|  |
| --- |
| **A lightweight Deep Learning model for side on RGB images for near-real time, in field, hedgerow condition monitoring.** |
| Trees outside of woodlands are often overlooked landscape features, which deliver important ecosystem services, particularly in agricultural areas. In Northwestern Europe, hedgerows are managed linear shrub networks which have historically served as boundaries. Management of hedgerows is required to maintain their structure, but over or under management can lead to deterioration in their condition, affecting their ability to provide ecosystem services. Their ecosystem services are increasingly being valued in the market through government payments, biodiversity credits, and their contribution to net zero.  To empower farmers to monitor condition and appropriately adapt their management would often require either in-depth ecological training, or a monitoring tool to inform management decisions. In situ monitoring should be low cost, easy to use and perform rapid analysis for prompt results for uptake by land managers. Until now, hedgerow remote sensing research has been limited to aerial and satellite imaging, LiDAR and SAR data for national inventories, but has not previously assessed the potential of low-cost ground-based imaging solutions to address monitoring needs of land managers.  Here we develop a lightweight deep-learning (DL) model based on a YOLO (You Only Look Once) architecture to detect and segment stem, canopy and scale bars from side-on RGB photos of hedgerows. The model is trained on 286 images of Hawthorn (*Crataegus monogyna*) dominated hedgerow sections, the dominant species in 50% of British hedgerows, photographed at 5 locations across the Northeast of England, UK. The dataset includes images containing edge cases, including sections with other dominant hedgerow species, mostly blackthorn (*Prunus spinosa*) and ivy (*Hedera helix*), and structures including dense, frequently managed and unmanaged, to ensure a representative and broadly applicable sample.  During post processing we transform the DL model outputs into structural parameters able to act as biomass and biodiversity indicators such as height, canopy base height, stem diameters, canopy density, stem density which we evaluate against established remote sensing methods including UAV SfM, TLS and aerial LiDAR, as well as ground truth measurements. Here we present the preliminary results of the model development and discuss the operational potential.  Considering the costs, time and model size trade-offs, our lightweight field model delivers novel monitoring data to assist land managers decision making. This novel methodology could also provide a framework to engage citizen scientists to gather geo-tagged images as reference data for satellite based and other remotely sensed data. |