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LIGHTWEIGHT MATERIAL MODEL LIMITS WITH APPLIED PRE-STRESS

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Summary: Current industrial robots and manipulators are designed with relatively stiff and heavy arms especially for the structures of the open kinematic chain type. During the motion of these structures high loading forces act that negatively influence the duration of the production cycle due to the large masses resulting into high inertia forces or low ration stiffness –mass resulting into low eigenfrequencies and limited feedback gains. The concept of lightweight material is one of the possible ways how to remove this disadvantage.

This paper deals with the design and investigation of properties of a concept of the new lightweight material based on the pre-stressed membrane structure either deflated (with vacuum) filled with the circular particles or inflated. In analogy with tensegrity and tensairity this can be called tensvacrity (tension- vacuum-integrity).

Using this concept a robotic arm as a beam is designed and investigated. Several different design concepts were proposed and a promising one was selected. It consists of pre-stressed deflated membrane filled with balls closed in outer inflated membrane. This enables that the balls with good buckling properties are kept together by pressure of required value. The balls are hollowed from different materials. This structure is investigated for the ratio stiffness-mass and for the stability corresponding to the strength of such material.

The more complex structures like complete robots can be assembled. The robot can consist of separate links designed from this new lightweight material interconnected by traditional joints (revolute, prismatic) or the robot can consist of one complete arm that is split into particular links by contracted necks which create the flexible joints. Such robotic structures can be then driven by cables.