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Development of Next Generation Tunnel Construction System: Remote Control Technology for Shotcrete

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Background

The work of applying shotcrete inside mountain tunnels has various risks such as exposure to dust or getting involved in the collapse of the tunnel face. This is because workers operate the shotcrete robot near to the face within the narrow tunnel. To improve the working environment and safety, we developed a technology to remotely operate the shotcrete robot in a clean working environment away from the tunnel face.

Outline

The main technology used for the shotcrete robot is the use of multiple network cameras on the erector boom and the main body of the erector-mounted shotcrete sprayer (Photo 1)These are to ensure the operator's field of view. The operator can operate the remote control box of the shotcrete robot while viewing the images taken by the camera on a monitor screen installed in a mobile operation room away from the tunnel face (Photo 2)The network camera is highly waterproof and dustproof, with a dustproof air shower ring around the lens to prevent aggregates and cement particles from attaching.
The remote-control system is a network-compatible system that efficiently transmits video data and operation signals wirelessly (Fig. 1).
The shotcrete robot has an automatic nozzle swing function, which eliminates response reduction caused by the video delay (200~300ms), which is a common issue in remote operation. Also, laser beams come out from the tip of the nozzle to enhance the visibility of the spraying area through the screen and ensure the efficiency of shotcrete application.

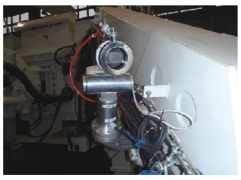

Photo 1

Photo 2

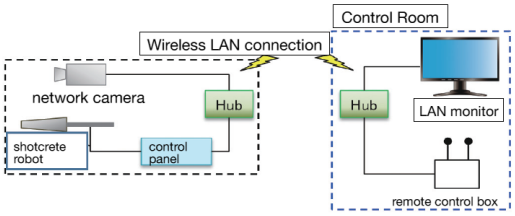

Fig. 1 Shotcrete system