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COUNTRY:	Japan	PREF. SUBJECT: PS2
REGISTRATION NUMBER: 7734		QUESTION No.: Q2.19

Question 2.19: What was the confidence level of the AI system inspection conductors and towers? How many images were used to train the AI for recognition?

Contribution for Q2.19

We have about 15,000 kilometers of transmission lines. Inspecting them is very time-consuming because it mainly involves shooting with a helicopter, then reconfirming the state of the line visually via slow-motion replays (at around 1/10 of normal speed).

Conversely, we have about 43,000 steel towers, 80% are more than 30 years old and aging. Inspecting to check for deterioration caused by rust in the region near the coast is particularly time-consuming.

In response, we are trying to improve efficiency by introducing AI into equipment inspection (steel towers and electric wires). We would like to present evidence reaffirming the reliability of AI and how it is learned.

○ Development of a conductor diagnosis-imaging system using helicopter VTR and AI

We used VTR data taken by helicopters during inspections over the period 2013 to 2017 to learn the AI model. The VTR was cut into still images and about 140,000, including normal and failure conditions, were used for learning.

For normal state teacher data, images showing wires of various line types and the number of conductors were used, particularly the ACSR wires mainly used in our company. (Fig. 1)

In addition, approximately 450 images recorded over five years were processed to increase the number to 7,000 before using teaching data under failure conditions. Failure conditions are defined as those in which the strength of electrical wiring machinery is considered at risk of deteriorating, e.g. due to the wiring breaking or melting.

Table 1 Number of images used to learn AI

For normal state teacher data	For Failure state teacher data	Total
Approximately 133,000	Approximately 7,000	Approximately 140,000

○ Example variation of the wire type

Steel core aluminum-stranded wire (ACSR)

Low-noise ACSR (LN-ACSR)

Snow accretion-prevention ACSR (SL-ACSR)

○ Example variation in the number of conductors

Single conductor

Four conductors

Eight conductors

Fig. 1 Examples of normal state images used for learning

Wire breakage

Melting

Corrosion

Fig. 2 Examples of failure state images used for learning

The metrics used to measure AI accuracy are expressed in the form of non-detection and false detection rates, respectively. The non-detection rate indicates the probability of the AI failing to detect an abnormality. The false detection rate indicates how likely it is that the AI erroneously determined an abnormality. As verifying the AI accuracy, both the non-detection and false detection rates were confirmed as under 6%, so the transmission line system was confirmed as having high accuracy.

We will continue implementing additional learning to reduce non-detection and false detection rates.

○ Development of a steel tower deterioration diagnostic method using drones and AI

This AI model is constructed by additionally learning images of rusting on 22 steel towers as part of a versatile rust detection approach, which involves the AI deep-learning numerous rust images of all kinds.

About 1300 images are used for learning, with the versatile rust detection AI as a base. We conducted additional learning by adding 350 or so still images, including an enlarged still image of the rust area and an overhead view of the steel tower containing the rust area, as shown below.

Enlarged still image of the rusted area

Overhead view of the steel tower containing the rusted area

Fig. 3 Examples Images Used for Additional Learning

In actual drone images taken, certain objects appear dark due to accessories other than steel tower members reflecting or backlights. The AI rust detection model, which has been optimized for power transmission towers, was constructed by ensuring appropriate annotation and backlight correction for additional learning. It has been confirmed that the accuracy of this AI involves a recall rate of 97% or more and precision of 91% or more.

We are now tuning the AI to match human visual criteria. Further study is planned so that abnormalities such as corrosion under the coating film can be detected for painted steel towers.

