Surface Profile Measurement of Pavement Using Ultrasound

空中超音波を用いた舗装道路の表面プロファイル測定

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1. Introduction

It is well known that the life span of Japan's paved road is approximately 50 years. Although, there are already a lot of roads requiring maintenance, maintenance costs are increasing. Since it is expensive to replace the road, reparing the damaged road bedore it needs to be replaced, is significantly important to extend the life of the road by repairing the crack.

Many researchers reported on detecting the crack using optical camera [1,2] and laser[3]. Some detecting systems have been commercialy released. However, these systems were developed for detecting cracks, not for evaluating the repaired road.

After the crack is repaired with sealing material, if the repaired point becomes uneven, and this irregularities often occur noise problem. To evaluate the irregularities after repair, the surface profile of paved road is needed. In this study, the surface of a paved road was scanned using aerial ultrasonic waves and profile measurements with various conditions were performed.

2. Method

The ultrasonic experiments were carried out using a customized measurement machine on a paved road in the area of Kumamoto university. In the measurement machine, the commercial ultrasonic distance sensor (US-015) was used to measure the distance from the sensor to the ground. This module can measure the distance from 2 cm to 4 m range with resolution of 1 mm. This sensor was attached to a 2-axis linear stage to scan the surface of the paved road. This ultrasonic sensor and 2-axis linear stage were controlled by using Arduino Uno R3. The experimental system is shown in **Fig.1**.

3. Results

In this study, scanning area was set as 10 x 10 cm^2 was scanned using the experimental system. The pitch of scanning was 1 mm, and 10,000 points of depth data were obtained at each scan point. **Figure 2** shows relatively smooth surface road. The yellow box indicates the scanning area. Its scanning result is illustrated in **Fig. 3**.

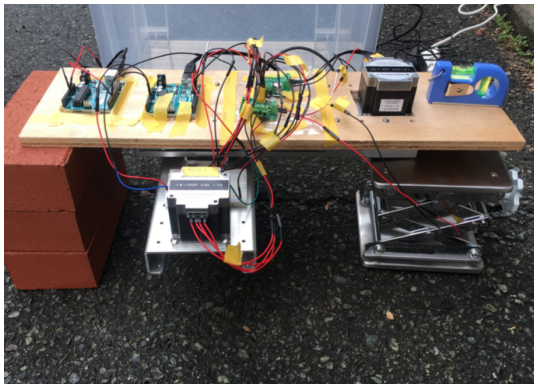

Fig. 1 Experimental system.

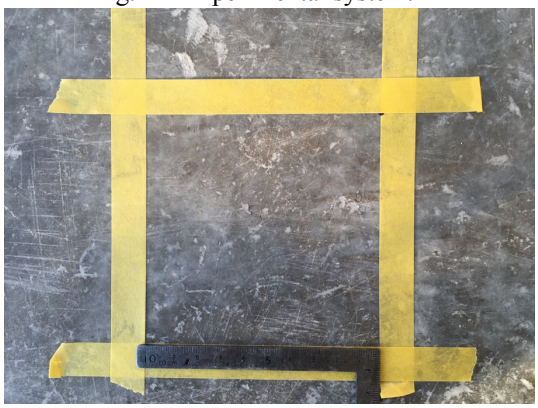

Fig. 2 Picture of smooth surface road.

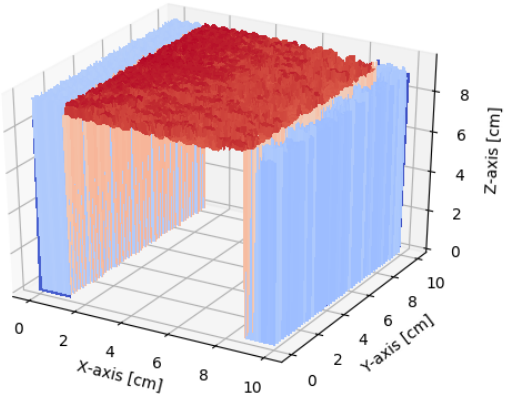

Fig. 3 Depth of smooth surface road.

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On the rough surface road as shown in **Fig. 4**, the obtained result showed uneven depths in **Fig. 5**. Subsequently, two crack roads were investigated. **Figure 6** shows the smooth road which has relatively simple straight crack. The obtained result from this road illustrate the straight crack even there is still unknown error near the crack point. More complex shape of crack at rough surface road was also investigated as shown in **Fig. 8**. The depth image of the complex crack represents the crack well, as shown in **Fig. 9**. However, the quantitative analyses of them are required to evaluate this system.

