

# NIRA Dynamics

## Master Thesis Summary 2023

### **Absolute Pressure Drop Indicator**

Keywords: Digital signal processing, tire modelling, regression analysis

### **Adaptive Rolling Radius Estimation**

Keywords: Digital signal processing, tire modelling, filtering, statistics

### **Model Based Road Roughness Estimator**

Keywords: Digital signal processing, mechanical modelling, frequency analysis

### **Roll Radius Fusion**

Keywords: Digital signal processing, filtering, sensor fusion

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# NIRA Dynamics

## Master Thesis Proposal 2023 [1/4]

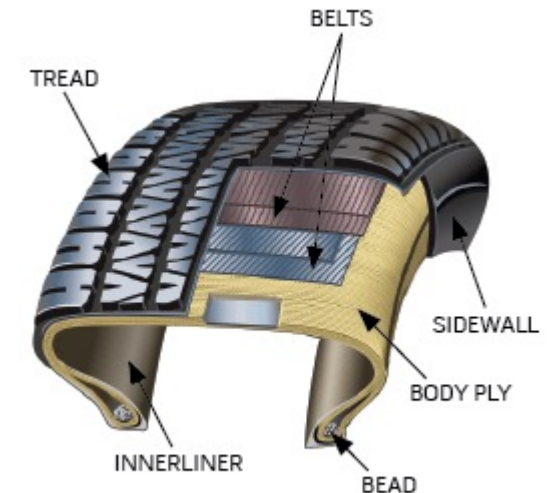
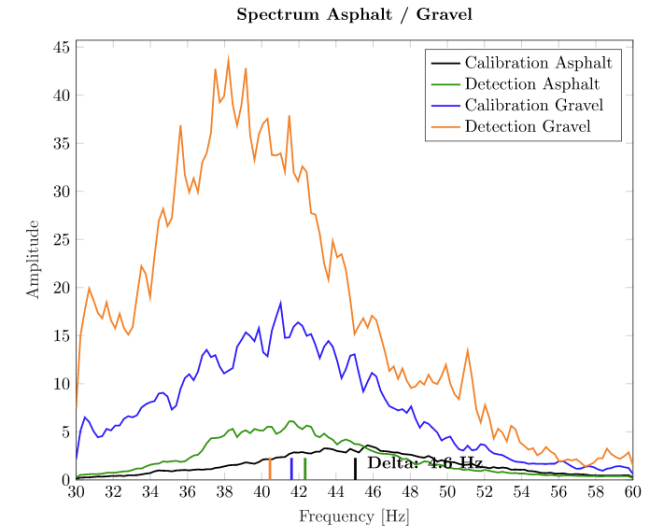
### Absolute Pressure Drop Indicator

Keywords: Digital signal processing, tire modelling, regression analysis

Today many features within the Tire Pressure Indicator, TPI, are tuned by collecting data and adapting parameters to fit the specific tire or vehicle characteristics. These features can be difficult to model and a good approach to learn more about the system would be to use machine learning to predict these characteristics.

One particularly difficult problem is to estimate the actual deflation percentage of a tire. The difficulty lies in the spread of the tire program in a customer project, where different tires may respond differently to deflation.

Given a tire response in the roll radius or frequency to deflation, and computed tire features like the tire stiffness, use machine learning to predict the deflation level (0-100%). Additionally, add computed features to support the prediction.



# NIRA Dynamics

## Master Thesis Proposal 2023 [2/4]

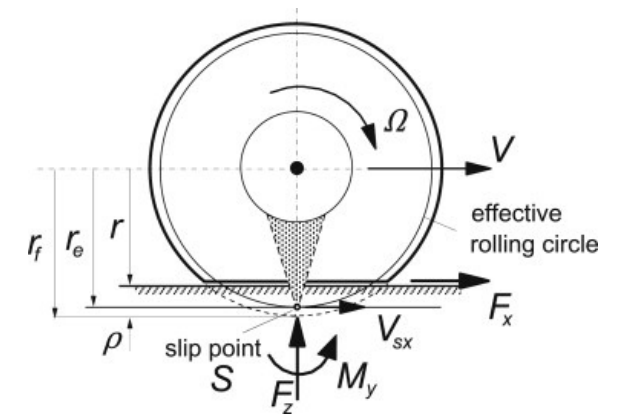
### Adaptive Rolling Radius Estimation

Keywords: Digital signal processing, tire modelling, filtering, statistics

Several of NIRA's products relies on accurate rolling radius estimations in different ways (i.e., the wheel/tire radius during driving). The rolling radius is not a constant, but varies with several factors, e.g., tire pressure, vehicle speed, vertical load, and more.

