World Academy of Science, Engineering and Technology
International Journal of Industrial and Manufacturing Engineering
Vol:17, No:08, 2023

An Approach on Intelligent Tolerancing of Car Body Parts Based on Historical Measurement Data

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Abstract : To achieve a high quality of assembled car body structures, tolerancing is used to ensure a geometric accuracy of the single car body parts. There are two main techniques to determine the required tolerances. The first is tolerance analysis which describes the influence of individually tolerated input values on a required target value. Second is tolerance synthesis to determine the location of individual tolerances to achieve a target value. Both techniques are based on classical statistical methods, which assume certain probability distributions. To ensure competitiveness in both saturated and dynamic markets, production processes in vehicle manufacturing must be flexible and efficient. The dimensional specifications selected for the individual body components and the resulting assemblies have a major influence of the quality of the process. For example, in the manufacturing of forming tools as operating equipment or in the higher level of car body assembly. As part of the metrological process monitoring, manufactured individual parts and assemblies are recorded and the measurement results are stored in databases. They serve as information for the temporary adjustment of the production processes and are interpreted by experts in order to derive suitable adjustments measures. In the production of forming tools, this means that time-consuming and costly changes of the tool surface have to be made, while in the body shop, uncertainties that are difficult to control result in cost-intensive rework. The stored measurement results are not used to intelligently design tolerances in future processes or to support temporary decisions based on real-world geometric data. They offer potential to extend the tolerancing methods through data analysis and machine learning models. The purpose of this paper is to examine real-world measurement data from individual car body components, as well as assemblies, in order to develop an approach for using the data in short-term actions and future projects. For this reason, the measurement data will be analyzed descriptively in the first step in order to characterize their behavior and to determine possible correlations. In the following, a database is created that is suitable for developing machine learning models. The objective is to create an intelligent way to determine the position and number of measurement points as well as the local tolerance range. For this a number of different model types are compared and evaluated. The models with the best result are used to optimize equally distributed measuring points on unknown car body part geometries and to assign tolerance ranges to them. The current results of this investigation are still in progress. However, there are areas of the car body parts which behave more sensitively compared to the overall part and indicate that intelligent tolerancing is useful here in order to design and control preceding and succeeding processes more efficiently.

Keywords : automotive production, machine learning, process optimization, smart tolerancing
Conference Title : ICMMMM 2023 : International Conference on Manufacturing Models, Metrics and Methodologies
Conference Location : New York, United States
Conference Dates : August 10-11, 2023