Technical Note: Lightweight Camera Stand for Close-to-Earth Remote Sensing

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Abstract

Digital photography and subsequent image analysis for ground-cover measurements can increase sampling rate and measurement speed and probably can increase measurement accuracy. Reduced monitoring time (labor cost) can increase monitoring precision by allowing for increased sample numbers. Multiple platforms have been developed for close-to-earth remote sensing. Here we outline a new, 5.8-kg aluminum camera stand for acquiring stereo imagery from 2 m above ground level. The stand is easily transported to, from, and within study sites owing to its low weight, excellent balance, and break-down multipiece construction.

Key Words: rangeland monitoring, vertical, photography, nadir, digital photography

Introduction

The first use of vertical photography for plant cover analysis was reported by Cooper (1924), who used a wooden camera stand to acquire photographs of permanent plots. Between 1924 and the present, a succession of camera-stand designs have been used in the study of rangeland vegetation (Table 1). Claveran (1966) was the first of these researchers to use a camera stand for acquiring stereophotographs of quadrats. Key aspects of a successful stand design include low weight, ease of use, and simplicity. Here we present a design that combines rigidity, low weight, and balanced construction for a stand suitable for a single user working in a variety of plant communities.

Lightweight Camera Stand With Quadrat Base

For monitoring all types of rangeland, a highly portable, yet rigid, camera stand is desirable. In consultation with the Colorado State University Agricultural Engineering Center, we designed and constructed an aluminum camera stand similar to that described by Louhaichi et al (2001). The new stand is 2 m in height with a 1-m² base, constructed of 2.25-cm, thin walled aluminum tubing with custom-milled joints (Fig. 1). The base breaks down into four 1-m lengths and the 2 vertical poles each break down into two 1-m lengths. Each joint has a removable pin around the base and top, permanently attached by a 10-cm cable to one side of each joint to avoid pin misplacement (Fig. 1, upper inset). These pins allow the stand to be rapidly disassembled into nine 1-m segments for transport and storage. The 2 segments of the 2 vertical poles are connected via a flared coupler with hand-tightened setscrews (Fig. 1, lower inset). The stand weighs 5.8 kg, not including the camera, and is easily balanced and carried in the field by a single operator. The horizontal top bar is square in cross section. A quick-release camera mount is attached to a carriage that rolls laterally along the top bar, allowing for stereo image acquisition. Setscrews along the top bar regulate lateral movement of the mount to control the degree of parallax in the stereo imagery.

