SYNTHESIS OF MULTIAXIS STATIONARY NON-GAUSSIAN SHAPED VIBRATION

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MOTIVATION

Road vibration is **random** in nature and **non-Gaussian**, although it is usually approximated through stationary Gaussian processes with prescribed PSD.

Since objects move in a 3D space, vibration is also a **multidimensional** physical process, but is usually simplified to a single dimension.

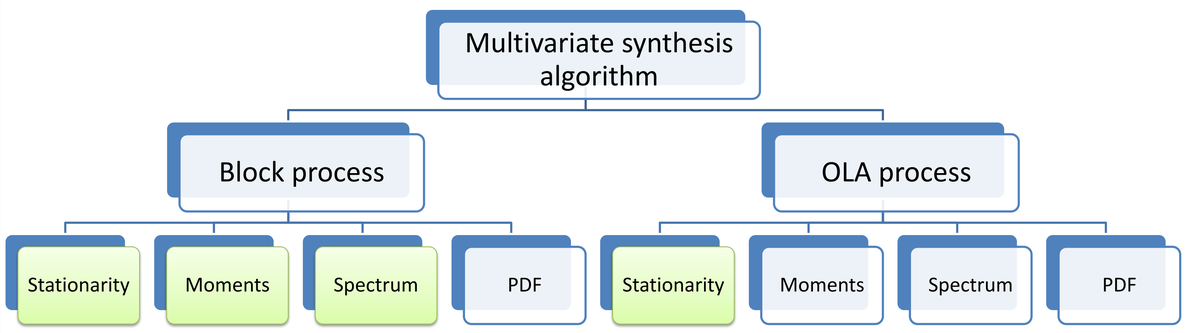
One of the most relevant properties of random processes is **stationarity**, leading to significant advantages in both theoretical and practical treatment.

OBJECTIVE

The objective of this thesis is the development of a method for the **synthesis of non-Gaussian multiaxis road vibration**, with a prescribed PSD, *pdf* and cross-correlation. The goal of the third phase is the development of a **multivariate phase manipulation algorithm** for the synthesis of non-Gaussian vibration.

METHODOLOGY

The same methodology as for the univariate case is followed for the characterization of the multivariate non-Gaussian process, and includes four main lines of research, that should be addressed for both the block and OLA process [1].



PLANNING FOR 2018-2019

Tasks for 2018-2019 include completing the analysis of the multiaxis non-Gaussian synthesis, evaluating the feasibility of a closed loop control algorithm and completing the thesis.

Task	Description	2014				2015				2016				2017				2018				2019			
		T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
1	Literature review																								
2.a	Definition of the measurement conditions																								
2.b	Field measurements																								
2.c	Signal analysis									R															
3	Single axis non-Gaussian random vibration synthesis														R										
4	Multiaxial Gaussian random vibration synthesis																								
5	Multiaxial non-Gaussian random vibration synthesis																		R						
6	Closed loop control feasibility analysis																								
7	Reporting																					R	R	R	

RESULTS AND DISCUSSION

Phase manipulation technique for multiaxial non-Gaussian random vibration synthesis

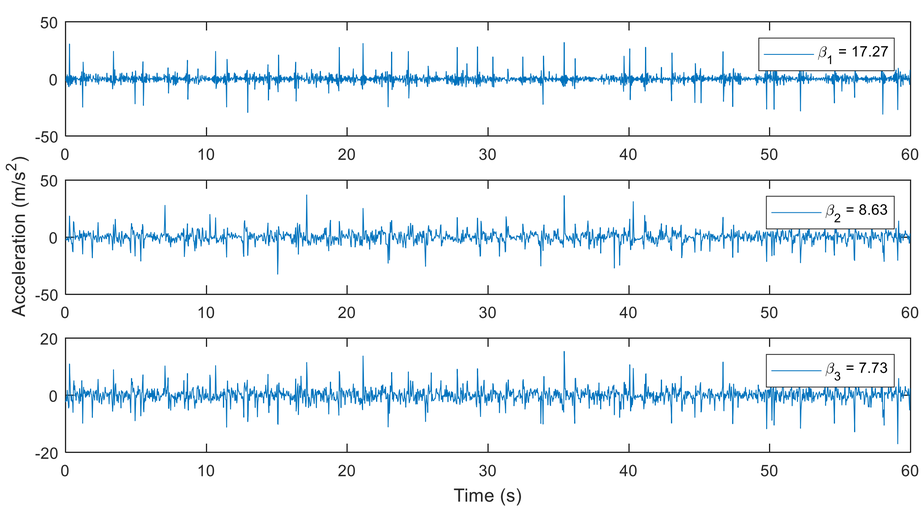
An extension of the univariate phase manipulation technique described in [2] was developed for multivariate non-Gaussian vibration synthesis, based on the process model suggested in [3].

