REAL-TIME MANAGEMENT OF BOLT AXIAL FORCES WITH BOLT HEAD PHOTOGRAPHS USING DEEP LEARNING

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Proposal of Photograph Resolution for Real-Time Management of Axial Forces

BACKGROUND

As shown in the Fig.1, **residual axial force decreases by 10~20% from the design bolt axial force by p**revious study investigates.

It is crucial to **ensure the appropriate bolt axial force in the initial stage.**

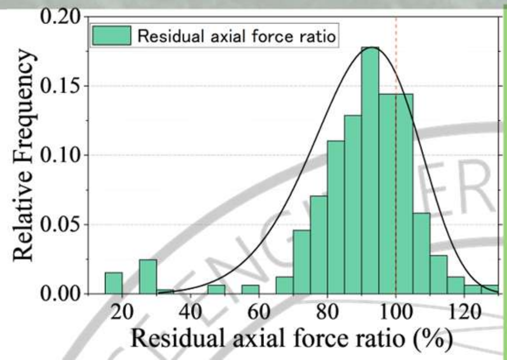

Fig. 1 Residual aixal force ratio

Contactless vision-based autonomous bolt axial force detection methods using **deep learning**. This method focuses on the deformation of the bolt head.

Additionally, illumination conditions may affect the determination, and it is necessary to evaluate how this affects the axial force precision

METHOD

(1) FE model: Check the deformation of the bolt head whether the camera lens can capture the degree of deformation or not.

(2) Convolutional Neural Network(CNN): Extract minimum feature information in the bolt photograph.

(3) Axial force and photograph recognition system: Obtain and labialization training photographs using recognition system

(4) Smart LED light: Create various light illumination conditions by adjusting RGB values.

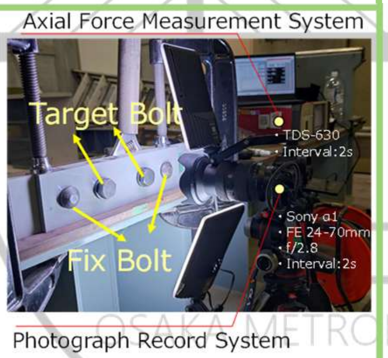

Fig. 2 Tightening test

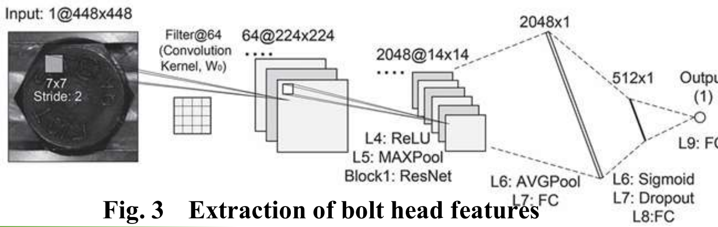

Fig. 3 Extraction of bolt head features

KEYWORDS

☐ Bolt Axial Force, Deep Learning, Tightening test

RESULTS

(1) Displacement distribution at snag tight: Observing the displacement at 50 kN(Fig.3), the maximum displacement(shrinkage) point was located at the circumference of the bolt, and the maximum displacement amount was 0.003 mm which can be captured by the SLR camera.

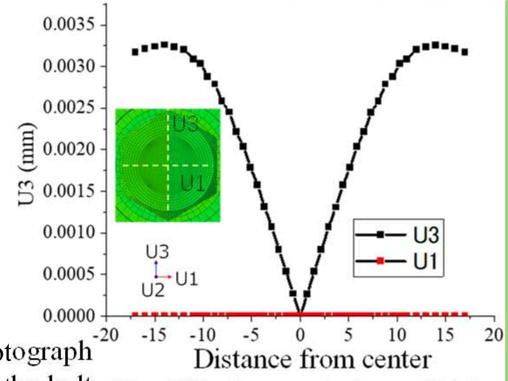

Fig. 3 Displacement at snag tight

(2) Influence of illumination conditions

Normalized (Equ.1) each RGB component of photograph. The illumination conditions and the deformation of the bolt head follow the equivalent function(f(rgb→Y), Equ.2), and the accuracy(Fig.4) of the determination of axial force increases as the number of training sessions is increased.

f(rgb)=0.299·R+0.587·G+0.114·B(Equ.1)

Y=f(rgb)+n(rgb)(Equ.2)

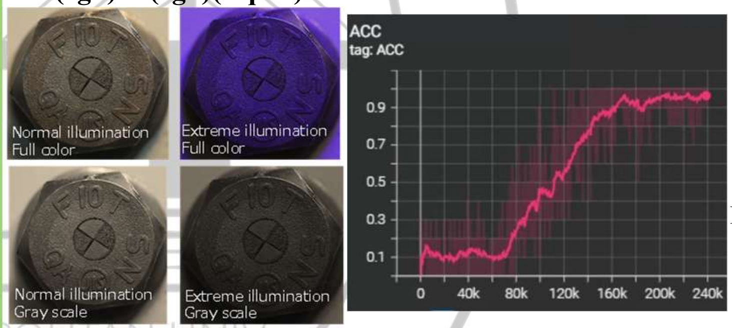

Fig. 4 Influence of illumination conditions

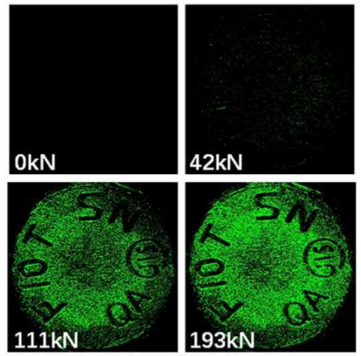

Fig. 5 Visualization of feature values

(3) Extraction of feature values

Using CNN and Visualization tools, the most significant deformation location was circumference of head, and also found in Fig. 3

SUMMARY

(1) the deformation of the bolt head from snag-tight could be captured by a SLR camera.

(2)The CNN was able to extract the feature values of the deformation in bolt head

(3) Even noise such as light illumination conditions was added to these photograph, with the increasement of training epoch, the precision also increased