A Method to Measure Golf Ball Lie in Various Turf Types Using Digital Image Analysis

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Golf ball in deep rough

Photo by Mike Richardson

Summary. Golf ball lie describes the characteristics of how a golf ball comes to rest on the turf after a golf stroke. Although the lie of a golf ball is an important factor affecting the play of the next shot, there have been few attempts to measure this characteristic or determine how management practices, turfgrass species, or cultivars affect ball lie. A new technique utilizing digital image analysis was developed for measuring ball lie. The image analysis technique could easily distinguish changes in ball height within a turfgrass canopy. In addition, the new technique was easier and faster to collect data compared to the Lie-N-Eye, the only other method of ball lie analysis available. The development of this technique will allow us to study a range of factors that can influence ball lie, including turfgrass species, cultivars, and a range of cultural practices.

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The lie of a golf ball after it comes to rest after a stroke can have a significant impact on the ability of a golfer to play their next shot. Although golf ball lie is generally considered to be uniform and adequate on fairway or tee-height turf, turf that is maintained at higher heights of cut, such as found in intermediate or deeper cuts of rough, will produce significant variability between the lie of balls landing in close proximity. Although the effects of species, cultivars or management practices on ball lie are often mentioned in turfgrass management textbooks, there have been limited efforts to quantify ball lie under a range of conditions or identify morphological or physiological parameters that impact ball lie. One of the major limitations to such an effort has been the lack of quantifiable measurements of ball lie that can be applied over a range of turfgrass systems.

Cella and co-workers at the University of Illinois developed two tools, identified as the Lie-N-Eye and Lie-N-Eye II (Fig. 1), to measure golf ball lie on turf mowed at either 0.6 to 1.0 inch, or 0.5 inch, respectively (Cella and Voigt, 2001; Cella et al., 2004). Using this technique, they were able to measure the height of a golf ball above the canopy and differentiate ball lie among both Kentucky bluegrass cultivars and bentgrass species and cultivars. Although this technique effectively separated differences in ball lie on closely-mown turf, it was not applied to taller-cut turf in any of their studies. In an effort to improve the speed and accuracy of measuring golf ball lie over a range of turf conditions, digital image analysis (DIA) techniques may be capable of quantifying the amount of golf ball visible within the turf canopy over a range of turf management conditions. The objective of this study was to determine the effectiveness of DIA to measure ball lie in turf maintained over a range of conditions.

Materials and Methods

Ball lie measurement device. A device was developed that uniformly takes a digital photo of a red golf ball from a fixed focal length (Fig. 2). Adjustable legs on the device can be set to match the mowing height of the turf, which positions the camera precisely at the top of the canopy. Digital images were obtained using an Olympus SP-510UZ Digital Camera (Olympus Optical Co.). The images were collected in the JPEG (.jpg) format, with an image size of 1024 x 768 pixels. Camera settings included a shutter speed of 1/250 s and an aperture of F8.0. Digital images were batch-analyzed using SigmaScan Pro (v. 5.0, SPSS, Inc., Chicago, Ill., 60611) software. For these studies, a hue range from 200 to 256 and a saturation range from 20 to 100 were found to selectively identify the red ball in the image (Fig. 3). The number of pixels represented by the ball in an image was divided by the number of pixels from when the ball was positioned fully above the canopy to calculate the percent of ball exposed.

Calibration of the device. In order to determine the ability of the device to detect changes in ball lie within the canopy, a calibration study was conducted in which golf balls were placed on tees (Super Korectee, www.korectee.com) that could be set to a predetermined height above the soil in a Kentucky bluegrass (*Poa pratensis*, cv. Midnight) turf maintained at a height of 2.0 inches. Nine replicate balls were placed at each tee height above the soil, which ranged from 0.48 – 1.8 inches. Digital images were collected for each ball using the device described in Figure 2. After analysis, the percent of ball exposed above the canopy was compared to the height at which the ball was placed above the soil.

