Using Computer Vision and RGB images to quantify plant spatial distribution in corn

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The spatial and temporal uniformity of the plants in maize crop (*Zea mays L.*) is a key factor in determining yield. Spatial non-uniformity can cause losses of the order of 80 to 100 kg ha-^{1} for each centimeter of increase in standard deviation above a threshold. The development of precise and automated methods to characterize this non-uniformity at a specific site scale is essential. Computer vision allows automatic detection of plants in crops through RGB images analysis. The use of computational algorithms can allow the measurement of different crop traits. Until now, they have not been used to quantify the spatial uniformity at the specific site level with field validations of the groundtruth distances such as those proposed in this work. To achieve this objective, two maize trials were implemented with three different planting densities: 4, 6 and 8 pl m-2 in Río Cuarto and La Aguada (Córdoba, Argentina) in the 2020 growing season. In the development stages V_2 and V_4, a survey was carried out with an iPhone 6 video camera in a zenithal position of 200 consecutive plants per repetition. The same day, the distance between each consecutive plant was measured using a tape measure (groundtruth distances). At the Lab, the videos were processed to obtain the sequence of images of the 200 plants surveyed in the field per plot. Deep learning models were trained with the *RetinaNet Object Detection Network* for plant detection. The distance between the centers of plants in each row was automatically and digitally measured. Measurements made in the field (groundtruth distances) were compared with those obtained using the deep learning model. The error of the predictions was quantified through the *mean average precision (MAE)* metrics. The *MAE* results show values in a range of 1.2 - 2.6 cm for the evaluated densities. The prediction error increased with the increase in planting density. The present work shows promising results of automatic quantification of spatial uniformity in corn through computer vision methods that could be used in site-specific management approaches to evaluate the quality of corn crop planting.

Keywords: *Retina Net, Planting Uniformity, Deep Learning, Digital Agriculture* .