REPRODUCTION OF REBAR MESH ARRANGEMENT INSIDE CONCRETE BRIDGE DECK FROM GROUND PENETRATING RADAR VOLUME IMAGES BY 3D FILTERING

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1. INTRODUCTION

Deterioration of infrastructures and increase of its maintenance cost have been a worldwide issue, and shifting to preventive maintenance that detects and repair damages of structures beforehand is an effective approach for reducing the cost. Bridge deck is known as one of the most difficult structures for maintenance due to its complexity. Recent years, vehicle mounted multi-channel Ground Penetrating Radar (GPR) is attracting attention for realizing fast acquisition of subsurface information. This research aims to detect rebars in GPR images that often trigger damages of bridge decks. Rebars in GPR images is recognized as hyperbolas, and previous research focused on detecting rebars based on hyperbolic shapes [1][2]. There is no research focused on detecting rebars inside 3D radar images. This research aims to reproduce 3D rebar mesh from GPR volume images based on 3D frequency filtering method.

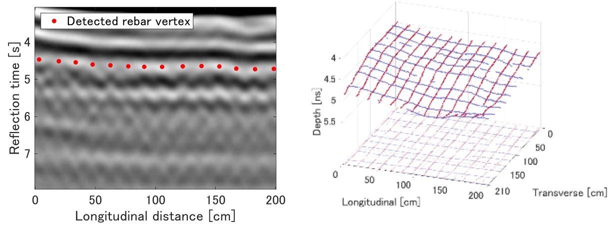
2. METHODOLOGY AND RESULTS

Measurement was conducted using a real scale bridge deck specimens with known rebar spacing of 15 cm in each longitudinal and transverse direction. Utilized vehicle mounted GPR contains 29 channels in transverse direction in 7.5 cm pitch and data is acquired 1 cm interval in longitudinal direction. The frequency band of the transmitted electromagnetic wave is 50-3030 MHz.
Proposed algorithm uses two 3D filtering in purpose of denoising. 3D filtering is done by first applying the 3D Discrete Fourier Transform (DFT) to data, multiplying certain shape of filter, and applying 3D inverse DFT. The first filter extracts components along depth axis in the frequency domain with cone shape. Applying this filter enables to extract curved surfaces such as road surface, bridge deck surface, and rebar surface. The reason of the curved surface is due to car vibration and heterogeneity of structure's relative permittivity.

The second filter emphasizes rebar response in the radar data. As rebars being placed in a certain spacing, peaks appear on longitudinal and transverse axes in the frequency domain. Focusing on a surface that includes rebar vertex in the filtered data and by a peak detection method, 3D rebar mesh was produced.

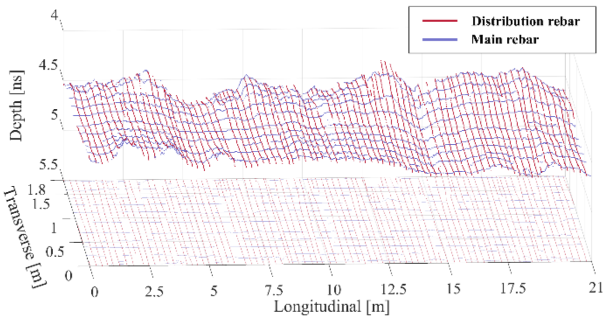
Figure 1 Location of rebars. Concrete is constructed afterwards (left). 3D DFT of the radar data (right).

Figure 2 Reproduced rebar mesh and the overlayed vertex in the radar data before processing.



The proposed method was also effective for an in-service bridge data that was acquired 7 cm interval in the longitudinal direction.

Figure 3 Reproduced rebar mesh of the in-service bridge. The total longitudinal distance is 21 m.



3. CONCLUSIONS

In this paper, algorithm of reproducing 3D rebar mesh from radar volume images was proposed. In future studies, observation of the rebar mesh intensity is needed for determining the integrity of bridge slabs.

REFERENCES

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