

## Tunnel Crack Detection with Deep Learning

RTRI has developed a new technique to detect cracks on tunnel lining using deep learning technology. This technique will enable more efficient tunnel maintenance.

### 【Outline】

With this technique, the cracks are automatically detected from the images of tunnel lining. (Fig. 1)

- (1) Using deep-learning technology, this technique is capable of detecting cracks as accurately as visual detections. (Fig. 1) With this technique, it is possible to clearly distinguish cracks with other similarly-looking objects such as signaling cables, contact wires and joints and exclude these noises.
- (2) It automatically processes, at one time, all the images of the entire tunnel lining surface taken by a laser-camera.
- (3) It is capable of detecting more than 83% of cracks wider than 0.5 mm.
- (4) It is capable of checking the images covering 1 km length of a tunnel in 15 minutes.
- (5) The images can be processed with a computer at offices near tunnels.

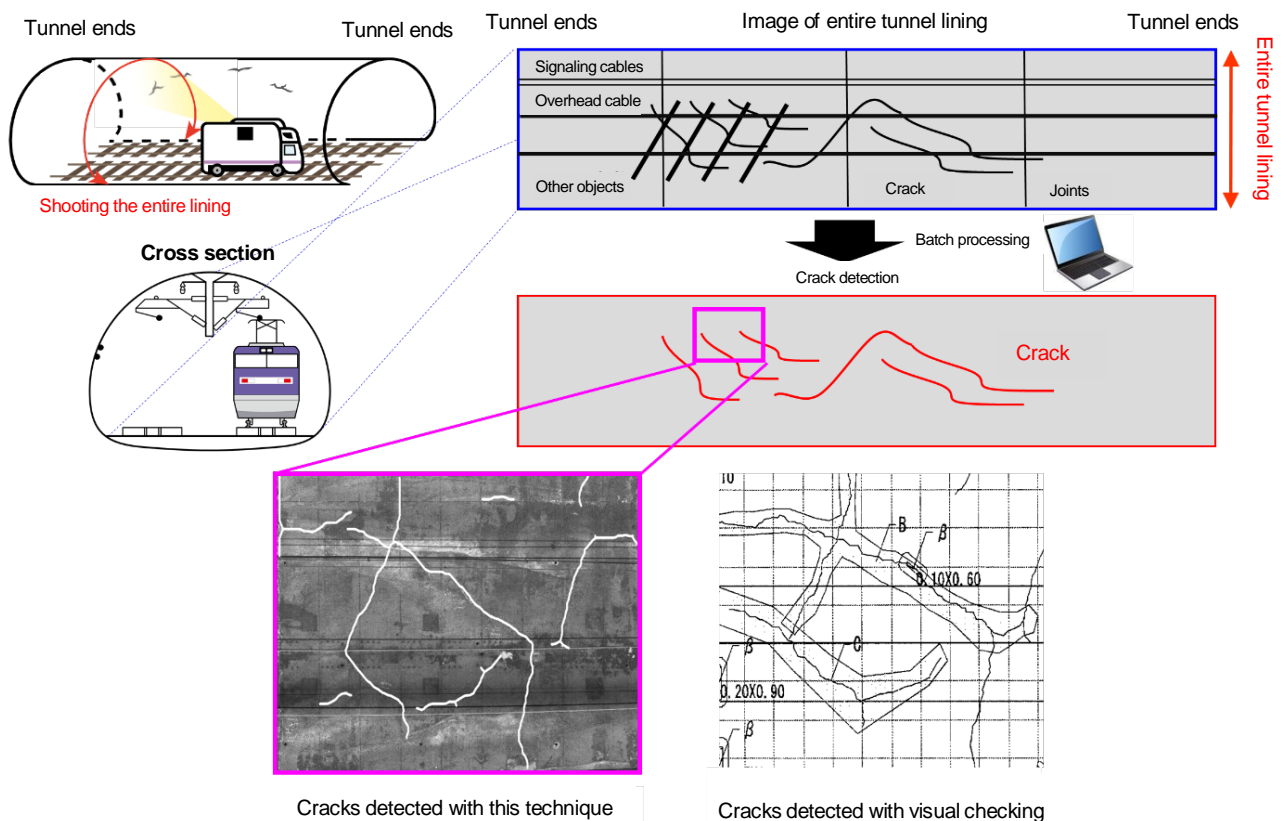


Fig.1 Cracks detected this technique

## 【Detection using deep learning】

This technique has applied deep learning technology to crack detection. It makes a computer to learn both images with and without cracks so that the computer will be able to recognize cracks accurately. (Fig. 2 left) Then the computer will examine the images of tunnel lining, detect cracks and process the images to display the detected cracks accurately. The results have succeeded in showing only cracks without other similar objects such as cables and joints. (Fig.2 right)

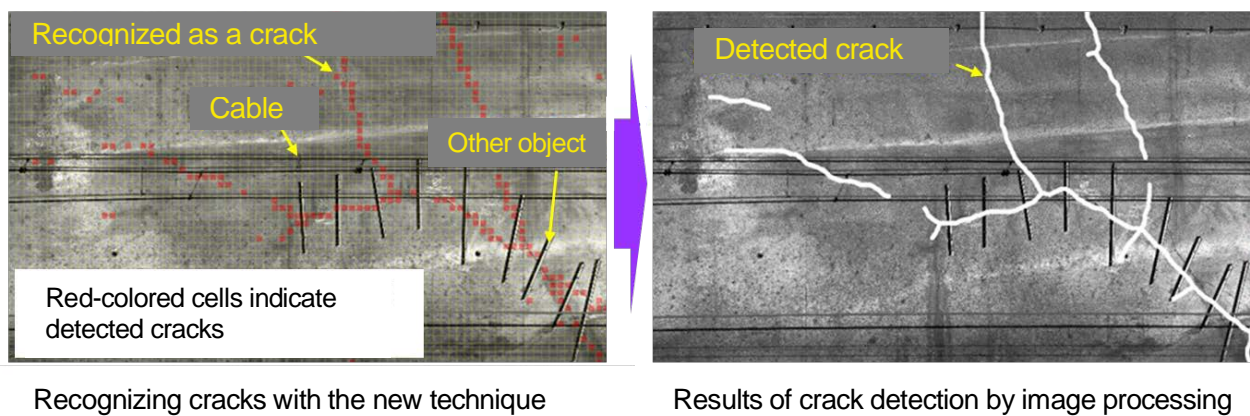


Fig. 2 Crack detection using deep learning technology

## 【Existing image processing technology】

In order to correctly detect troubles on tunnel lining surface such as cracks with existing image processing programs, it has been necessary to adjust parameters according to tunnel shapes and conditions of tunnel lining, using special know-how based upon experience. In addition, it takes a lot of work to correct detection errors caused by similar objects.

- ◇ Deep learning is one of the analytical methods using machine learning. Its neural network algorithm which has imitated the human brain's neural system has multiple layers between the input and output layer in order to be able to solve complicated problems. We have made our computer learn the images with and without cracks repeatedly with the deep learning method so that it will be able to recognize the rules and patterns of the images, and to detect whether the tunnel lining has cracks or not as accurately as humans do.

【Patent pending】