Comparing digital image analysis to the Lie-N-Eye. The ability of the two devices to measure ball lie was compared in a cultural practice study on 'Tifsport' bermudagrass that was maintained at mowing heights of 0.5, 1.0, or 1.5 inch. Within each mowing height, nine balls were rolled onto the turf using a modified Stimpmeter. Without disturbing the lie of the nine balls, three raters each measured the height of each ball above the canopy using the Lie-N-Eye II and also collected digital images of each ball for DIA. Each rater was also timed as they collected data on the nine balls using each method. Coefficients of variation (CV) were determined for each method and the number of analyses that could be conducted per minute using each method was also determined. In addition, regression analysis was performed on the data collected with both devices to assess the relationship between the results using the two techniques.

Results and Discussion

Calibration of the device. There was a strong linear relationship between height above the soil and percent ball exposed (data not shown), but the data best fit a sigmoidal equation (Fig. 3). Since the golf ball is a sphere, the first incremental drops of the golf ball into the turf canopy only shielded very small percentages of the ball, resulting in relatively small decreases in percent ball exposed. As the center of the ball moved into the canopy, larger sections of the ball were shielded with each decrease in ball height, until the top of the ball was reached, when small changes again occurred with further decreases in the canopy. These results clearly indicated that DIA could detect small changes in ball height within and above the canopy of taller-cut turfgrass such as bluegrass rough.

Comparing digital image analysis to the Lie-N-Eye. Across all mowing heights, both techniques produced consistent results using different data collectors, with CV values of 5.8% for DIA and 5.7% for the Lie-N-Eye II (Fig. 5). The biggest advantage of the DIA technique over the Lie-N-Eye II was the speed at which data could be collected (Fig. 5). With DIA, an average of 5.4 measurements could be made per minute, while the average measurements per minute with the Lie-N-Eye II were 2.2 (Fig. 2). In addition to increased speed of data collection, the DIA technique was also less physically demanding, as the data collector must kneel down on the ground using the Lie-N-Eye II to accurately determine the ball height (Fig. 1). When the results obtained with the two techniques were compared, there was a positive, linear relationship observed between the techniques and a good fit ($R^2 = 0.89$) to the data (data not shown). These results clearly demonstrate that DIA is a viable means to evaluate ball lie and the results are comparable to the only other technique available for such analysis. The development of this technique will allow us to study a range of factors that can influence ball lie, including turfgrass species, cultivars, and a range of cultural practices.

Literature Cited

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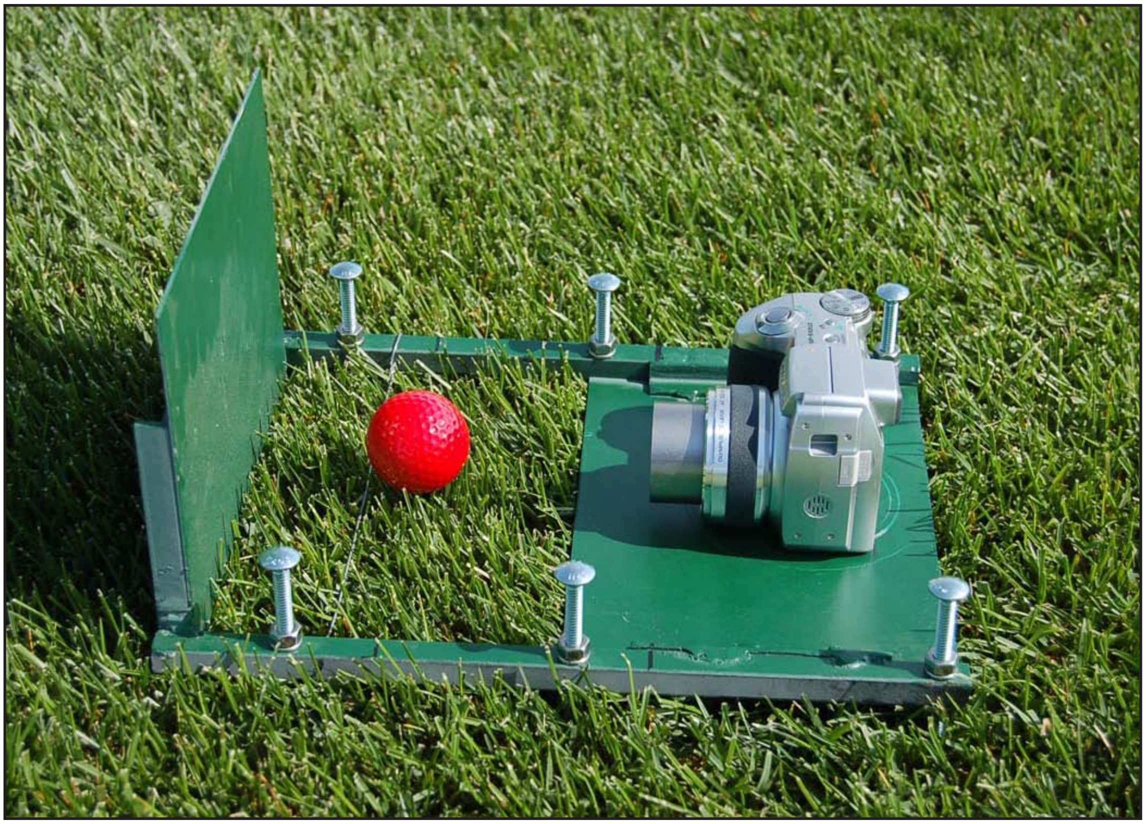

