Development of an optimization algorithm for estimating the state of loads of a structural component based on its optimal shape

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ABSTRACT

Biological structures adapt their shapes to their mechanical environment with the aim of optimizing the energy they need for functioning. On that way, a bone will change its shape according to its state of loading making denser bone where more load is supported [1]. Starting from the fact that shapes on nature are optimal and that loading state in human body parts are not completely known, this study targets to find a precise state of load based on shape, and not the way that mechanical designing does which seeks an optimal shape based on loads.

Since the component's design domain and actual shape are known, the algorithm described is approached iteratively, taking the first parameter to build optimal shapes through the Finite Elements Method for assumed loads [2][3], followed by a module that compares the obtained computational model with the actual shape of the part.

As a starting point, the problem is solved for a cantilever beam, loaded by vertical, static, concentrated forces [4]. In this way, the algorithm is proved for a simple case in order to be applied for more complex components and come closer to real biological structures.

We hypothesize that is possible to identify those loads indirectly via an algorithm which estimates the load based on computational modelling.

The authors believe that this study will make specialists in medical sciences to go further and do more complete analysis around illnesses and peculiarities of bones and structural components of living beings.

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