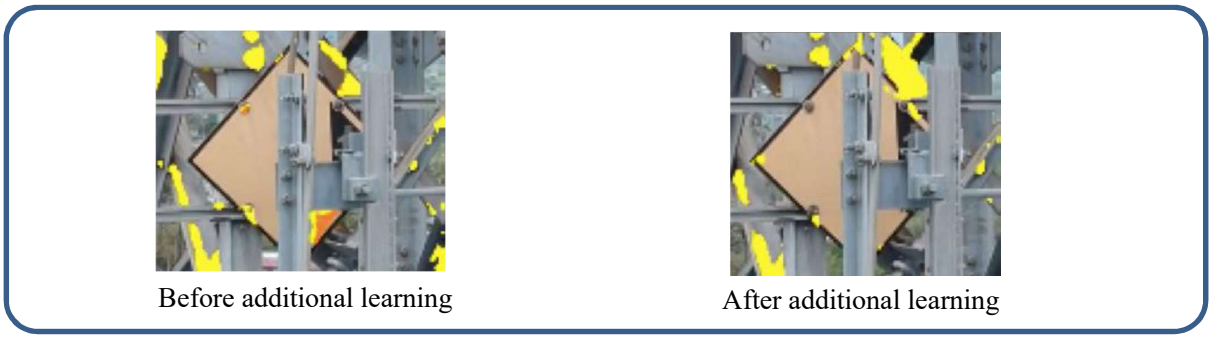

Fig. 4 Example of preventing false positives with annotations

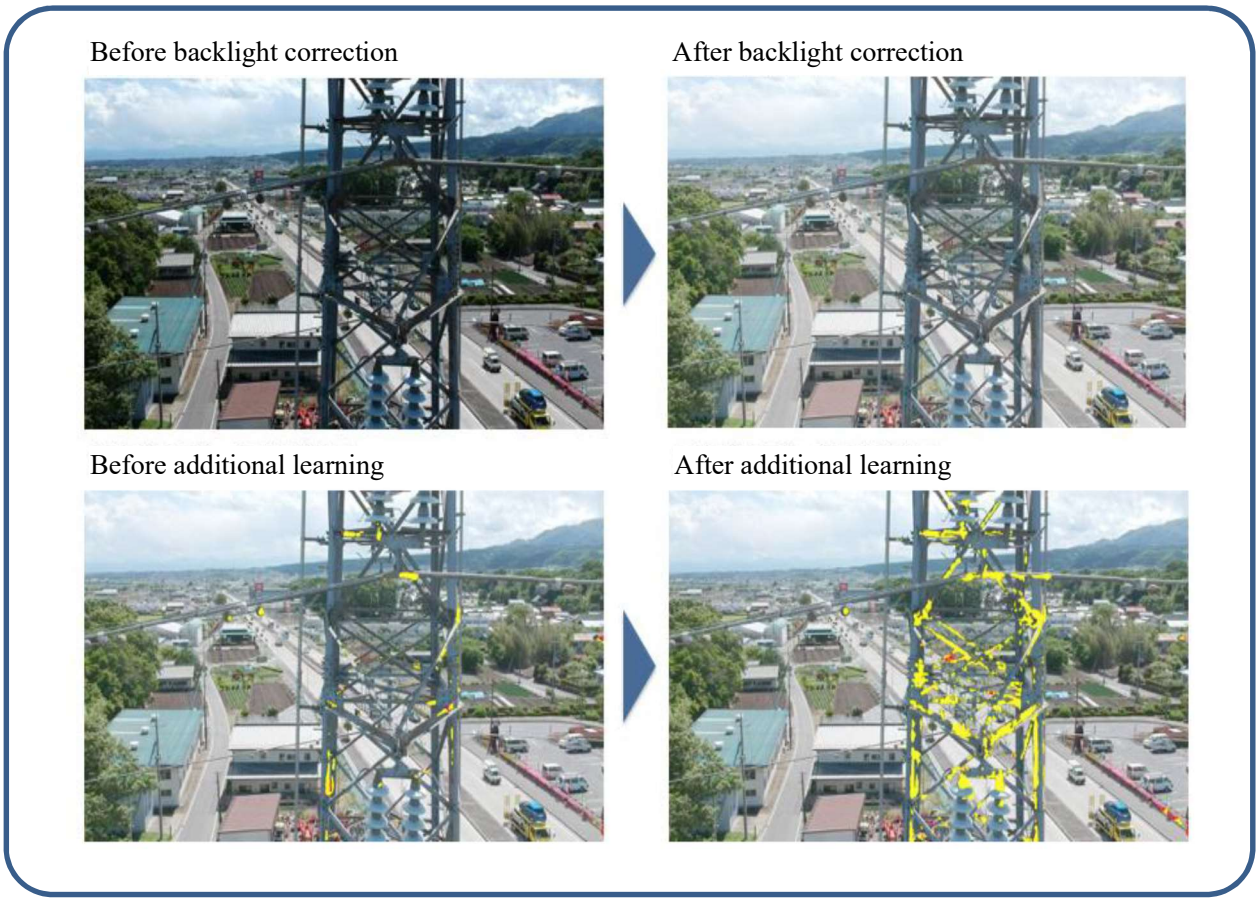

Fig. 5 Example showing a detection area expanded by backlight correction