Fig. 1. Device developed at the University of Arkansas to collect digital photos of golf ball lie, which are subsequently analyzed using image analysis software.

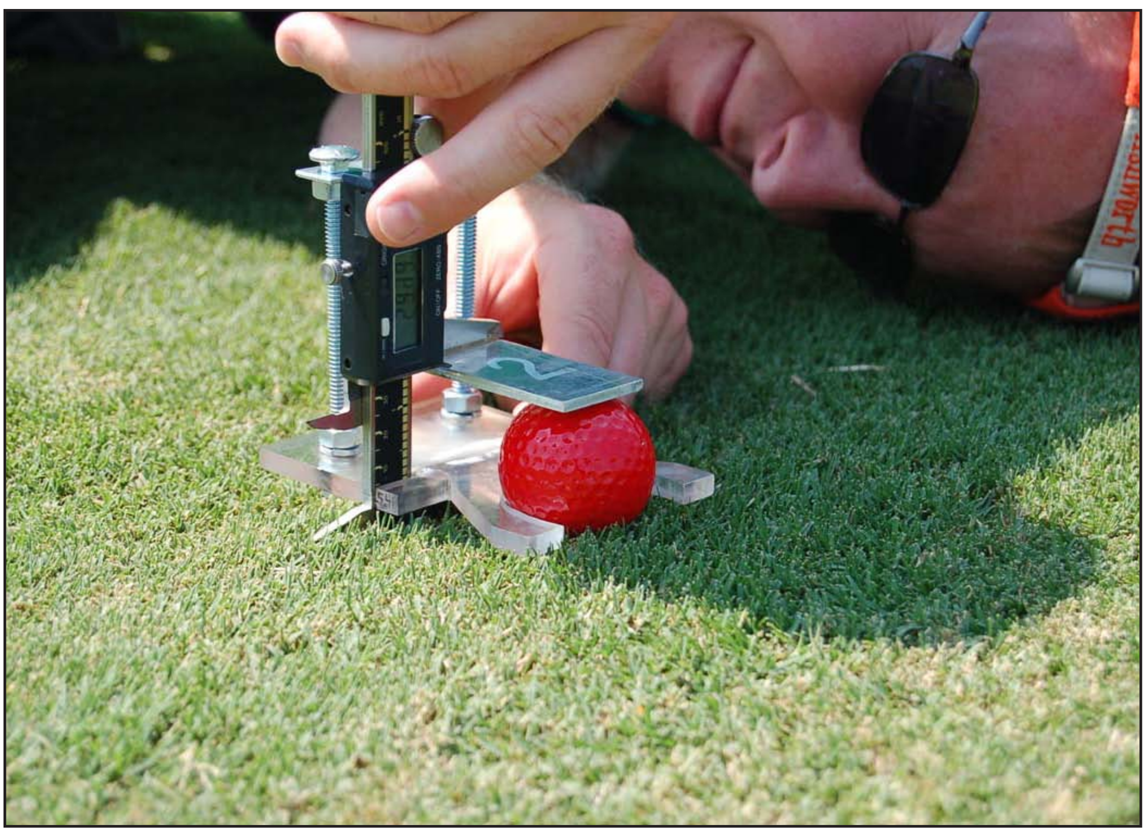

Fig. 2. The Lie-N-Eye II, a device developed by the University of Illinois to measure the height of a golf ball above the canopy.

