Oofelie::PiezoElectric

Oofelie Multiphysics 2010

Oofelie::PiezoElectric, driven by SAMCEF Field, provides engineers and analysts with unique capabilities to analyze piezoelectric systems, such as sensors and actuators, ultrasonic motors and accelerometers. With Oofelie::PiezoElectric, driven by SAMCEF Field, you are getting at the core of the physics in one conveniently integrated simulation package.

Oofelie::PiezoElectric is a Virtual Prototyping tool for the analysis and design of piezoelectric systems. Through the use of its modeling capabilities, it becomes possible to start simulating the performance of such systems even before a single physical prototype is built. Design changes can be evaluated faster and in a more affordable manner, reducing the number of actual prototypes needed to achieve a required design maturity, thus accelerating significantly product development. Thanks to such a tool, the engineers acquire a capability to isolate and analyze the effect of each parameter. With such insight available at their fingertips, information can be quickly gained to correct or improve previous designs efficiently, knowing which are the influent factors.

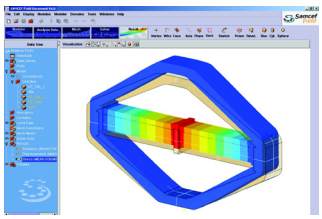
Reduced design time, improved quality and reduced costs are some of the benefits one can now obtain from using OOFELIE PiezoElectric.

MODELING ENVIRONMENT

Oofelie::PiezoElectric is driven by a user-friendly integrated graphical user interface, SAMCEF Field, for the modeling, the analysis and the post-processing of piezoelectric systems.

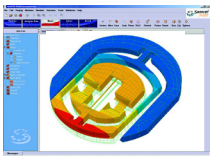
SAMCEF Field, a complete and interactive user environment providing all the tools necessary to design, simulate and analyze a range of configurations, has been tailored to approach efficiently the field of piezo-electricity. Its visual and hierarchically arranged layout will guide you through all the steps of model preparation, resolution procedure and analysis.

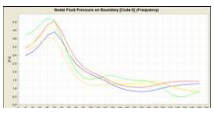
A CAD **modeler**, as well as **import capabilities** from other leading CAD providers, is integrated for modeling and **data preparation**. As data are directly defined on the geometry, users can easily switch system components modeling level from one behavior to another.



Parameterized data entry is easily done using contextual pull-down menus and pop up boxes using a wide selection of preprogrammed functions for the definition of time and frequency varying properties and boundary conditions.

As soon as the analysis is completed, the results are easily accessible from a simple click in the navigator. Results may be displayed in different forms over the whole model or through user's defined cross-sections to study detailed behavior. In addition to all the state-of-the-art **standard graphic outputs (i.e. X-Y plots, isovalues, animations, etc.),** results may also be inserted in tabular forms in the analysis report. SAMCEF Field is common to all the solutions provided by Open Engineering, allowing other analyses to be performed on the same model as for piezoelectric simulations.



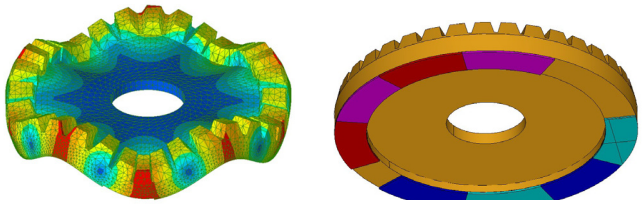


PLATFORMS

Oofelie::PiezoElectric, driven by SAMCEF Field, is available on Windows and Linux platforms.

PIEZOELECTRIC EFFECT

The direct piezoelectric effect consists in the ability of certain materials to generate an electrical potential in proportion to an externally applied force. The inverse piezoelectric effect refers to the reciprocal effect by which the application of an electric field induces a deformation of the piezoelectric material. These dual effects, which can be used simultaneously, are increasingly being used today in the application of piezoelectric materials.



Ultrasonic engine

ANALYSES

Oofelie::PiezoElectric allows specific analyses for systems including piezoelectric materials.

This product offer the five classical analysis and for each of them, a strongly coupled approach is used:

- The **static** analysis permits to compute the coupled static response of the system. It can be linear or non-linear.
- The extraction of strongly coupled **eigenmodes** can be performed using linear modal analysis with block Lanczos algorithm.
- The **forced response** of the coupled system in the frequency domain is performed with the linear harmonic analysis. Direct resolution and efficient modal superposition methods are available.
- It is also possible to compute the **transient response** of the coupled system submitted to time excitations with the transient analysis (linear and non-linear HHT algorithm).
- Finally, the **super element generation** (SEM) analysis enables the creation of **reduced** piezoelectric **models**. Those super elements can then be used in other analyses, for instance with standard FEM elements.