Feature highlights

✓ **Independent** adjustment of the following signal properties:

1. Spectral Density Matrix.
2. Kurtosis of each individual dimension.

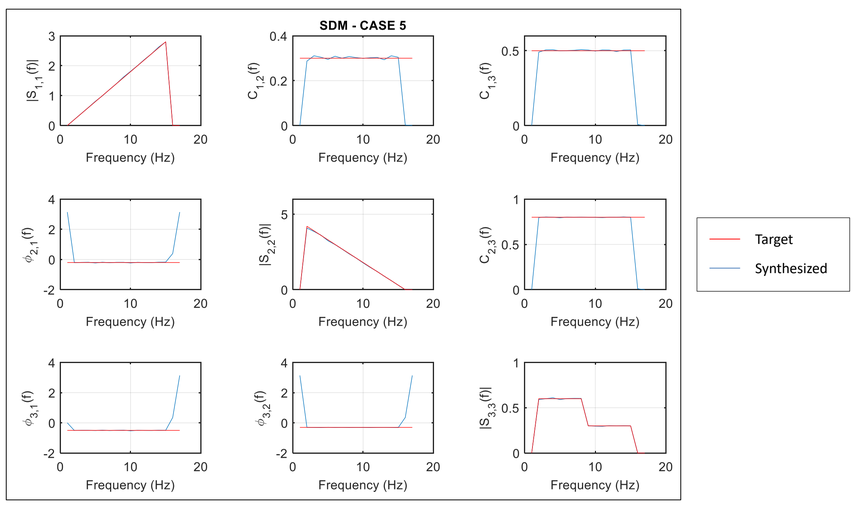
✓ The algorithm operates on an arbitrarily large number of dimensions.
✓ Low computational cost, allowing real-time signal synthesis.
✓ Suitable for closed-loop control, since the algorithm reacts immediately to changes in the control parameters (no memory).
✓ Closed-form expression relating the kurtosis of the individual dimension to the synthesis parameters.



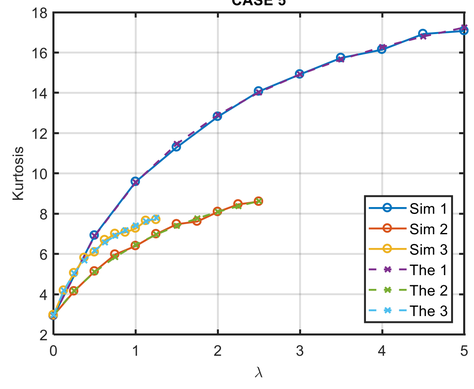
Simulation results

A Monte-Carlo simulation for a three dimensional process is performed in order to assess the spectral and statistical performance of the developed algorithm.

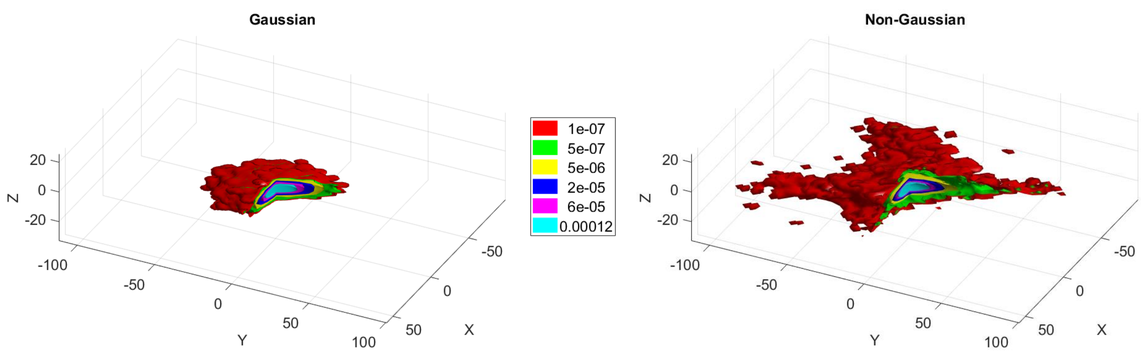
✓ Good adjustment of the Spectral Density Matrix is achieved:



✓ Match between theoretical kurtoses and simulation:



✓ Distribution of the resulting process: application of ellipticity test to the synthesized signals does not reject null hypothesis [4].



REFERENCES

[1] D. González and R. López-Valcarce, *Maximally stationary window design for overlap-add based random vibration synthesis*, submitted for journal publication.
[2] D. González and R. López-Valcarce, *Synthesis of stationary non-Gaussian shaped vibration*, Master Thesis, University of Vigo, 2013.
[3] D. González and R. López-Valcarce, *Spectral and statistical evaluation of the properties of the vibration measured at the base of an automotive seat for non-Gaussian random noise synthesis,* in: Proceedings of the International Conference on Noise and Vibration Engineering, in press 2018.
[4] D. Cassart, *Optimal Tests for Symmetry*, PhD Thesis, Université Libre de Bruxelles (2007).