



**University of Salford**  
A Greater Manchester University



# 3d forest canopy structure from terrestrial laser scanning

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Application of hemispherical photography to measure forest canopy structure  
Use to measure gap fraction, leaf angle distribution and gap size distribution  
No range information so cannot extract 3d stand characteristics like tree height



# Can we use terrestrial laser scanners to measure 3d forest canopy structure?



Riegl LMZ 210i	
Two-axis beam scanning mechanism	
Single shot time of flight measurement	
Wavelength	900nm
Range (typical)	350m
Line scan angle range	<b>0 – 80°</b>
Frame scan angle range	0 – 333°
Laser beam divergence	0.3 mrad
Angular step width	0.072 - 0.36°
Measurement resolution (one shot)	25mm
Pulse repetition rate (maximum)	28,000 Hz
Measurement time (typical)	3 mins for 1 million points





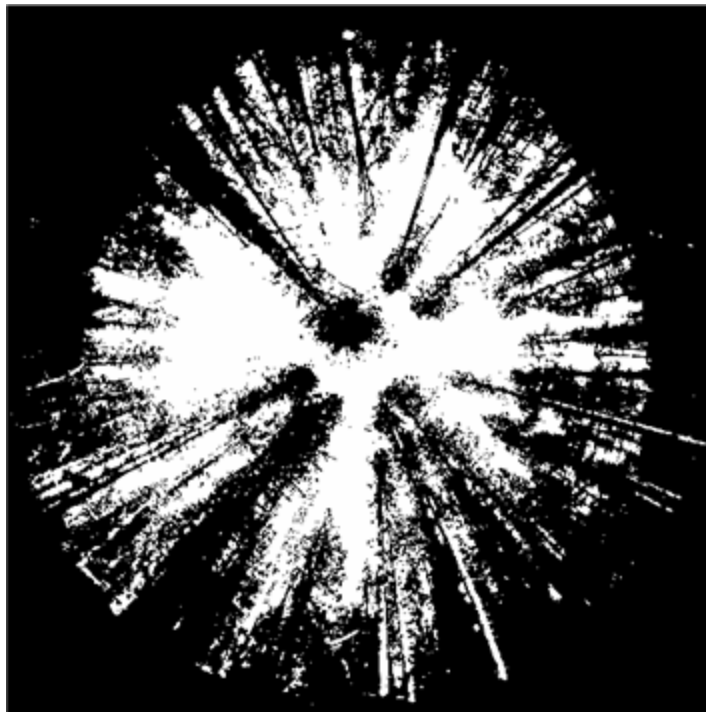
## Laser scanner data processing:

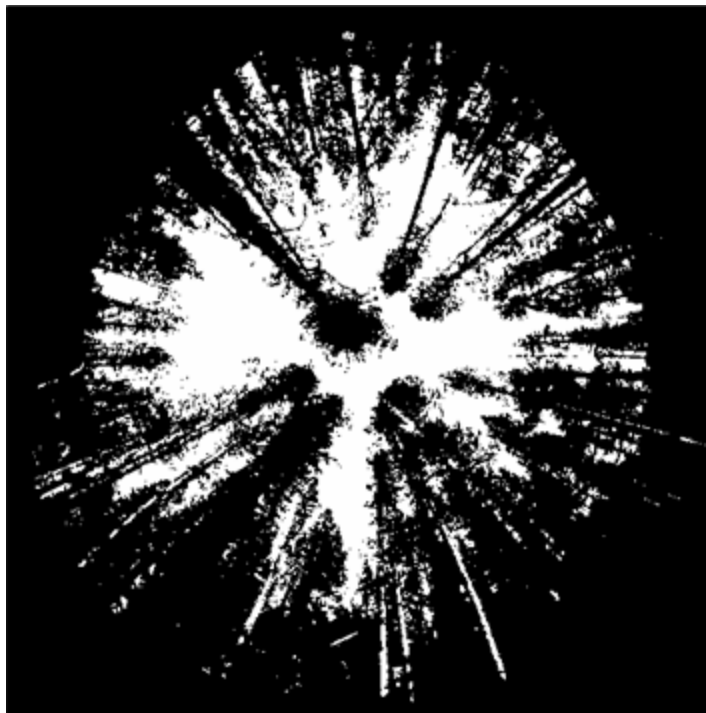
- Scanner model to compute misses
- Cartesian to spherical transformation
- Projection onto hemisphere of unit  $r$
- Spherical to Cartesian transform
- Data filter to mask non-scanned areas
- Compute ratio of shots to hits at different zenith angles