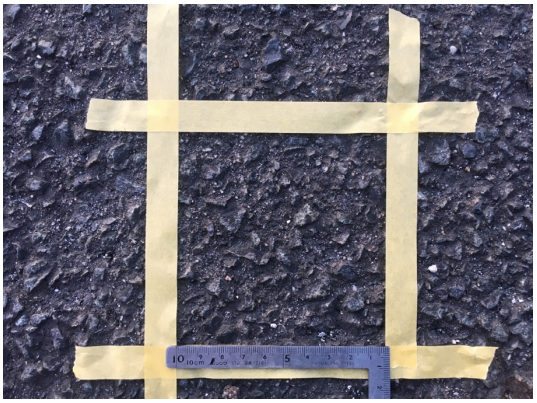

Fig. 4 Picture of rough surface road.

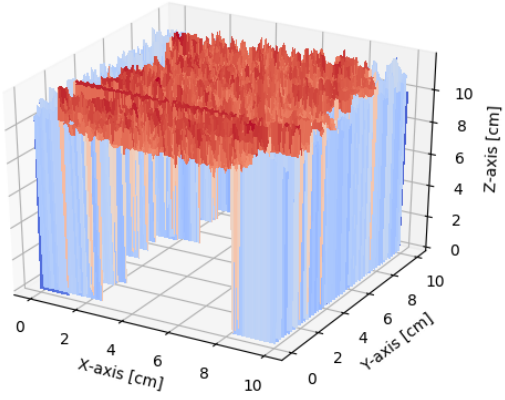

Fig.5 Depth of rough surface road.

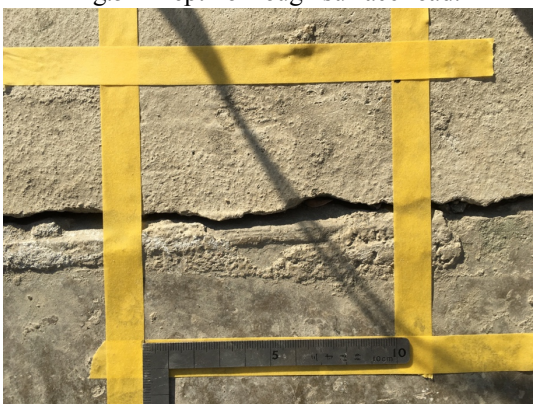

Fig. 6 Picture of smooth surface road with straight crack.

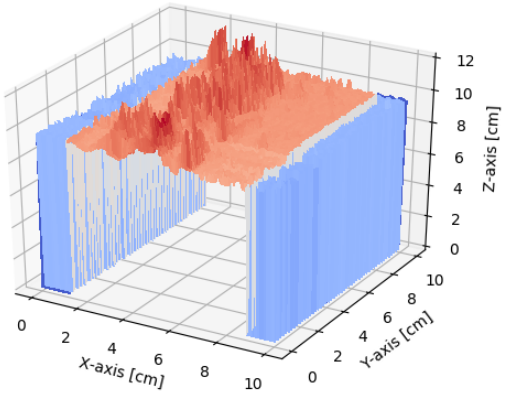

Fig.7 Depth of smooth surface road with crack.

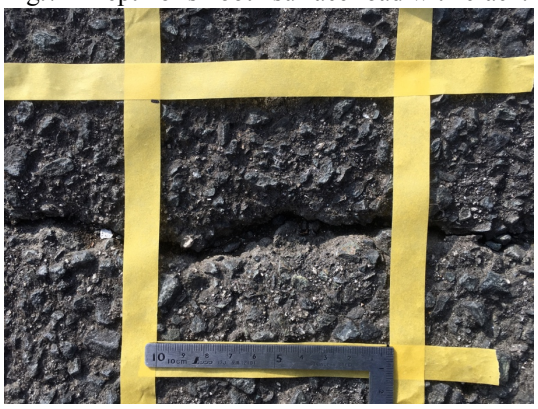

Fig. 8 Picture of rough surface road with complex crack.

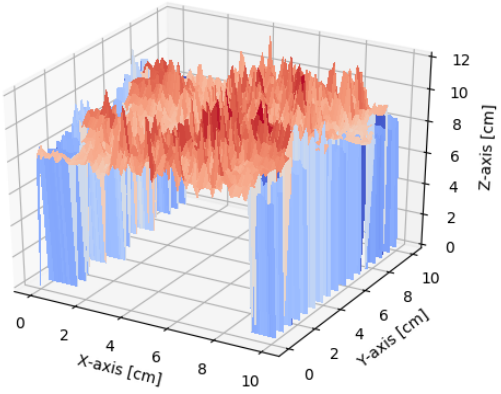

Fig.9 Depth of rough surface road with complex crack.

4. Conclusion

In this study, the surface profiles of paved road with various conditions were evaluated using ultrasonic distance sensor. The obtained results show that this approach has potential to visualize the surface profile of the road with crack in detail.

References

1. M. Ichitubo and M. Shinozuka: Proc. Japan Concrete Institute **24** no.1 (2002) 1653.
2. A. Cubero-Fernandez, F. J. Rodriguez-Lozano, et al.: EURASIP J. Signal Image Video P. **2017** no.1 (2017) 39.
3. J. ChoiL. ZhuH. Kurosu: ISPRS **XLI-B1** (2016) 559.