EMBEDDED SYSTEM FOR CONDITION MONITORING OF MARINE PUMPS

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Aims

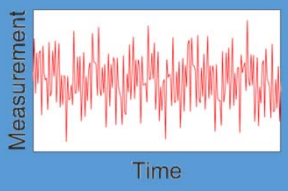
- Build a functioning embedded system which can measure data from a pump
- On board processing of the data to extract information about the condition of the pump
- Transmit information to another system
- Demonstrate system in a live environment

Why?

- Present condition monitoring systems on ships are too expensive for non-vital components
- Time and money is wasted repairing them on a fixed schedule or only once they have failed [1]
- Providing a cheap solution would allow Condition Based Maintenance of these pumps and pave the way for Autonomous Shipping

Data Collection

Large ships can have hundreds of pumps on board



Modern embedded systems can collect accurate data at a much lower price point than existing solutions

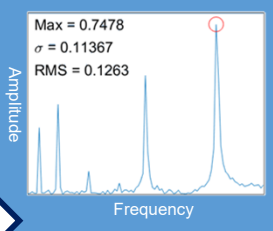
Vibration analysis

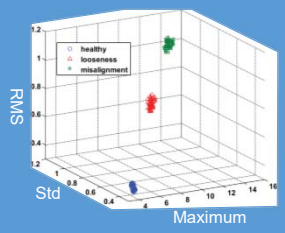
- Widely used for industrial machinery
- Detects faults on mechanical components
- Requires measuring high frequencies ~10 kHz [3]

Motor Current Signal Analysis (MCSA)

- Detection of electrical and mechanical faults
- Lower frequency range ~ 5kHz [4]
- Very noisy measurements [3]

Data Processing





Maximum, Root Mean Square and Standard deviation of frequency spectrum used for diagnosis [2]

- Modern diagnosis methods can identify specific faults but run on powerful, expensive computers
- On board processing will transfer the time-based data to the frequency domain where it is more useful
- Even simple features such as maximum, RMS and standard deviation can detect faults
- Runtime and operating speed are simple and useful features that are not currently recorded
- Combining statistics such as mean time to failure with information about operating conditions, enables data driven prognostics tools to predict remaining lifetime of components

Testing

- Motor, shaft, bearings and accelerometers
- Healthy, faulty bearings and shaft bending
- Long term tests to simulate live environment

Remote Access Laboratory available in Tribology department at University of Southampton

Commercialisation

Industrial Partnership with Lloyd's Register

- New monitoring options to offer clients

Smart Shipping and Autonomous Shipping

- Requires detailed information about components
- Will require better models to estimate failure rates
- Sensor vendors or integrated solutions
- Possible legal issues facing autonomous vehicles

References

[1] Z. Hameed, S. Ahn and Y. Cho, "Practical aspects of a condition monitoring system for a wind turbine with emphasis on its design, system architecture, testing and installation", Renewable Energy, vol. 35, no. 5, pp. 879-894, 2010
[2] A. Moosavian et al., "Fault diagnosis and classification of water pump using adaptive neuro-fuzzy inference system based on vibration signals", Structural Health Monitoring: An International Journal, vol. 14, no. 5, pp. 402-410, 2015
[3] R. Randall, Vibration-based condition monitoring, Hoboken, N.J.: Wiley, 2013
[4] F. Bonnardot, R. Randall and J. Antoni, "Enhanced Unsupervised Noise Cancellation using Angular Resampling for Planetary Bearing Fault Diagnosis", The International Journal of Acoustics and Vibration, vol. 9, no. 2, 2004

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