AN IMPROVED MULTIANGULAR OBSERVING PLATFORM FOR BRDF MEASUREMENTS

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Abstract:

The bidirectional reflectance distribution function (BRDF) was first presented by Nicodemus in 1977, and it is a theoretical concept that describes directional reflectance phenomena by relating the incident irradiance from one given direction to its contribution to the reflected radiance in another specific direction[1].The derivation of BRDF from earth-surface features provides a more complete basis for the estimation of both surface composition and physical structure than single-angle reflectance measurements[2]. The ground-based BRDF measurement has become more and more important for the validation of remote sensing image products and canopy BRDF models.

Field goniometric radiometer devices, herein called “field goniometers”, are specialized devices for ground-based measurement of bidirectional reflectance factors. Usually the goniometer has two components: a sensor measuring radiance and a flexible platform positioning the sensor. Up to now, there are some goniometers have already been used in the field measurements, such as the Swiss Field Goniometer System (FIGOS), the Sandmeier Field Goniometer (SFG), the University of Lethbridge Goniometer System (ULGS), etc. These three kinds of field goniometers have similar structure (Figure 1). All of them have three major parts: a zenith arc, an azimuth rail, and a sled where the sensor is mounted. The FIGOS is semiautomated, while the SFG is fully controlled by a laptop computer. Different from the first two apparatus, the ULGS does not use computer-controlled positioning components.

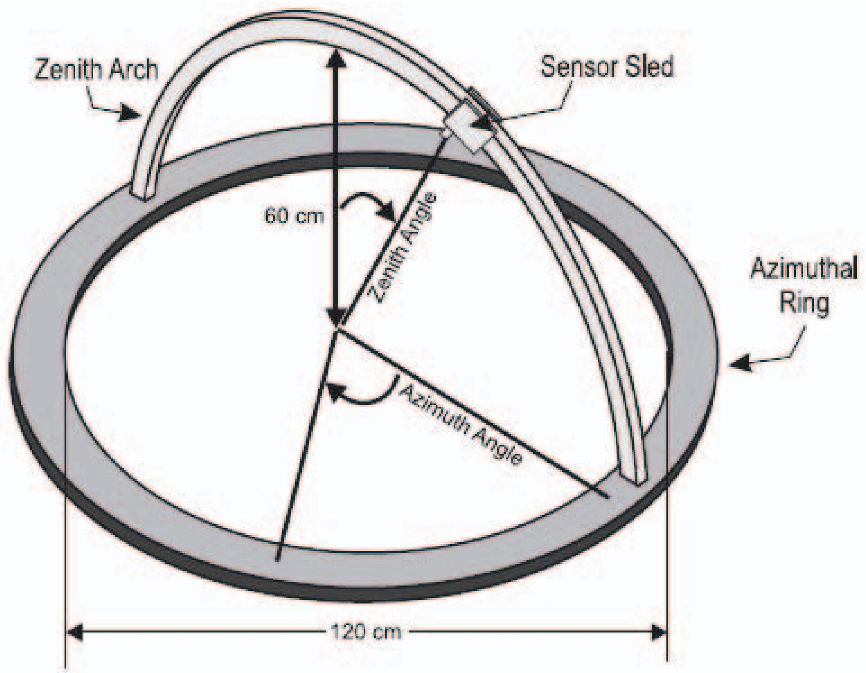

Figure 1 Similar structure of FIGOS、SFG and ULGS [2]

These apparatus have four disadvantages as follows:

(1) They are heavy and big. Consequently, it's very hard to move them from one site to the other in the filed. Further, much power is required to operate them.

(2) The height of zenith arc is fixed and not high enough, leading to a relative small FOV. So they are limited to observe lower targets, such as short grass.

(3) The FIGOS、SFG have complicated structures and their shadows in the principle plane inevitably made the measurements in this crucial plane with more errors. .

(4) The angular resolution of their zenith arc, such as 15°, is low so that BRDF characteristics of targets can not be captured effectively in the principle plane. The rapid angular variation of solar incident beam during data acquisition makes it necessary to keep the angular resolution of zenith measurements within 1° in order to obtain homologous BRDF data sets[3].

We developed an automatic field goniometer. This goniometer was composed by light weight steel tube, steel rope and 2 stepping motors. The total weight of this device is less than 30kg. It can be fixed on the tripod and moved easily in the field. The sensor can be installed on the goniometer at a maximum height of 4.5m. The stepping motors can be controlled by a laptop via the USB port. The software can automatically compute the solar zenith angle and solar azimuth angle if the local solar time and the geocoordinates are known. As a result, the goniometer can automatically measure the hemispherical BRDF with emphases of the solar principle plane and cross plane. It can give relative accurate measure even in the hotspot since only the shadows of the sensor and a thin steel tube appeared in the field of view (FOV) of the sensor.

Reference:

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[2]Coburn C A, Peddle D R. A low-cost field and laboratory goniometer system for estimating Hyperspectral bidirectional reflectance[J].Canadian Journal of Remote Sensing,2006,32(3):244-253.

[3]St Sandmeier, Ch Miiller, B Hosgood, G Andreoli. Sensitivity Analysis and Quality Assessment of Laboratory BRDF Data[J].EEMOTE SENS.ENVIRON，1998，64：176-191.