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2-DIMENSIONAL OUTLINE SHAPE REPRESENTATION FOR GENERATIVE DESIGN WITH EVOLUTIONARY ALGORITHMS

Paul Lapok, Alistair Lawson, Ben Paechter

Edinburgh Napier University, United Kingdom
p.lapok@napier.ac.uk, a.lawson@napier.ac.uk, b.paechter@napier.ac.uk

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Abstract: In this paper, we investigate the ability of genetic representation methods to describe two-dimensional outline shapes, in order to use them in a generative design system. A specific area of mechanical design focuses on planar mechanisms. These are assembled of mechanical components, e.g. multiple levers, which transmit forces and torques over their contour. The shape of the contour influences the performance of the overall system. The genetic representations are based on floating-point chromosomes, where each value maps to a specific parameter of a resulting shape. In order to evaluate the performance of each representation method, a set of target shapes was defined. These consist of simple symmetric and asymmetric shapes with edges and curves, and also of more complex mechanical lever shapes, extracted from an automotive device. An evolutionary algorithm with crossover and mutation operators is used to search for the best approximation of these target shapes. The fitness function is based on two penalty values: first, calculated by comparing the area of a candidate solution with the area of a target shape; and second, based on the intersection area between a candidate solution and a target shape compared to the entire area of the target. Experiments were undertaken to investigate the capabilities of the representations in terms of search space coverage; compatibility with evolutionary operators; and the ability to produce shapes with mechanical characteristics. The results show the benefits and drawbacks of using each of selected methods of representation, and their suitability of reassembling different outline shapes.