Oofelie::PiezoElectric

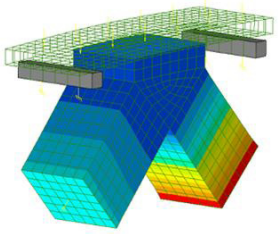
ADVANCED FEATURES

Oofelie::PiezoElectric provides the user with following advanced fatures:

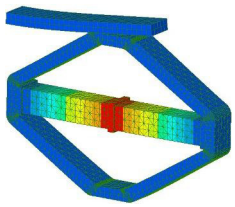
- A **dielectric medium** can be modeled with boundary element method (BEM). This kind of modeling technique is efficient if we have to consider infinite extension dielectric medium. It happens when radiative capacitive coupling has to be taken into account. Note that the solver integrates a strongly coupled FEM/BEM approach in this case.
- A **flexible contact** between mechanical mediums can be modeled.
- Non-linear **large displacement** 3D elements are available.
- A **prestressing effect** can be taken into account. For example, the variation of system eigenfrequencies due to a prestressing can be computed.
- Electrodes can be added, whether "passive" (fixed potential) or "active" (constant but unknown isopotential value, whether in closed or open circuit). It is also possible to add and **connect multiple RLC** circuit elements to model the connected circuitry.

APPLICATIONS

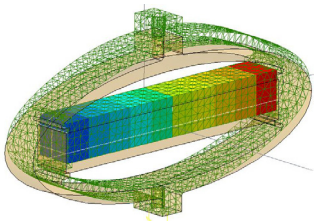
The general, three-dimensional, models offer generalized methods that can be adapted and used for many different applications in the transportation (aircraft, automotive), equipment (machinery, motors, sound systems), electronic appliances, biomedical and building industries for instance. Some applications are presented hereafter:



Piezoelectric linear engine

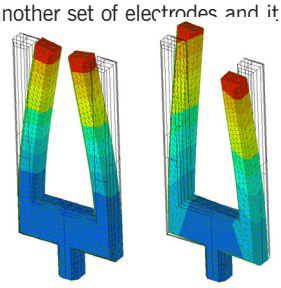


APA actuator with contact



APA actuator

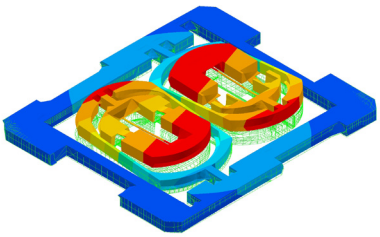
In a vibrating gyrometer, the driving mode (left picture) is excited with a set of electrodes. If the gyrometer is in a rotating frame, the **Coriolis** effect induces some vibrations in the perpendicular direction (right picture). The amplitude of this last vibration by another set of electrodes and it is related to the angular speed to measure.



Vibrating Gyrometer

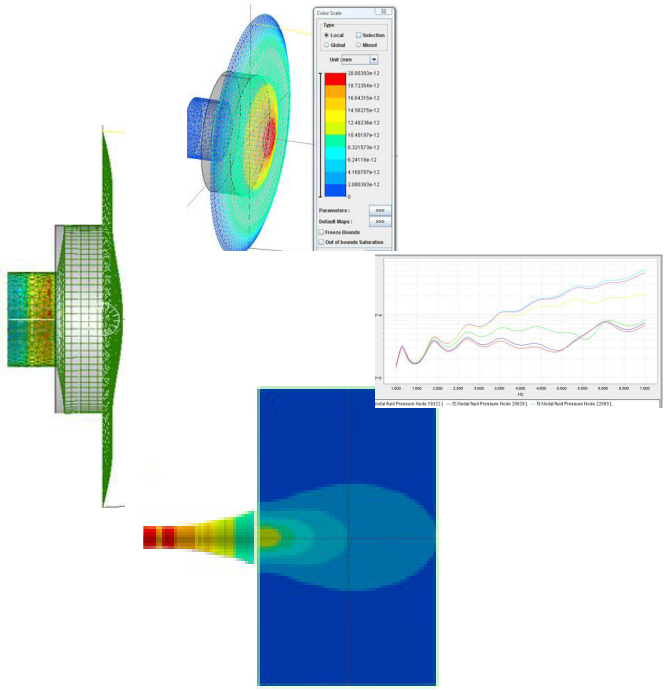
EXTENSION

The **Oofelie::PyroPiezoElectric** product contains all the capabilities of Oofelie::PiezoElectric product. Here, the thermal field and its couplings with mechanical and electrical fields are taken into account, in the strongly coupled analysis procedures. A relevant feature is the prediction of thermoelastic damping which is generally the main source of damping in small vibrating structure. A typical application is the Differential Inertial Vibrating Accelerometer (DIVA).



DIVA courtesy of ONERA

When acoustic mediums surrounding the piezoelectric system have to be taken into account, Oofelie::PiezoElectric can be extended to **Oofelie::PiezoVibroAcoustics.** Here, the internal and/or external acoustic mediums can be modeled in the fully coupled solution approach. Typical applications are piezoelectrically actuated loudspeaker, piezoelectric microphone, sonars, ..



PiezoVibroAcoustic analysis of a horn loudspeaker

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