Master Thesis 2016: Wheel speed spectrum simulation for indirect tire pressure monitoring

NIRA Dynamics AB develop innovative software-based functions to the vehicle industry. The current flagship is Tire Pressure Indicator (TPI), which is the market-leading indirect tire pressure monitoring system currently activated in 15 million vehicles worldwide. TPI uses signals already available in the vehicle, and detects based on this information if one or more tires are under-deflated. The computations are based on vehicle models and numerous advanced signal processing and sensor fusion algorithms.

An indirect tire pressure monitoring system for a car (such as TPI) detects changes in basically two areas:

- Relative roll radius (continuous comparison of all four wheels)
- Spectral behavior (frequencies and amplitudes of vibrational modes)

The first roll radius part can efficiently detect pressure losses in one to three wheels; to detect a symmetric loss in all wheels (‘diffusion’) the second spectral part is necessary.

Traditionally, for general development and application projects we have relied heavily on empirical data, i.e. data collected from real driving. However, for several reasons, it is desirable to create simulated data that we can feed into the production TPI code:

- Understanding of different phenomena
- To complement real driving and reduce test amount
- To create scenarios that are difficult or impossible to create in reality
- To create idealized reproducible test scenarios to isolate effects
- To be able to assess TPI behavior in the conceptual phase of vehicle development, or whenever vehicle availability is a problem

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A thesis work could include the following tasks, focusing on the spectral behavior:

- Create a Matlab/Simulink model that can reproduce:
    a. Tire vertical mode
    b. Medium-frequency tire mode
    c. High-frequency tire mode
- Feed the model with representative input (road noise)
- Tune the model parameters to represent a realistic vehicle
- From the Matlab/Simulink model, generate a time history of wheel speed sensor time stamps that can be fed into the TPI code.

This would be done in cooperation with a similar thesis work during 2016 to simulate roll radius part.

- Also, it should be possible to generate “non-physics based” simulated spectral data, based on higher-level parameter description (e.g. natural frequency and damping as a function of vehicle speed etc)
- Drive train disturbances may be implemented, if time allows
- The theoretical work may be complemented by additional testing

The work assumes good knowledge in modelling/simulation, signal processing and mechanics. Algorithms will be developed in Matlab/Simulink. Appropriate educational background is studying at a Masters program with specialization D, E, F, M, Y, Z or equivalent with a strong focus on signal processing & sensor fusion or vehicle & tire dynamics. We expect you to have excellent study results (average 4 or higher) and that you are driven and can take initiative and work independently. The project will be carried out at our head office in Linköping.

If you are interested in the above M.Sc. projects, please send a personal letter written in English including a course listing with grades to info@niradynamics.se. Earliest expected start-date is January, 2016.