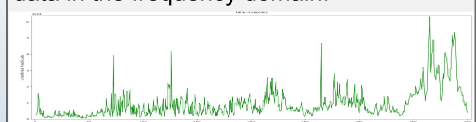
Sensor's picked up loud periodic air compressor sounds:



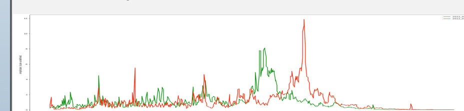
The air compressor sounds had to be removed to leave a clean signal:



With a cleaned signal, fast Fourier transforms were performed, delivering data in the frequency domain:



Over time and with the addition of heat certain frequency profiles shifted into higher ranges, indicating a change indicative of wear. This can be seen in a plot overlay:



The red overlay is one week after the green plot.

Conclusion

As of now, our frequency comparisons over time show changes, this implies a timeline that should show the point of vacuum gate failure. With further testing, exact failure characteristics can be determined. Then signals can be analyzed for those failure characteristics, and the system can be serviced at the more efficient time.