Taller features require less parallax to achieve optimal stereo effect. Too much parallax can prevent stereo viewing or lead to difficulty in focussing the images, so attention must be paid to proper adjustment of these setscrews. An Olympus E20, 5-megapixel, color digital camera with infrared remote control is mounted on the camera stand to acquire nadir imagery from...
Table 1. Review of camera stands used for vertical ground photography.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>AGL (m)</th>
<th>Fid (m²)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper</td>
<td>1924</td>
<td>1.8</td>
<td>1</td>
<td>Wooden, offset tripod with all parts on 1 side of quadrat</td>
</tr>
<tr>
<td>Rowland and Hector</td>
<td>1934</td>
<td>NG</td>
<td>NG</td>
<td>Wooden trestle over square meter quadrat</td>
</tr>
<tr>
<td>Winkworth et al</td>
<td>1962</td>
<td>NG</td>
<td>2.5</td>
<td>Tall stepladder</td>
</tr>
<tr>
<td>Claveran</td>
<td>1966</td>
<td>1.7</td>
<td>1</td>
<td>Metal tripod opened at top with 15-cm wooden bars</td>
</tr>
<tr>
<td>Wimbush et al</td>
<td>1967</td>
<td>1.2</td>
<td>0.9</td>
<td>Rectangular frame supported with 4 spreading, detachable legs</td>
</tr>
<tr>
<td>Pierce and Eddleman</td>
<td>1970</td>
<td>1.5</td>
<td>1</td>
<td>Aluminum angle bar supported between 2 standard camera tripods</td>
</tr>
<tr>
<td>Wells</td>
<td>1971</td>
<td>1.3</td>
<td>1.5</td>
<td>Wimbush stand modified for 2 cameras</td>
</tr>
<tr>
<td>Tueller et al</td>
<td>1972</td>
<td>2.5</td>
<td>2.3</td>
<td>Tripod supporting 2 cameras</td>
</tr>
<tr>
<td>Ratliff and Westfall</td>
<td>1973</td>
<td>1.2</td>
<td>0.09</td>
<td>Square base ~0.09 m², camera handheld against cross bar between uprights</td>
</tr>
<tr>
<td>Pierce and Eddleman</td>
<td>1973</td>
<td>1.5</td>
<td>1</td>
<td>Tripod (HighBoy IV; Quick-Set, Skokie, IL)</td>
</tr>
<tr>
<td>Owens et al</td>
<td>1985</td>
<td>≤7</td>
<td>≤6 x 9</td>
<td>Offset tripod with adjustable camera boom</td>
</tr>
<tr>
<td>Roshier et al</td>
<td>1997</td>
<td>Variable</td>
<td>Variable</td>
<td>Gantry connected to automobile</td>
</tr>
<tr>
<td>Northrup et al</td>
<td>1999</td>
<td>≤5.5</td>
<td>16</td>
<td>Telescoping camera boom mounted on all-terrain vehicle</td>
</tr>
<tr>
<td>Bennett et al</td>
<td>2000</td>
<td>2</td>
<td>1</td>
<td>Offset aluminum tripod with collapsible camera arm, bubble levels</td>
</tr>
<tr>
<td>Richardson et al</td>
<td>2001</td>
<td>1.5</td>
<td>NG</td>
<td>Monopod of PVC</td>
</tr>
<tr>
<td>Louhaichi et al</td>
<td>2001</td>
<td>1.7</td>
<td>3.5</td>
<td>A PVC prototype of the stand described here</td>
</tr>
<tr>
<td>VanAmberg</td>
<td>2003</td>
<td>2</td>
<td>1.4</td>
<td>Wheeled, with a telescoping vertical post and a 0.5-m camera arm</td>
</tr>
</tbody>
</table>

1AGL indicates camera altitude above ground level; Fid, field of view; NG, not given; PVC, polyvinyl chloride.
2The given field of view is that obtained by the authors using their own particular camera and lens settings.

2 m above ground level (AGL). Each image covers a 1 × 1.4 m area at wide-angle (35 mm) zoom and produces a pixel resolution of 1.16 mm².

When sampling in tall shrub areas where it is difficult to place the 1-m quadrat base flat on the ground, sections of the stand (one vertical pole and one 1-m base length) can be fitted together via the attached pins to create a monopod. The monopod and the attachment of a specialized aluminum camera mounting plate holds the camera 2 m above the ground and 1 m from the vertical pole allowing for easier nadir image acquisition (stereo imagery has not yet been acquired using the monopod configuration).

Shadows from tall vegetation confound many types of image analysis either by hiding areas of interest or by altering color in shaded areas. We mounted a 183-cm-long × 104-cm-wide roll-up window shade along the base of the stand such that it could be pulled up and attached anywhere along the vertical side support to shade the entire plot (Fig. 1). The shade is made of medium-weight light-filtering vinyl that allows even illumination of the entire plot, eliminating shadows and providing for more saturated colors, thus improving the quality of the imagery obtained. The shade can be removed when not needed. The entire plot can be shaded except when the sun is higher than 67.5°. Thus, the plot can be shaded during approximately 75% of the daylight hours at an equatorial location at equinox. Northern latitudes have more daylight hours with the sun below this angle.

