High-resolution reconstruction of images for estimation of plant height in wheat using RGB-D camera and machine learning approaches

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In this study, a pipeline has been proposed where colour image and depth information of wheat plants are captured using an red green blue-depth (RGB-D) camera; later these two are combined to create a three-dimensional point cloud of the plant. The point clouds were processed to calculate the plant height. The results were then statistically analysed with the help of machine learning algorithms, viz. linear regression, support vector machine and artificial neural network (ANN). The comparison of the results shows that ANN performed better than the other two models with mean squared error 189.94, root mean squared error 13.70, mean absolute error 11.40 and mean absolute percentage error 18.73. The proposed study shows a high-precision and low-cost technology that can be widely used for non-destructive measurement of phenotyping parameters for wheat and other crops.

Keywords: 3D reconstruction, image processing, Open3D, plant phenotyping, RGB-D imaging.

Despite the significant progress made in two-dimensional (2D) plant phenomics, a struggle exists to understand intricate spatial arrangements and three-dimensional (3D) structure of plants[1,2]. The reason is that traditional imaging systems do not capture the depth information of the subjects, which is essential for understanding the position of the object in the 3D world. Traditional 2D image analysis provide valuable insights into plant characteristics like size and colour, which are visible in two axes (x, y). With the adoption of 3D imaging technologies, researchers have revolutionized the measurement of plant phenomics parameters by providing more information in the form of depth, allowing for an accurate representation of the shape, size and spatial characteristics of the plant.

There are different ways in which 3D images can be represented, like meshes, texture maps, octrees, bounding volumes and point clouds[3–5]. Each includes the placement of spatial information in different ways and is suitable for various applications. In all the data structures, 3D point