MORPHING WING WITH SURFACE DISCONTINUITY KINEMATIC CONCEPT

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Abstract: The article describes morphing wing kinematics as groundwork for wider project focused on novel morphing flying wing concept. It is based on multipoint distribution of wing twist as the only mechanism for flight control and performance optimization. The project involves optimization of wing twist distribution, number and width distribution of the wing elements in attempt to find the best configuration for realization of control strategy and geometry adaptation to different flight conditions. Proposed solution utilizes advantages of morphing technology without problems of structure's elastic deformation, which is possible due to wing's modular construction formed by rigid, distinct elements, pivoted around the main spar (Figure 1).
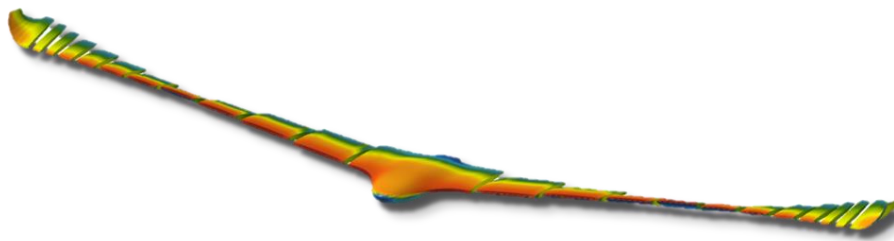
Figure 1. New morphing concept for the flying wing

After preliminary analysis it was proved that such flight control is feasible, and mechanical solution of such flying structure has to be firstly developed to test its properties in wind tunnel and then in flying prototype. Aerodynamic analysis suggests tailless aircraft configuration with substantial sweep angle (about 30 degrees). Such geometry dictates that wing elements' pitch axis will be positioned at the same large angle to the wing's main spar. This together with thin airfoil (10%) limits possible main spar position, its dimensions, and number of elements per wing.
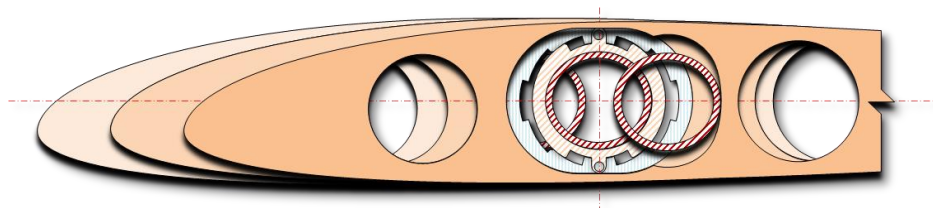

Figure 2. Pivot mechanism (one element cross-sections)

There are two main problems to be addressed: kinematic solution of wing element pivot mechanism and twist distribution control strategy and its realization. Second problem has two solutions: individual control of each wing element or control of few selected elements, elastically connected with its neighbors (similarly to Bezier curves controlled by few control points). Both solutions have its pros and cons; however, as they are strongly coupled with flight control and performance optimization, they have to be analyzed in later stages of the project. As for the first problem several solutions have been proposed (e.g. Figure 2) and are discussed in the article.