

Pasture biomass estimation using an image processing approach to LiDAR data processing

Jaco Fourie
Lincoln Agritech Ltd
Engineering Rd, Lincoln University
Lincoln 7460, New Zealand
jaco.fourie@lincolnagritech.co.nz

Kenji Irie
Red Fern Solutions
306 Port Hills Rd, Hillsborough
Christchurch 8022, New Zealand
kenji@redfernsolutions.co.nz

Jeffrey Hsiao
Lincoln Agritech Ltd
Engineering Rd, Lincoln University
Lincoln 7460, New Zealand
Jeffrey.Hsiao@lincolnagritech.co.nz

Kioumars Ghamkhar
AgResearch (Grasslands Research Centre)
Tennent Drive, Palmerston North 4442
New Zealand
Kioumars.Ghamkhar@agresearch.co.nz

Abstract

Our aim in this project was to develop a tool for measuring ryegrass morphological data larger phenomics for grass breeding project. Specifically, we used a LiDAR (Light Detection and ranging) based tool to accurately estimate ryegrass biomass by scanning from a mobile platform. While high-throughput phenotyping platforms are available for arable crops and tree type plants, to our knowledge, no such platforms exist for ryegrass.

The unit is designed to scan individual ryegrass segments or plots planted in rows and separated from each other with buffer zones of bare soil. The unit must be able to continuously scan as it drives along the rows and automatically detect plot boundaries so that data collected from multiple segments can be separated from each other and collated in a biomass report.

Our approach is to use a high-speed, high-resolution LiDAR to collect a dense 3D-point cloud of the grass from a top-down perspective. As the unit moves over the grass the LiDAR pointing straight down collects data and builds a 3D model of the ryegrass canopy. By projecting this 3D model of the grass canopy to a 2D plane we create an image similar to a relief map that we process using image processing techniques to segment individual grass plots from each other and to build an accurate convex hull around each grass plot. This convex hull represents the volume of the ryegrass plot based on the point cloud data and is the basis of our biomass estimation.

We tested our method at two different sites. The first site contained irrigated ryegrass planted as individual segments

of 30 rows, each comprising of 30 segments. We scanned all segments at 3 different events over a period of two weeks during a period of intense growth. This experiment showed a consistent growth trend over all the segments scanned and showed that our estimated biomass correlated well with the real growth.

Our second experiment was a dryland trial (not irrigated) at a site that consisted of 5 rows of 16 segments each and one row of 18 segments. We scanned 3 times a week over a period of two months to monitor growth at a finer granularity than our previous experiment. Results from this scan again showed a consistent growth trend for most segments but also highlighted some interesting growth trends from those segments that did not follow a trend that we expected.