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Short Note

RockSee: Video image measurements of physical features to aid in highway rock cut characterization

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Abstract

Maintaining highway rock cuts for the safety of the motoring public from the risk and consequence of falling rock is an enormous task for State Departments of Transportation. The amount of work to even evaluate and prioritize the remediation effort is prohibitive. To facilitate the prioritization of remediation efforts, a new rock fall hazard rating system has been developed for Missouri highways. To make the process much more efficient, video logs are used screen the rock cuts, parameters used in the system are measured on video images, and data is automatically transferred to a GIS system.

Keywords: Rock hazard rating; Rock mass classification; Highway video logs; Computer-scaled measurements

1. Introduction

It is incumbent on highway departments of transportation (DOTs) to maintain highway rock cuts for the safety of the motoring public and to reduce the risk and consequence of falling rock on lives and property. This is an enormous task, as highways cover vast areas through differing geological terrains. It is clearly unrealistic to remediate all rock cuts, so efforts have to be prioritized.

Many jurisdictions now use a rock mass classification system to streamline the process of scoring each major rock cut (Maerz, 2000). The road cuts with the worst scores in the classification can be quickly evaluated further and prioritized for remediation.

A new risk/consequence classification system called Missouri rock fall hazard rating system (MORFH RS) has been developed for Missouri highways (Youssef et al., 2003; Maerz et al., 2005). A summary of MORFH RS is given in Appendix A. Efficiencies are introduced into the system by

1. using digital highway video logs, imaged at highway speeds for prescreening,
2. making measurements of key classification parameters on the video images using the RockSee program, and
3. facilitating data entry of rating data, storing, printing, and transferring reports to a GIS system, via a personal computing device (pcd) attached to a GPS unit.

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Fig. 1. Simple video setup, consisting of a camcorder mounted in dash of a vehicle.

2. Video preview and pre-screening of rock cuts

Video images are a highly efficient way to document the rock cuts along a highway. Images can be taken at highway speeds, digitally recorded, and evaluated back in the office by the engineer or geologist. Many DOTs already have special vehicles designed to travel down highways whilst obtaining video and making other types of measurements. An example is Roadware's Automatic Road Analyzer (ARAN) described by Maerz and McKenna (1999). This is a highly sophisticated instrumented vehicle that collects measurement data about objects, features, structures, and landmarks located along highways and roadways, for highway planning, managing, and maintenance. It consists of a video system with a precisely calibrated high resolution video camera, a distance measuring instrument for spatial positioning, a gyroscopic geometrics system and an ultrasonic grade system for precise measurement of vehicle attitude.

Alternatively, a simple inexpensive video setup can be used to obtain similar results (Maerz et al., 2003). Fig. 1 shows the hardware setup, which consists of a digital camcorder mounted on the dash of a vehicle. The digital video is recorded on mini-DV tapes, and transformed to avi files using commercially available software such as Adobe Premiere®.[1]

Trained engineers or geologists can review the video footage at a computer workstation in their office to identify problematic cuts and then decide which sites warrant more detailed investigation, which would call for making measurements on the images and viewing the rock cut in the field.

[1]Adobe Premiere is a registered trademark of Adobe Systems Incorporated.

3. Measurements on scaled video

The same images that can be used for video logging and previewing can be used to measure some of the parameters required for the hazard rating system. Measurements can be made on single images without extensive vehicle instrumentation and modifications. Although not as accurate as manual measurements in the field, the measurements are sufficiently accurate to provide input data for a rock hazard rating system.

3.1. Measurement principle

The measurement concept is based on trigonometric relationships (Fig. 2) between the image size and the object size using:

$$\text{Ratio} = \frac{\text{image size}}{\text{object size}} = \frac{d}{L},$$

where L is the distance between the camera and measurement object and d the distance to the projection plane of the image.

Fig. 3 shows the imaging layout. Variables used in the calculations include:

1. vehicle direction vector,
2. mean camera direction vector (M),
3. measured object endpoint vectors in the image with respect to the camera direction vector (e.g. L and R in Fig. 3 defining the width of the ditch),
4. horizontal distance between the camera and the edge of the road, and
5. vertical distance between the camera and the plane of the road.

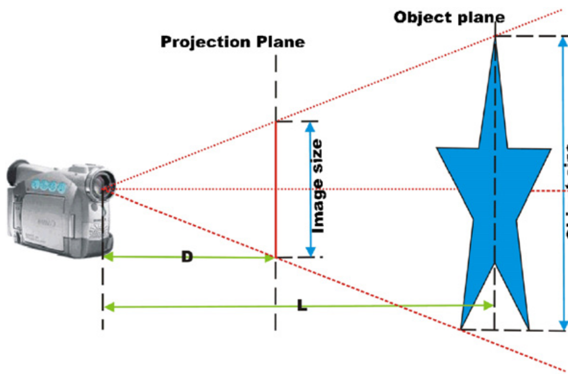

Fig. 2. Illustration of relationship between projection and real-life object.