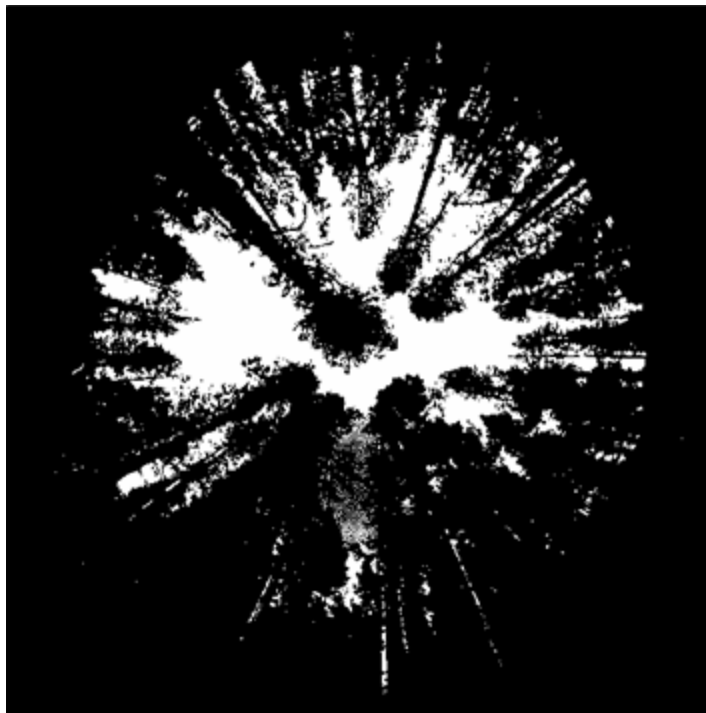
Coincident hemispherical photography and laser scanner data in 9 plots  
Line and frame step angle 0.12 degrees, line scan angle range 80 degrees  
Two orthogonal scans cover most of the hemisphere





