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Abstract

Drone-Image Based Fast Crack Analysis Algorithm Using Machine Learning for Highway Pavements †

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1. INTRODUCTION

Transportation agencies automatically collect and analyze pavement cracking data using agency-owned equipment and software or contracted services. The pavement cracking data are then used to determine the most appropriate maintenance and rehabilitation strategies to provide a safe and reliable roadway [1]. However, it requires a high-cost equipment or services [2].

A digital image processing algorithm was developed to compute a unified crack index and crack type index [3,4]. A robust position invariant neural network was developed for digital pavement crack analysis [5]. The accuracy of automated pavement surface image analysis system has been evaluated against the ground-truth cracking data [6]. Image-based data collection procedure was then evaluated against the AASHTO provisional standard for cracking on asphalt-surfaced pavements [7].

Currently, ten state DOT's are using drones for bridge inspection and six state DOT's for pavement inspection [8]. Recently, there are increased interests on automatically analyze drone images from integrators/service providers and end-users [9]. This paper presents a low-cost pavement distress data collection using a drone and subsequent drone image analysis using pavement crack analysis software.

This paper discusses the state-of-the-art drone imaging technologies and advanced image analysis algorithms adopting advanced machine learning software tools. Drones were used to capture pavement surface images, which were analyzed using the crack image analysis software. This paper is timely given the increased new development in drone imaging technologies.

2. METHODOLOGY

Drone images were collected and a machine learning algorithm was developed for road segmentation and crack detection.

1) Data Set Preparation

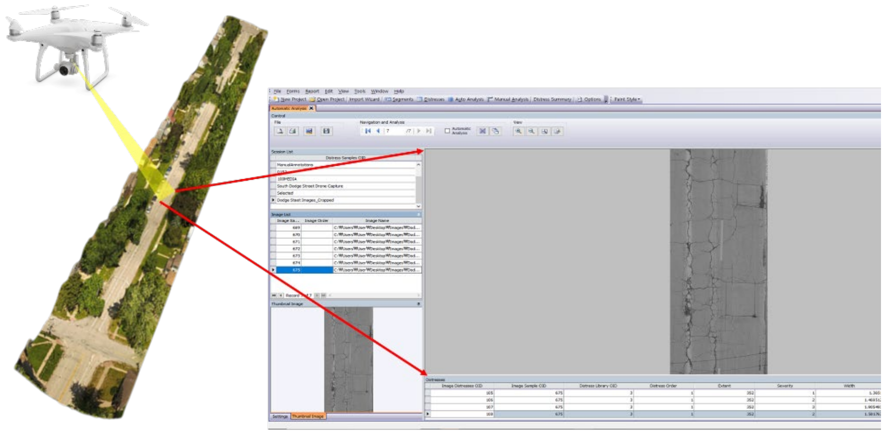
Drone images of pavements were collected using a drone, which were then used for training for developing a machine learning algorithm. A second set of drone images were collected for validation of the developed machine learning algorithm.

2) Pavement Extraction from Drone Images

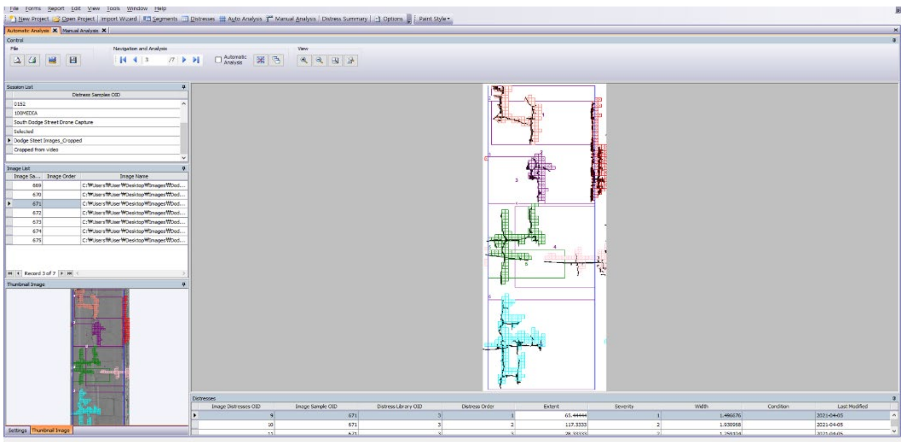
Drone images cover wide range of earth surface and the first task is to extract pixels, which belong to pavements. To extract pavement pixels from drone images, a semantic segmentation method was used to develop a convolutional network architecture designed to accomplish the this first task.

3) Crack Detection

For a given crack image, a proposed machine learning algorithm was developed to yield a crack detection scheme, where crack regions have higher probability and non-crack regions have lower probability. Figure. 1 shows an example drone image acquisition and analysis result.



(a) Importing a drone image of pavement surface



(b) Automatically analyzing a drone image

Figure 1: Importing and Analyzing a Drone image

3. SUMMARY AND CONCLUSIONS

Increasing number of public agencies and companies are using drones for pavement inspection. Images can be automatically captured by a drone and stored in a point cloud for 3-D modeling. A DJI drone was be used to capture pavement surface images in a high resolution at a low cost. Software was developed to analyze drone image images and analysis results can be integrated with GIS software. In the future, LiDAR camera can be mounted on a drone to measure a depth of cracks.

The template details the sections that can be used in a manuscript. Note that each section has a corresponding style, which can be found in the "Styles" menu of Word. Sections that are not mandatory are listed as such. The section titles given are for articles. Review papers and other article types have a more flexible structure.

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