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Abstract
The development of technology and upgrade in industry has a causative relationship with metrology. To achieve the goal for quality improvements, an accurate measurement system is required. The gauge repeatability and reproducibility (GR&R) in the measurement system analysis (MSA) applies experimental design to analyze the variation due to operators and the variation due to measurement equipments.

The purpose of the research is to improve the measurement evaluation system nowadays, modify the flaw of Classical GR&R and Long Form methods to develop unbiased gauge variance estimators for the case of without interaction between operators and parts. Finally we compare the accuracy and precision of three methods and the unbiased estimators method proposed in the research. Thus, we provide one gauge variance estimation method which is more accurate and precise. The modified method will have enormous impact on the current MSA handbook and the software applying Classical GR&R as a method to design it.

I addition, the research uses simulation method to compare the gauge variance estimators of four different estimation methods based on the three criterion of mean ratio, sample variance, mean squares error of the estimated gauge variances. We discovered the gauge variance estimators of the modified method are close to those of ANOVA. The research also confirms the lager value of npk, the more accurate and precise the gauge variance estimates are. The research also validates that increasing the number of operators is the best policy to enhance the gauge accuracy and precision.
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