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THE INFLUENCE OF THE RELATIVE POSITION OF THE MASSES ON THE MOVEMENT OF THE MONOWHEEL VEHICLE

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Abstract: *Monowheel vehicles present a number of challenges to the designer and several compromises have to be made to get everything come together into a functional machine. The first problem is stability; because monowheel depends on gyroscopic effect to keep it upright.*
Keywords: *monowheel, Design of Experiments, movement*

1. INTRODUCTION

In this paper, it is present the studies about the “strange” conditions in which this single wheel may be controlled by a driver placed inside the wheel. Taking into account that the power source is also placed inside the wheel, the problem presents some challenges to any engineer.
As we can see, the vehicle is composed by:

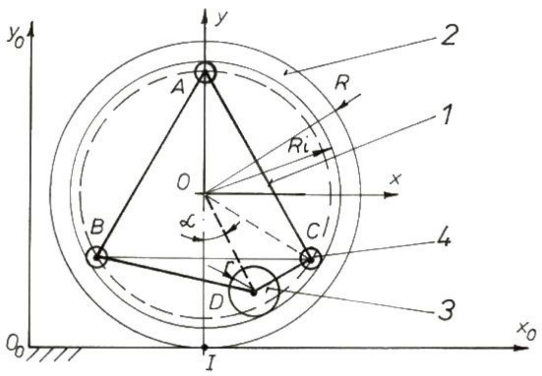


Figure 1: Simplified model

- An inner body 1, having a rigid frame and possessing a saddle and an engine;
- An outer ring 2 (the wheel), which rolls over the ground;
- A driving roller 3, which rolls inside the rim of the wheel:
- Three or more guiding rollers 4, which rolls also inside the rim.

2. DESIGN OF EXPERIMENTS

ADAMS/Insight, part of the MSC.ADAMS® suite of software, is a powerful design-of-experiments software. ADAMS/Insight lets you design sophisticated experiments for measuring the performance of your mechanical system. It also provides a collection of statistical tools for analyzing the results of your experiments so that you can better understand how to refine and improve your system.

Within the MSC.ADAMS analysis environment, there are conduits between ADAMS/Insight and the other MSC.ADAMS products (for example, ADAMS/Car, ADAMS/Chassis, and ADAMS/Engine). These conduits streamline the process by taking advantage of the inherent parametric strengths of the vertical application. ADAMS/Insight ASC is a general-purpose tool that helps you work with various analysis environments, from your own or inhouse-developed applications to commercial applications which accept an ASCII input deck.

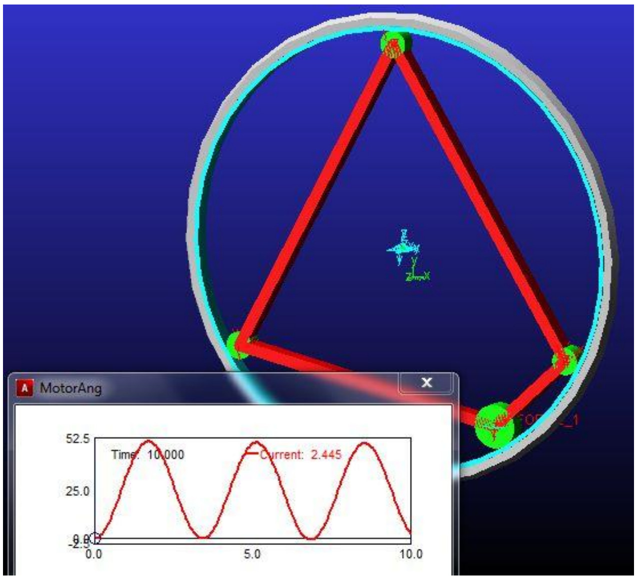


Figure 2: ADAMS model

Experimental design (also called Design of Experiments or DOE) is a collection of procedures and statistical tools for planning experiments and analyzing the results. In general, the experiments measure the performance of a physical prototype, the yield of a manufacturing process, or the quality of a finished product.

Although experimental design techniques were originally developed for physical experiments, they also work very well with virtual experiments. In the case of ADAMS/Insight, the experiments help increase the reliability of your conclusions, get you answers faster than trial-and-error or testing factors one at a time, and help you better understand and refine the performance of your mechanical system.

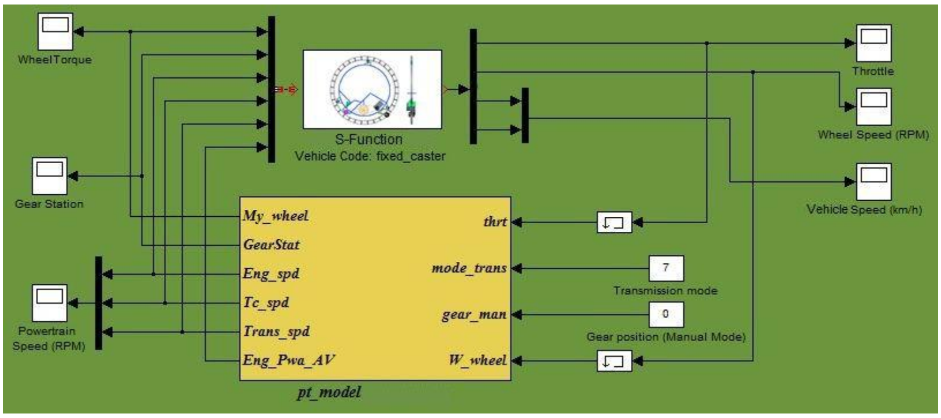
For simple design problems, one can explore and optimize the behavior of the mechanical system using a combination of intuition, trial-and-error, and brute force. As the number of design options increase, however, these methods become ineffective in formulating answers quickly and systematically. Varying just one factor at a time does not give you information about the interactions between factors, and trying many different factor combinations can require multiple simulations that leave you with a great deal of output data to evaluate. To help remedy these time-consuming tasks, ADAMS/Insight provides the planning and analysis tools for running a series of experiments. ADAMS/Insight also helps in determining relevant data to analyze, and automates the entire experimental design process.

3. PROCESS

The experimental design process includes five basic steps:
- Determine the purpose of the experiment. For example, to identify which variations most affect the current mechanical system.
- Choose a set of factors for the system that are under investigation and develop a way to measure the appropriate system responses.
- Determine the values for each factor (called levels), and plan a set of experiments (called runs or trials) in which you vary the factor values from one trial to another. The combination of actual runs to perform is called the design.
- Execute the runs, recording the performance of the system at each run.
- Analyze the changes in performance across the runs, and determine what factors most affect your model.

The following steps are necessary for performing this optimization:

1. parametrize the virtual model;
2. defining the design variables, constraints and the design objectives for optimization;
3. performing design/parametric studies for identifying the main design variables;
4. optimizing the model on the basis of these variables using the GRG algorithm from the OPTDES code.



5. **Figure 3:** Design of Experiments

The optimization study is performed using a virtual model build in the multi-body system (MBS) environment ADAMS of MSC Software, considering a DOE-based (Design of Experiments) investigation strategy.

It was simulated the motion behavior of various designs in order to understand the sensitivity of the overall system to these design variations

4. CONCLUSION

The optimization was performed in five steps: configuring the purpose of the experiment; setting the set of factors; planning a set of trials in which we vary the factor values from one trial to another; executing the runs and recording the performance of the suspension mechanism at each run; analyzing the changes in performance across the runs. With all these in mind, it can be consider that the obtained variations exists in the acceptable domains for the Routh-Hurwitz criterion.

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