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Massive shape adaptivity in shell-membranes

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Summary

Certain technical applications of smart structures require massive shape adaptivity. Examples for that are space antenna and reflectors, where via reconfiguration of shapes changing mission requirements for earth observation and especially for communication purposes can be achieved. This task requires the consideration of high interaction between the shape material and structure together with the actuators and control loops. Since rather high spatial frequencies and high amplitudes in the cm-range with an accuracy in the micro-meter range for the modified shapes are needed, new type of materials and actuators are to be considered. They should be quite felxible in the morphing phase and suficiently stiff in the operational phase. Several options will be discussed. These are for example properly reinforced silicones, which from a structural point of view result int membranes or shell-membranes, i.e. shells with very low bending stiffness. For the acttuators a mix of inchworm type actuators or those based on electro-active polymers is considered. Apart from sufficient stroke with high resolution and low mass, also the quite oiften severe temperature environment has to be taken into account. Simulation models for the materials and the whole system including the actuators lead to highly nonlinear problems, the results of which will be discussed. This also includes results of parameter studies and techniques for proper if not optimal actuator placement. Material and component characterisation poses challenging tasks for the test technology as well. For example, for the membrane type materials and components new types of specimen had to be defined for determination of stiffness and coefficient of thermal expansion. Correlation of analysis and test results on material and component level will be given. A further aspect is measurement and sensing of the modified shapes as feedback signals for control loops. For this purpose, several options will be discussed with special emphasis on integrated fibre optic Bragg sensors.