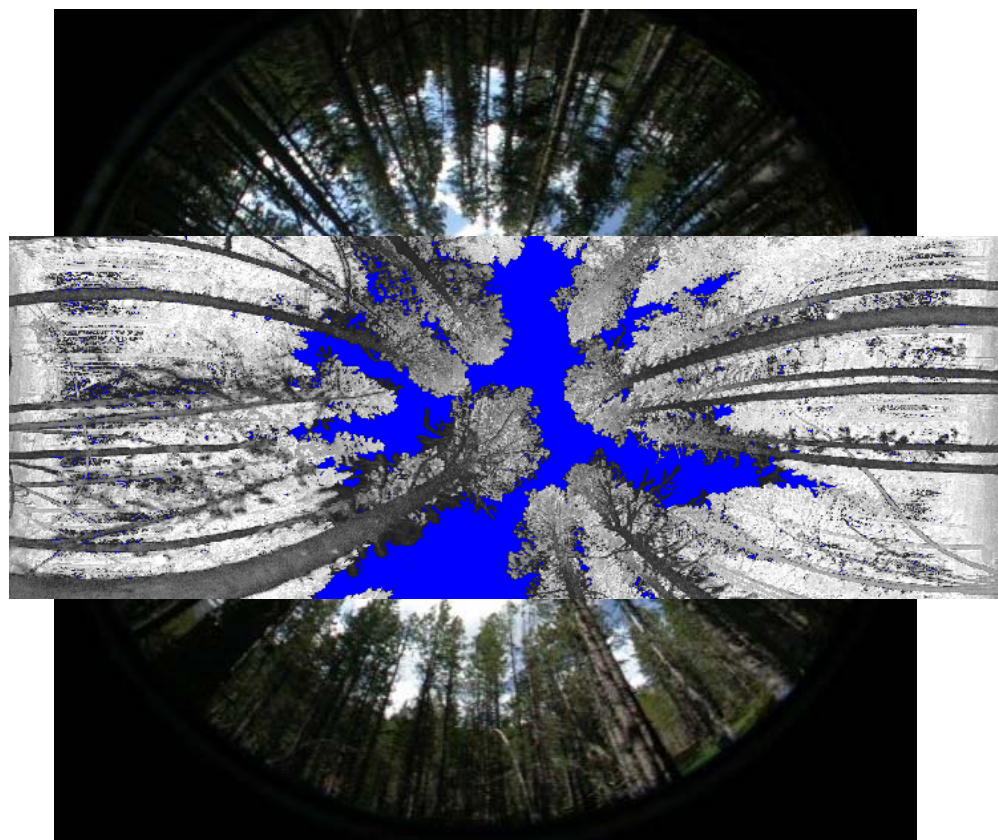


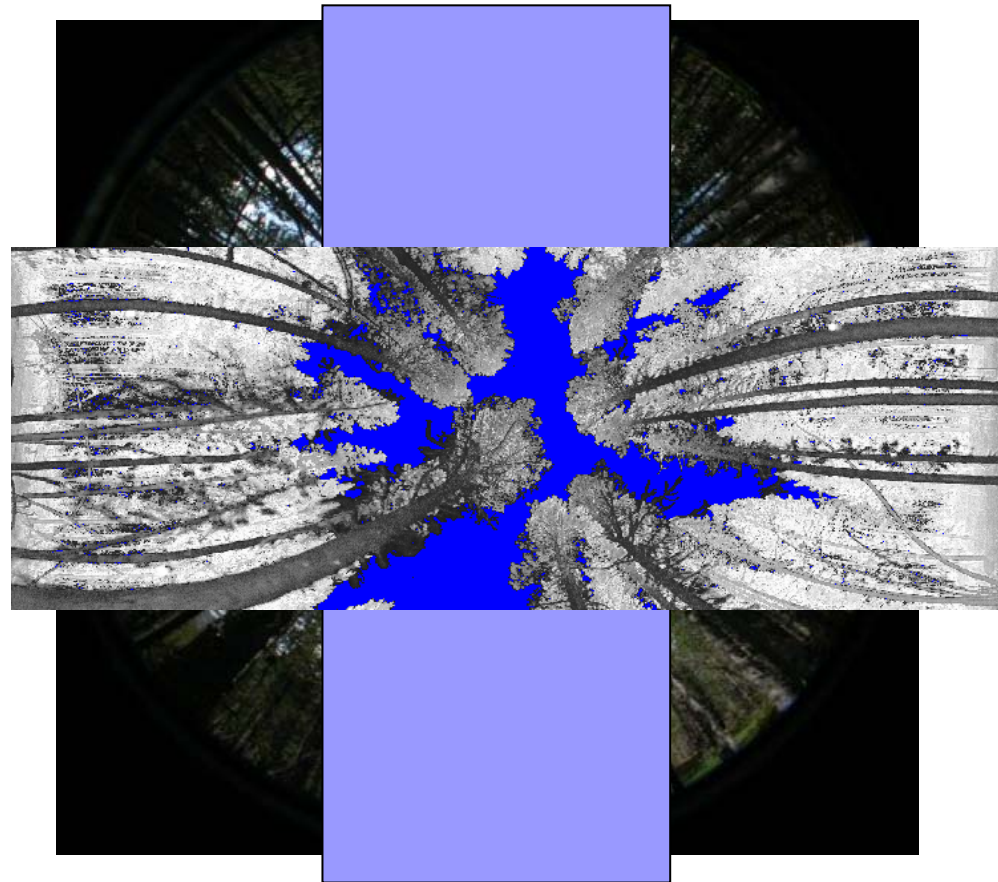




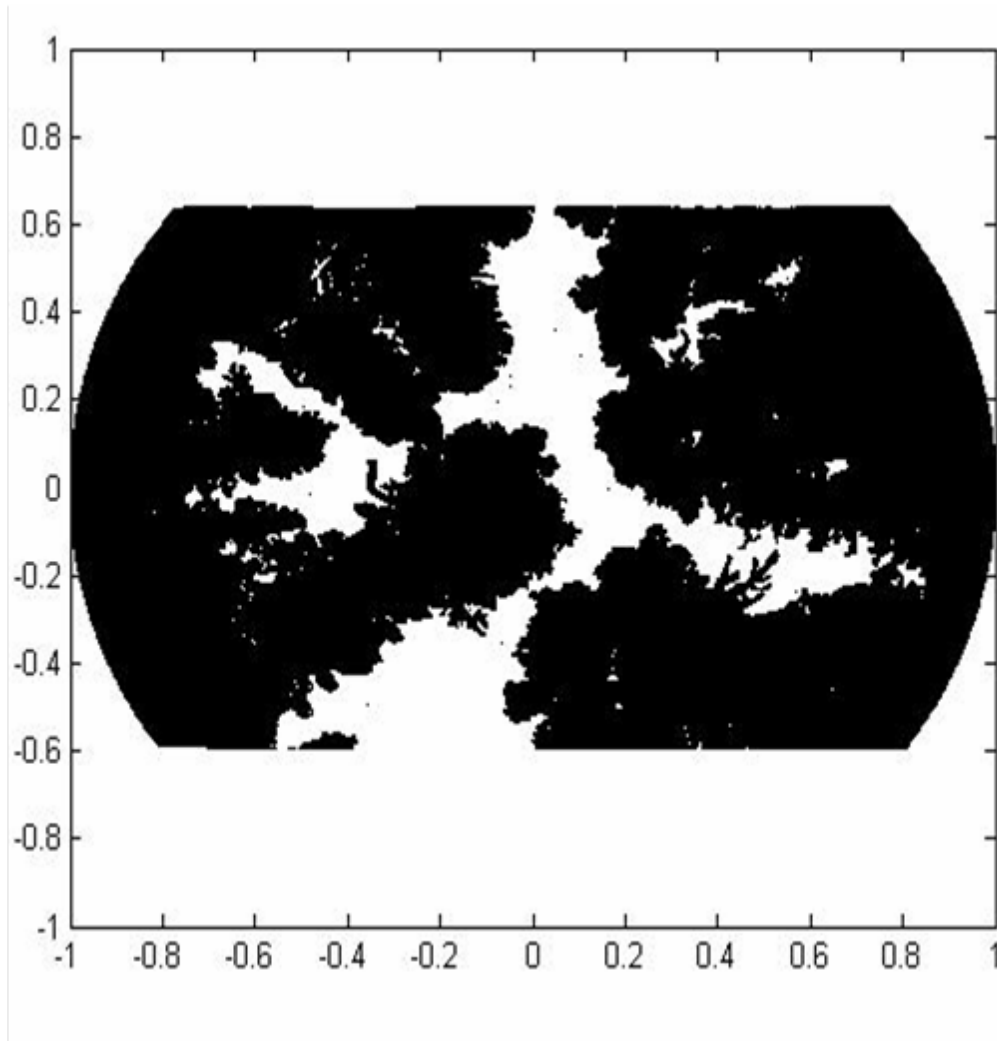


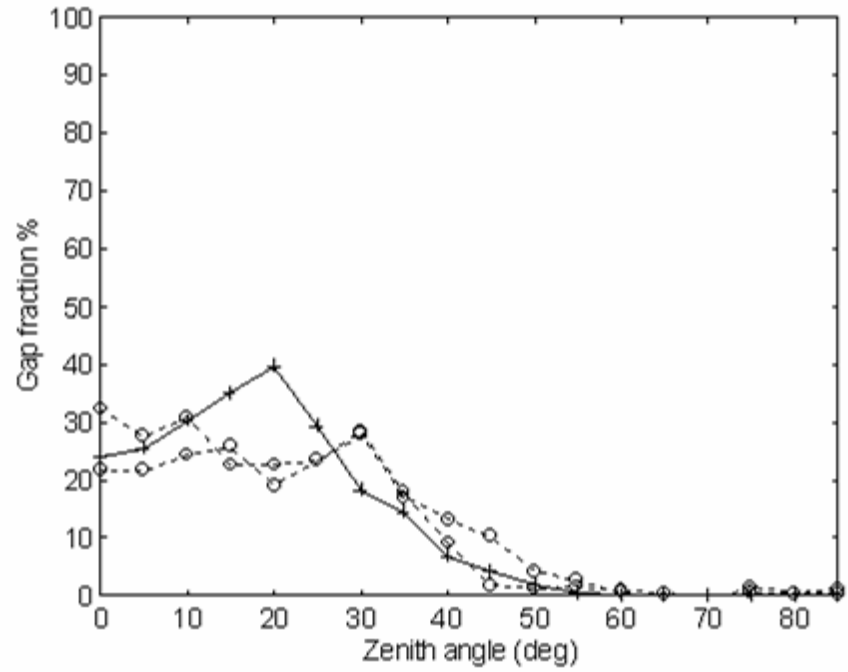


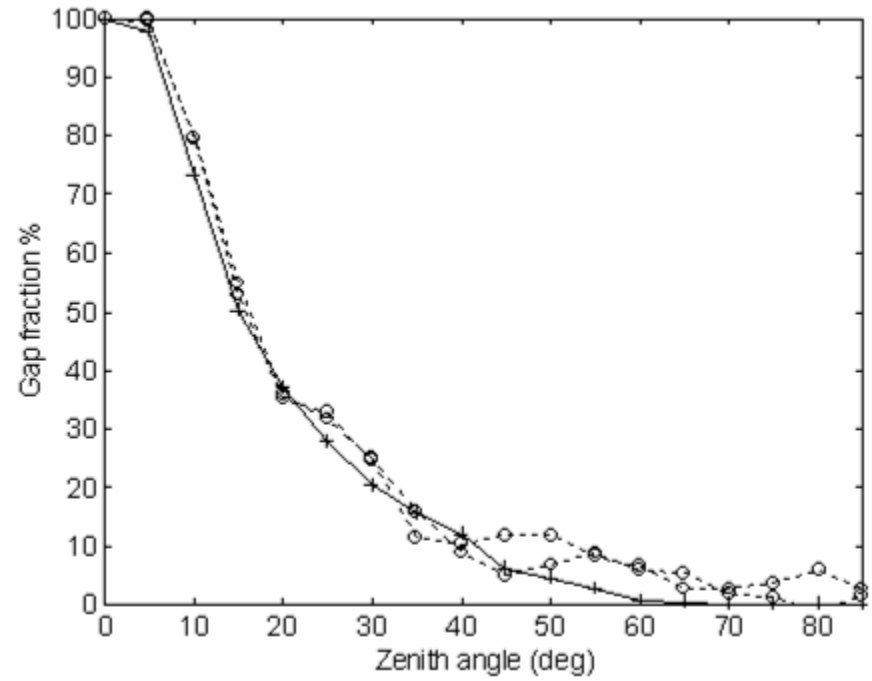














	Hemispherical photography	Terrestrial laser scanner
<b>Advantages</b>	<ul style="list-style-type: none"> <li>High speed data collection</li> <li>Simple data collection</li> <li>Low cost instrument</li> <li>Highly portable instrument</li> <li>Colour images for classification</li> </ul>	<ul style="list-style-type: none"> <li>Automatic data processing</li> <li>Automatic data extraction</li> <li>Data quality independent of sky conditions?</li> <li>Range information available</li> <li>Intensity information available (900nm)</li> <li>User defined resolution</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>Manual intervention in data processing</li> <li>No range information</li> <li>Data quality depends on sky conditions</li> </ul>	<ul style="list-style-type: none"> <li>Data collection slower</li> <li>Complex data collection</li> <li>Incomplete hemisphere of data</li> <li>Very high cost instrument</li> <li>Heavy and sensitive equipment</li> <li>Limited RGB capability</li> </ul>



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*Thank you for listening!*