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Unsupervised machine learning application in the selection of measurement strategy on Coordinate Measuring Machine

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A B S T R A C T

It is indisputable that some type of coordinate measurement system (CMS) is generally used to assess the quality of dimensional and geometric characteristics. Considering the required accuracy, flexibility, and speed of measurement, a CMM with a scanning sensor may offer the best performance. These measurement systems are very complex, and many factors affect the reliability of the measurement results. A Metrologist's choice represents the greatest variability in the measurement strategy. Previous research has shown that the measurement results can be changed up to 100 % by choosing a different measurement strategy when evaluating the form error. This paper conducts a detailed study of the impact of the measurement strategy on the cylindricity error when measuring eleven workpieces with the same nominal characteristics, but different real characteristics described by roughness and the reference value of cylindricity. To examine the influence and importance of certain factors and their levels, design of experiment (DoE) and unsupervised machine learning techniques of PCA (Principal Component Analysis) and Multiple Correspondence Analysis (MCA), were used. The results suggest that depending on the real geometry of the workpiece, different factors with different percentages influence the output characteristic. The objective was to choose a uniform measurement strategy when measuring cylindricity on the CMM, while the prior information about the actual geometry of the workpiece is lacking.

A R T I C L E I N F O

Keywords:
Coordinate Measuring Machine (CMM);
Measurement strategy;
Accuracy;
Principal component analysis;
Multiple correspondence analysis;
Unsupervised learning

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Izvirni znanstveni članek

Uporaba nenadzorovanega strojnega učenja pri izbiri merilne strategije na koordinatnem merilnem stroju

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P O V Z E T E K

Za ocenjevanje kakovosti dimenzijskih in geometrijskih značilnosti se običajno uporablja določena vrsta koordinatnega merilnega sistema (KMS). Glede na zahtevano natančnost, prilagodljivost in hitrost merjenja lahko KMS s skenirnim senzorjem ponudi najboljšo zmogljivost. Vendar pa so ti merilni sistemi so zelo zapleteni, na zanesljivost rezultatov meritev pa vplivajo številni dejavniki. Izbira merilca predstavlja največjo variabilnost merilne strategije. Prejšnje raziskave so pokazale, da se lahko rezultati meritev razlikujejo do sto odstotkov glede na izbiro merilne strategije pri ocenjevanju napake oblike. V tem članku je opravljena podrobna študija vpliva merilne strategije na pogrešek cilindričnosti pri merjenju enajstih obdelovancev z enakimi nazivnimi, vendar različnimi dejanskimi lastnostmi, ki jih opisujeta hrapavost in nazivna vrednost cilindričnosti. Za preučitev vpliva in pomembnosti nekaterih dejavnikov ter njihovih ravni sta bili uporabljeni načrt eksperimenta (DoE) in dve tehniki nenadzorovanega strojnega učenja: analiza glavnih komponent (PCA) in večkratna analiza ujemanja (angl. Multiple Correspondence Analysis - MCA). Rezultati kažejo, da glede na dejansko geometrijo obdelovanca različni dejavniki z različnimi odstotki vplivajo na izhodno značilnost. Cilj je bil izbrati enotno merilno strategijo pri merjenju cilindričnosti s KMS, kadar ni predhodnih informacij o dejanski geometriji obdelovanca.

P O D A T K I O Č L A N K U

Ključne besede:
Koordinatni merilni stroj (CMM);
Strategija merjenja;
Natančnost;
Analiza glavnih komponent;
Večkratna analiza ujemanja;
Nenadzorovano učenje

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