Mechanical Engineering Thesis Defense

Quantifying Deformations in Flexible Assemblies using Least Square Fit and Capture Zone Techniques

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Abstract

Almost all mechanical and electro-mechanical products are assemblies of multiple parts, either because of requirements for relative motion, or use of different materials, shape/size differences. Thus, we can say that assembly design is the very crux of engineering design. In addition to nominal design of an assembly, there is also tolerance design to determine allowable manufacturing variations to ensure proper functioning and assemblability. Most of the flexible assemblies are made by stamping sheet metal. Sheet metal stamping process involves plastically deforming sheet metals using dies. Sub-assemblies of two or more components are made with either spot-welding or riveting operations. Various sub-assemblies are finally joined, using spot-welds or rivets, to create the desired assembly. When two components are brought together for assembly, they do not align exactly; this causes gaps and irregularities in assemblies. As multiple parts are stacked, errors accumulate further. Stamping leads to variable deformations due to residual stresses and elastic recovery from plastic strain of metals; this is called as the 'spring-back' effect. When multiple components are stacked or assembled using spot welds, input parameters variations, such as sheet metal thickness, number and order of spot welds, cause variations in the exact shape of the final assembly in its free state. It is essential to understand the influence of these input parameters on the geometric variations of both the individual components and the assembly created using these components. Design of Experiment is used to generate sensitivity analysis study which evaluates the influence of input parameters on output parameters. The scope of this study is to quantify the geometric variations for a flexible assembly and evaluate their dependence on specific input variables. The 3 input variables considered are the thickness of the sheet material, the number of spot welds used and the spot-welding order to create the assembly. To quantify the geometric variations, sprung-back nodal points along lines, circular arcs, a combination of these, and a specific profile are reduced to metrologically simulated features.

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Zoom Link: https://asu.zoom.us/j/8541943188