Evaluation of Road Pavement Monitoring System

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Introduction

The Navlab group at Carnegie Mellon University has developed a system to assess pavements[1]. It is much more cost effective than traditional methods. In 2016 the company RoadBotics was incorporated and is commercializing the system. In this report the system is evaluated by comparing its pavement scores of Pittsburgh streets with pavement scores obtained by Cartegraph[2].

Road Pavement Monitoring System

The data used are GPS tagged images collected with a smartphone that can be mounted in any vehicle (Figure 1).

Figure 1: Smartphone mounted in the windshield of a car and powered by a 12V outlet.

After the collection, the data is downloaded to a server via WiFi. The images are analyzed to determine the amount of cracks in the pavement. An example is shown in Figure 2.

Figure 2: Left: Raw image. Middle: Detection of road area. Right: Detection of cracks.

The first algorithm determines the area of the image that contains the road. The second algorithm detects the cracks inside the road area. The ratio of the area that contains cracks to the area without

[1] See the web page http://www.cs.cmu.edu/~road/ for a video presentation, references in scientific papers, and press articles.

[2] www.cartegraph.com

cracks gives a score for each individual image. This score is averaged over a street segment and converted to five levels, these levels are shown for Pittsburgh in Figure 3.

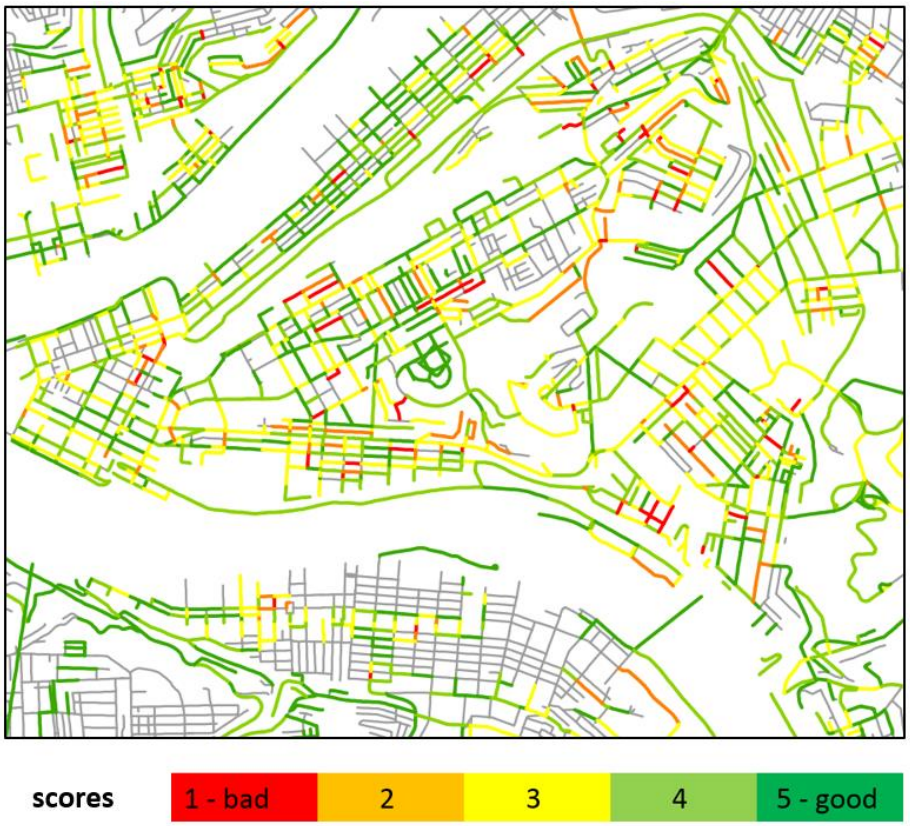

Figure 3: Scores obtained for the city of Pittsburgh.

The data for the comparison was collected in 2016 and up to August 2017.

Cartegraph data

Cartegraph collected Pittsburgh road data in spring 2016. It analyzed the data and obtained an overall condition index (OCI) for each road segment. The index goes from 0 (failed road) to 100 (excellent road). The City of Pittsburgh gave us this index in June 2017, corrected for the time passed since spring 2016 by reducing the index by a few percentage points. The road segments that were paved in the meantime were set to 100. We converted this index to a 5-level score to be able to directly compare it with the road pavement monitoring system.

Comparison

The direct comparison of the two scores gave the following:

- 54% - scores are the same
- 27% - scores differ by 1 level
- 19% - scores differ by more than 1 level

Most of the scores agree and it is expected that some differ by 1. We looked further into the almost 20% of cases where the scores differed by more than 1 level and found following explanations:

- **Time**: The road was paved between when we received the Cartegraph data and when we collected the road data.
- **Weather**: The data was collected during a snow day.
- **Distortions**: Glare, motion blur, etc. (see Figure 4)
- **Different measures**: The OCI considers additional distresses like rutting.

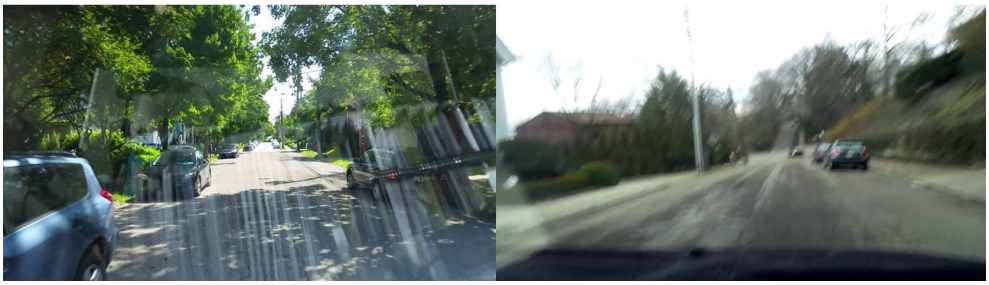

Figure 4: Examples of glare (left) and motion blur (right).

The scores of the road pavement monitoring system can be improved by discarding data that was collected during bad weather, reducing the glare with a reflection shield on the camera mount, detecting blur in images and discarding those with excessive blur, and finally training the algorithm for a greater variety of conditions.

Conclusion

Overall there is an agreement between the Cartegraph measurements and the scores from the road pavement monitoring system. The conclusiveness of the comparison is limited because the measures of the two systems are somewhat different. Additionally, the road pavement monitoring system can still be improved by considering weather, glare, and blur and by additional training. We estimate that after corrections and improvements the comparison will be

- ≈75% - scores are the same
- ≈ 20% - scores differ by 1 level
- <5% - scores differ by more than 1 level