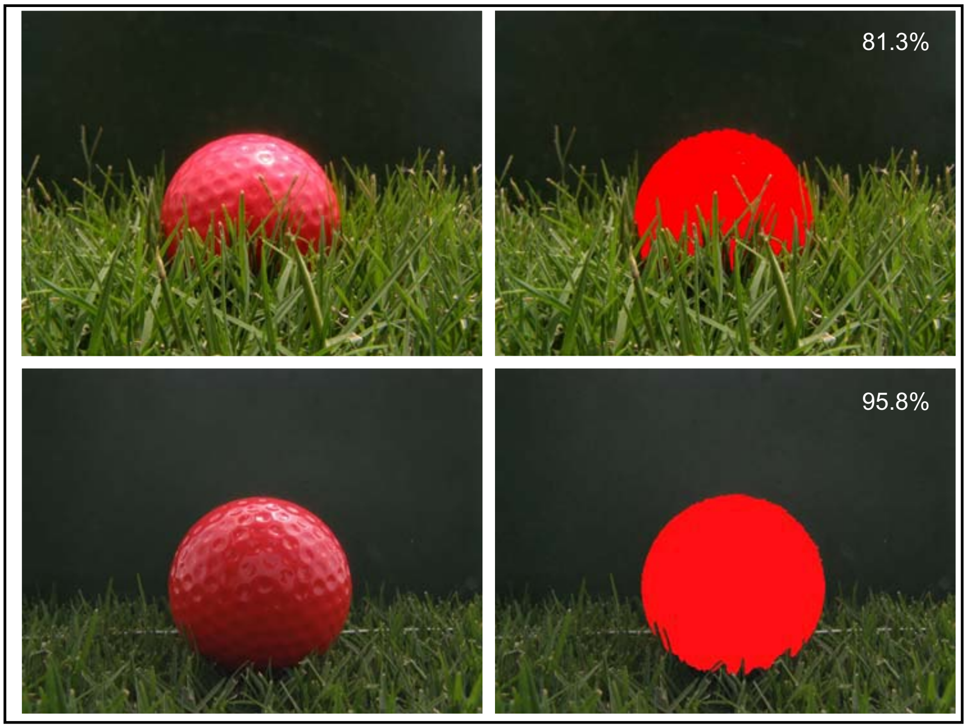

Fig. 3. Golf ball lie images collected with the digital camera (Photo 2) and then analyzed using image analysis software. Images on right demonstrate the software analysis, which identifies red pixels in the image.

