Abstract

of attestation master's degree work

on subject:

"Research of features of the hybrid method for constructing macromodels of non-electrical components of MEMS"

by

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Actuality of the work

Due to the wide spread of microelectromechanical systems (MEMS) in various fields of science and technology, demand on modern CAD systems with respect to the possibility of joint calculation of mechanical and electrical components is growing. To this end, all the subsystems of the object should be represented in the form of equivalent models of the same nature. Most often, the method of electromechanical analogies is used for the model constructing of objects with complex physical nature, but it’s use requires a circuit realization of models of non-electric units. Most CAD systems that are used for the design of mechanical systems, use the finite element method for the construction of the mathematical model. However, the main problem in this case is the huge size of mathematical models, reaching hundreds of thousands of equations. The only possible solution to this situation is reducing the dimension of mathematical models of MEMS and getting its schematic analogue as a macromodel. Therefore, the development and study of the effectiveness of methods for constructing circuit equivalents of non-electrical components macromodels of MEMS is an urgent problem nowdays.

The purpose of the work

The purpose of the work is researching of the characteristics and efficiency of the hybrid reducing method for the constructing of macromodels of non-electrical components of MEMS, identifying the flaws and developing of the ways to eliminate them, designing of

the universal macromodel on this base and creating of recommendations for the selection of its parameters.

Tasks solved in work

1. Research features of existing algorithms to reduce the size of mathematical models of complicated objects.

2. Defining the flaws of the hybrid reducing method and searching of the ways to eliminate them.

3. Design of the universal final macromodel of non-electrical components of MEMS.

4. Experimental research of the designed universal macromodel on the base of test tasks solution.

5. . Experimental research of the hybrid method for constructing macromodels of schemes, reduced by the Y-Δ transformation algorithm.

The achieved results

Solving the tasks put in-process, an author protects:

- results of analysis of the hybrid method for constructing macromodels of circuit equivalents of non-electrical components of MEMS;
- universal macromodel of mechanical components of MEMS, which provides a permanent structure of the interpritated equivalent circuit and the improved accuracy of modeling;
- results of the research on effectiveness of the universal macromodel based on test examples solution;
- results of the research on the effectiveness of the use of the hybrid method in combination with a reduction algorithm based on Y-Δ transformation.

Scientific novelty

The scientific novelty of the work consists of the following:

- problems of using the hybrid method with ill-conditioned conduction matrix of scheme, which is typical for the equivalent circuits of non-electrical components of MEMS, were analyzed;
- the universal macromodel was designed, which:
  - differs from the existing by topology and the number of bipolar components;
  - provides improved modeling accuracy at specified frequencies;
  - allows management of the final result accuracy.
- the complex method was designed that includes an Y-Δ transformation algorithm in the first stage and a hybrid method in the second stage, allowing to build macromodels of non-electrical components of MEMS with the large dimension initial data.

Practical value

Practical value of work consists of the following:

- the effectiveness of the designed universal macromodel was experimentally proved and the influence of its parameters on the accuracy of the final result was showed;
- the experimental research of the effectiveness of the use if the hybrid method for constructing macromodels of schemes reduced by the Y-Δ transformation algorithm, was conducted.

Conclusions

1. The analysis of the basic methods and algorithms of the mathematical models of MEMS reduction was conducted in terms of their effectiveness, ability to adapt to existing

CAD systems, in particular circuit design packages, and ability of the use of large-dimensional objects.

2. The hybrid method for constructing macromodels of equivalent circuits was researched. The flsaws of the method were found and the approaches to eliminate them were suggested. On this basis the universal macromodel of mechanical components of MEMS, which provides permanent structure of the interpritated equivalent circuit and the improved modeling accuracy, was designed.

3. The effectiveness of the developed universal macromodel was experimentally proved, based on the calculations of test examples. The results indicate that when used it greatly increases the accuracy compared to the base macromodel.

4. The experimental results show that the use of the parallel reduction algorithm based on Y-Δ transformation for the initial reduction of the equivalent circuit with the further construction of a macromodel by using the hybrid method can significantly reduce the time od macromodel building, and the relative error at the same time.

The work contains 98 p., 72 images, 27 sources.

Keywords: MICROELECTROMECHANICAL SYSTEMS, Y-Δ TRANSFORMATION, HYBRID REDUCTION METHOD, ALLTED, MACROMODEL.