Rapid and Accurate Assessment of Road Damage by Integrating Data from Mobile Camera Systems and Mobile LiDAR Systems

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Project Objective

We aim to develop an innovative approach to produce highly detailed orthomosaics of road surfaces, with a spatial resolution as fine as millimeters, utilizing panoramic photos obtained from a mobile camera system combined with Structure-from-Motion technology.

Problem Statement

Mobile camera systems (MCS) represent an affordable technology capable of capturing exceptionally detailed panoramic photos to document road surface conditions with high resolution (Fig. 1). However, converting these high-resolution images into georeferenced orthomosaics suitable for GIS applications poses a notable challenge, primarily due to the presence of non-road-surface objects (such as streetcars, pedestrians, and vehicles carrying the MCS) captured within the photos, causing interference.

Fig. 1. (Left) A MCS system with a 360o degree camera mounted on top of a vehicle. (Right) An example panoramic photo captured by the MCS.

Research Methodology

Our method emphasizes the necessity of accurately masking out the ego-vehicle (the vehicle carrying the camera), the sky, and any moving objects (such as cars, bicycles, and pedestrians) present in the street scenes captured by the photos. We employed a combination of deep learning, image processing techniques, and manual editing to perform this masking process. We then used Structure-from-Motion technology to generate orthomosaics of road surface by masking these interfering objects. We tested our methodology at three different roadways with contrasting traffic conditions and surrounding environments (campus, urban, and rural) in Hawaii.

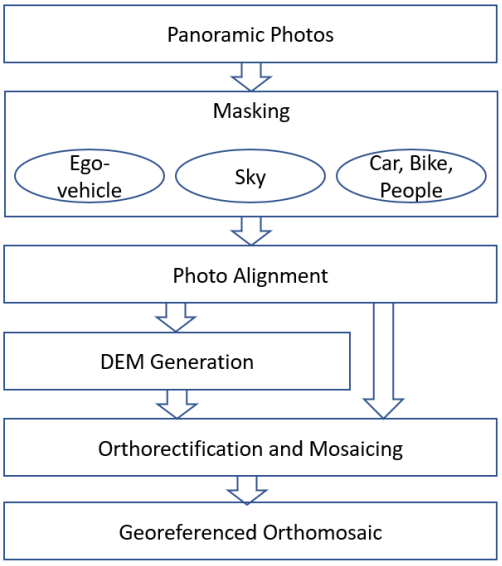

Fig. 2. Workflow of generating roadway orthomosaics from MCS photos.

Results

We produced very detailed georeferenced orthomosaics of road surface at millimeter spatial resolution for road surface damage assessment.

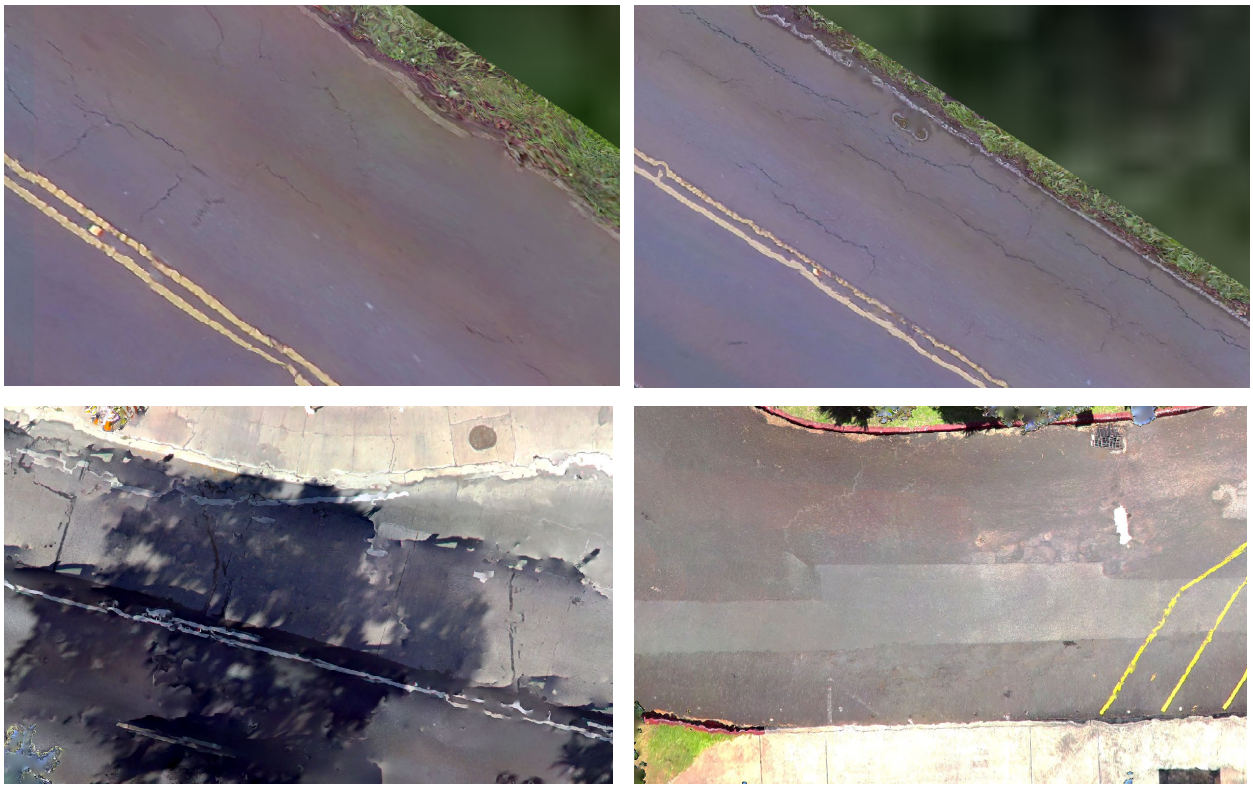

Fig. 3. Examples of georeferenced orthomosaics of roadway.

We learnt that the key of generating orthomosaics from panoramic photos is to minimize the interference of non-road-surface objects in the photo alignment process. We also found that the timing of capturing the photos can have impacts on the quality of orthomosaic and near noon is a better time window than early morning or later afternoon to minimize the shadows in the orthomosaics.