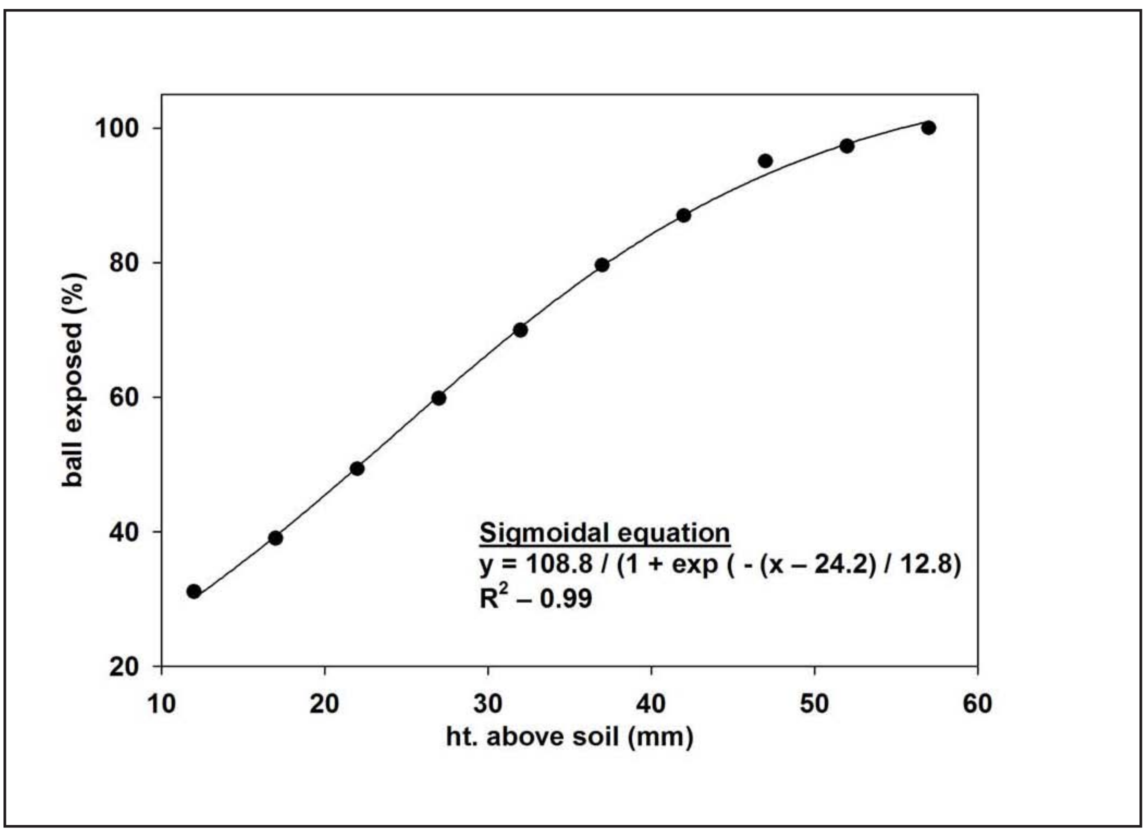

Fig. 4. Calibration curve showing the relationship between ht. of a golf ball above the soil and the % of ball identified with digital image analysis.

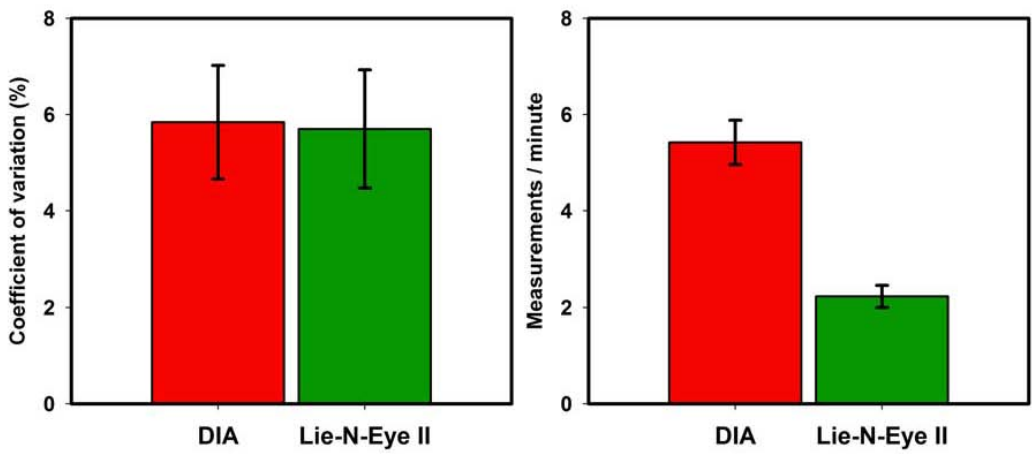

Fig. 5. Comparison of digital image analysis and the Lie-N-Eye II, showing the coefficient of variability of repeated measures with the two devices and the number of measurements obtained per minute using the two devices. Error bars represent 95% confidence intervals for the true CV values and number of measurements/minute, respectively.