Discussion and Conclusions

High-resolution digital images are useful for several types of data gathering and have proven to be a quick and accurate means for vegetation classification (Bennett et al 2000; Louhaichi et al 2001). As indicated in Table 1, various types of camera stands or other ground-based platforms have been used to collect nadir imagery. Some of the more recent designs include that of Northrup et al (1999), who constructed a telescoping camera boom from aluminum channel stock and mounted it to the front of an all-terrain vehicle at 45°. Bennett et al (2000) constructed a portable aluminum stand equipped with a collapsible camera arm and two telescopic legs. Richardson et al (2001) used a 1.5-m monopod made of 10-cm-diameter polyvinyl chloride (PVC) tubing, with a horizontal arm extending 1 m away from the top of the vertical axis. A camera mounted on the end of the arm was used to acquire nadir images in dense vegetation. Louhaichi et al (2001) mounted a 35-mm camera on a lightweight stand of PVC tubing with the camera mounted 1.7 m AGL and above a 1-m² base. The use of PVC as a construction material resulted in a lightweight stand (5.1 kg); however, PVC lacks rigidity. VanAmberg (2003) constructed a wheeled camera stand out of steel cornerstock that consisted of a 1-m² base, a single 1- to 3-m telescoping vertical post attached to the center of a base length, and a horizontal arm projecting 0.5 m from the top of...
the vertical post to which was attached a digital camera. Although convenient for open grassland, this rolling stand is difficult to maneuver in areas with shrub cover, and it is too heavy to carry.

Construction cost for the stand described here was $250 for materials and $390 for labor. After more than a year of using the stand, we conclude that it is a highly practical rangeland monitoring tool with advantages that include: 1) the stand can

Figure 1. Aluminum camera stand with roll-up vinyl shade and shaded 1-m² plot. The stand breaks down into nine 1-m lengths, adjusts for stereo imagery, and weighs 5.8 kg. The base is 1 m². The height is 2 m. Insets show enlargements of milled aluminum connector with attached connector pin, and flared coupler with hand-tightened setscrew for vertical pole segment connection.
be carried easily over uneven terrain and through most range-
land vegetation types; 2) it is stable in high-wind situations
owing to its square base and rigid, durable aluminum con-
struction; 3) the inclusion of the square meter frame (quadrat)
as part of the camera-stand base; 4) the capability of acquiring
stereo digital imagery with a single camera; 5) the roll-up vinyl
shade allows for evenly illuminated, shadow-free, color-satu-
rated imagery during more than 75% of the available daylight
hours; and 6) the ability to break down and store the stand in
a 1.1-m-long case.

**Literature Cited**

for measuring cover changes in perennial grasslands. *Journal of Range

Booth, D. T., S. E. Cox, and D. E. Johnson. 2004. Calibration of Threshold Levels in
Vegetation-Cover Classification Software. Abstract. Society for Range Man-
agement Meeting Abstracts.

Claveran, R. A. 1966. Two modifications to the vegetation photographic charting

Cooper, W. S. 1924. An apparatus for photographic recording of quadrats. *Journal

and aerial photography for documentation of grazing impacts on wheat.
*Geocarta* 16:63–68.

technique for near-ground remote sensing of herbaceous vegetation in

repeated mapping of rangeland plant populations in permanent plots. *Journal
of Range Management* 38:231–232.


vegetation changes on Nevada rangelands. Reno, NV: Agricultural Experiment
Station, University of Nevada, Reno. Report T16. Available from: College of
Agriculture, Biotechnology and Natural Resources, Mail Stop 22, 1660 N.
Virginia St., Reno, NV 89557-0107.

VanAmburg, L. 2003. Digital imagery to estimate canopy characteristics of short-
grass prairie vegetation [MS thesis]. Fort Collins, CO: Colorado State University.
122 p. Available from: Department of Forest, Rangeland and Watershed
Stewardship, The College of Natural Resources, Colorado State University, Fort
Collins, CO 80523-1472.

Wells, K. F. 1971. Measuring vegetation changes on fixed quadrats by vertical

Wimbush, D. J., M. D. Barnow, and A. B. Costin. 1967. Color stereophotography for

of estimating plant cover in an arid grassland community. *Journal of Range
Management* 15:194–196.