Plant stand count and corn crop density assessment using texture analysis on visible imagery collected using unmanned aerial vehicles

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Abstract. Ensuring successful corn farming requires an effective monitoring program to collect information about stand counts at an early stage of growth and plant damages due to natural calamities, farming equipment, hogs, deer and other animals. These monitoring programs not only provide a yield estimate but also help farmers and insurance companies in assessing the causes of damages. Current field-based assessment methods are labor intensive, costly, and provide very limited information. Manual assessment costs can be unbearable as the size of the field increases; as a result, the frequency of assessment is low. Timely information regarding the counts, heights, and health at various stages are required for effective treatment and replanting decisions. Automated monitoring programs may be an effective means to accomplish the requirements. Automatically estimating early plant stand counts and frequently monitoring corn crop density on a large corn field is of tremendous value. To accomplish this, we advocate employing an Unmanned Aerial System (UAS) capable of collecting geo-referenced high spatial resolution imagery. Such a system can collect high-resolution imagery at a fraction of time and cost as that of manual assessment. We have collected over 10 acres of imagery using Robota Triton and Precisionhawk Lancaster platforms fitted with visible and near infra-red cameras. The images were collected at altitudes of 150 feet, 200 feet and 400 feet with a ground resolution of approximately 0.5 to 2 inches.

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Determining corn crop density on a large field is of tremendous value to monitor plant health and damages caused by hogs and deer. In this work, texture modeling techniques are investigated to map three different densities (Low, Medium, and High) on a corn field by using visible imagery collected using a UAS. Images are then mosaicked to form an orthomosaic. The imagery has three spectral bands at 450nm (Blue), 550nm (Green) and 650nm (Red). This Scale and rotation invariant template matching algorithms are implemented to estimate the plant stand count. Template matching algorithm find individual corn plants in the orthomosaic by using the training set of corn plants (templates). This algorithm is used in problems such as face recognition, counting a number of faces in an image and medical imaging. The texture is an important feature in imagery; it can compensate for the lack of richness in spectral resolution when seeking to classify different densities of vegetation types. Visible imagery acquired from the UAS lacks high spectral resolution but it has a very high spatial resolution, hence texture can be a more meaningful feature for this application. Visual inspection of imagery from various corn fields revealed unique properties of for different densities of each plot; mainly roughness, granulation, and regularity. This observation motivated the use of texture features for Phragmites classification. Experimental results with template matching algorithms for stand counts and texture based analysis for density estimation show that it is possible to get a valuable information of stand counts, density and damage assessment.