Disaster prevention

An image-feature enhancement and interpretation system for crack detection of concrete surface based on feature composite moving image inducing visual illusion

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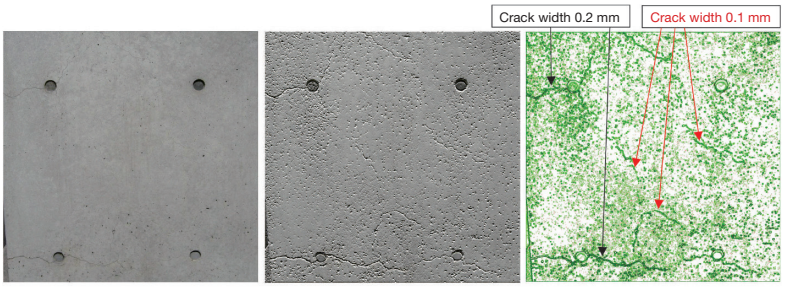
Purpose of Research

Images of concrete surfaces that are taken to find cracks are basic data for maintenance management of a concrete structure. Features included in such an image are often hard to interpret and thus are generally processed for image enhancement. However, conventional processing methods are not effective and tend to result in image degradation. To facilitate the crack detection of concrete surfaces, we have developed an optical illusion-inducing image interpretation support system. This allows real-time feature enhancement/support for interpretation of a video taken during inspection.

Summary of Research

We developed a method for combining images of features which maintains image quality and creates an afterimage optical illusion whose effect is to sharpen the whole image and thus make cracks on a concrete surface more visible. Spatial frequency components corresponding to changes in density among the frames of the feature composite moving image are calculated, and the power (amplitude) of each spatial frequency component is determined, allowing objective evaluation of the image visibility. Inspection of actual concrete surfaces demonstrated that this system composed of general-purpose devices such as a video camera and laptop performs adequately.



Original image | Optical illusion-inducing feature composite moving image (composite-imaged features are dispersed) | Moving image for visibility evaluation

Video recording & real-time analysis

<System components>
- PC (laptop or tablet)
- Video camera (UV, visible light, or near IR)
- Hyperspectral camera

Points

- Quick inspection, even in dark places such as inside tunnels and underneath bridges
- Supports on-site real-time analyses and subsequent analysis/graphing of captured images
- Sharpens various images obtained by observation (still and video images) and enhances image features (using optical illusion) (Applicable to various images obtained in the UV, visible, near-IR, and microwave ranges)
- Acquires video and still images displayed on a screen and processes them in real time (Real-time processing of video and still images displayed on existing systems)
- An idea creation support system that operates together with other existing systems

Comparison with Conventional or Competitive Technology

In our system, embossed images (virtually irradiated from 8 directions) are sequentially displayed to the user to provide a composite moving image of particular features that induces visual illusions (i.e., pseudo-rotational and persistent of vision). Conventional feature enhancement processing has the problem of image degradation. This optical illusion inducement provides image enhancement/sharpening while maintaining the quality of the original image. In addition, using DFT to calculate spatial frequency components, our system can quantitatively and objectively evaluate image visibility, which is evaluated subjectively in conventional methods.

Expected Applications

- Crack inspection of concrete structures.
- Interpretation, detection and graphing of crack propagation (in RC beam bending/shear test videos, etc.).
- Inspection aid in dark places (tunnel, etc.) (IR image acquisition and analysis available).
- Real-time image feature enhancement for drone videos

Challenges in Implementation

- Development of more portable systems, e.g. mountable on a UAV.
- Application to ultraviolet cameras and hyperspectral cameras.

What We Expect from Companies

Seeking for a joint research companies, local government or structure maintenance firms in evaluating the VIS system's applicability.

Future Developments

From April 2017 VIS system sales start
From June 2017 Application of concrete surface inspection VIS system (including UAV video)
From September 2019 Examination of function expansion of VIS system
From December 2020 Implementation of VIS version upgrade
From January2020 Expansion of applicable fields of VIS system, industry-academia collaboration activities (Various videos and still images)

■Intellectual Property:
Japanese Patent No. 04868509, Japanese Patent No. 05046119, Japanese Patent No. 05246770, Japanese Patent No. 5769295, Japanese Patent No. 6021053, Japanese Patent No. 6742036
■Patent license agreement entered into with four companies.
■Technical instruction contracts are available.

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