Some applications make use of these variations, while in other cases they need to be washed out with compensation algorithms. This is currently done with static compensation factors.

However, to cope with different tires' characteristics, and possibly changing properties over time, NIRA would like an adaptive compensation algorithm, which can learn the tire properties on-board and compensate for variations in tire pressure, load, and vehicle speed. If a successful algorithm is developed, implementation and validation in one of our products (C code) is encouraged to be included in this thesis project.



# NIRA Dynamics

## Master Thesis Proposal 2023 [3/4]

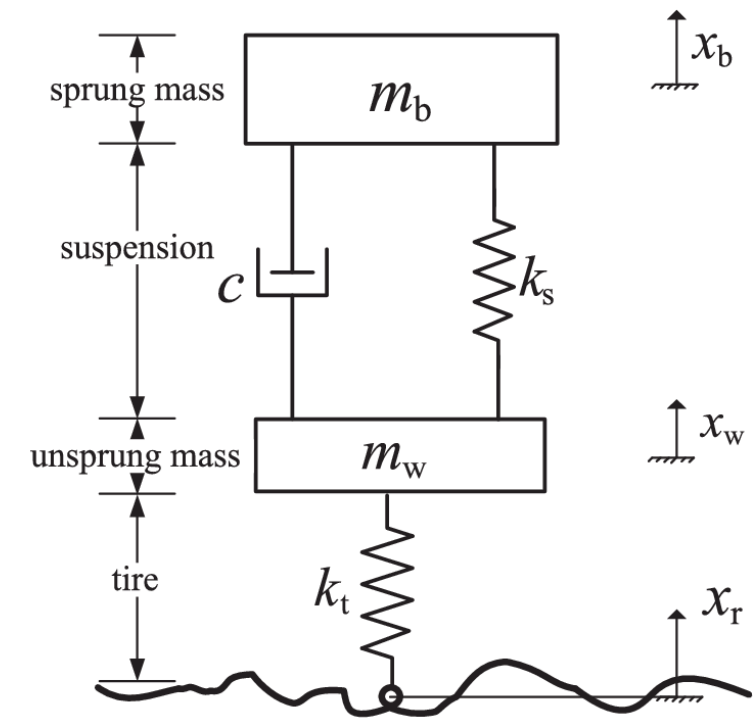
### Model Based Road Roughness Estimator

Keywords: Digital signal processing, mechanical modelling, frequency analysis

Currently, at NIRA, the road roughness is estimated by analyzing how much the car vibrates when driving over the road. But we do not know how different vehicle configurations effects the vibration. This can be understood by implementing a simple vehicle model and simulating the effects of different vehicle configurations. This model and these new insights can then be used to implement a model-based road roughness estimator. To understand how the road roughness effects the vibration of the car, the thesis can also consist of spectrum analysis and signal processing of different signals.

The implemented road roughness estimator can be verified using our available test data.

The outcome of this work could be used in our production code to improve the quality of our cloud-based products.



# NIRA Dynamics

## Master Thesis Proposal 2023 [4/4]

### Roll Radius Fusion

Keywords: Digital signal processing, filtering, sensor fusion

Accurate estimation of wheel roll radii is a recurring element in many of NIRAs products. Today two methods are used, one relative estimator which primarily uses wheel speeds and common vehicle buss signals as information source, and one absolute radius estimator which in addition uses absolute speed from e.g. GPS. In this master's thesis an additional method for estimation absolute roll radius will be introduced. This method uses yaw rate measurements together with wheel speeds to calculate the roll radius of a wheel. These three radius estimation algorithms should then be fused into one roll radius output. Outline of the work:

- Implementing the additional absolute roll radius estimation algorithm.
- The different algorithms come with different strengths and drawbacks which needs to be analyzed in order to fuse them adequately.
- Evaluation of different methods for fusing the different estimates.
- Implementation and analysis of the selected method.

