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Margarita N. Favorskaya
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Handbook on Advances in Remote Sensing and Geographic Information Systems

Paradigms and Applications in Forest Landscape Modeling

Springer

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Preface

The remote sensing (RS) and geographic information system (GIS), 3D forest landscape modeling using airborne and space laser and radar scanning, digital photography, and global positioning satellite systems provide novel opportunities for remote sensing monitoring and inventory of forest resources. High efficiency of laser and radar scanning in combination with centimeter spatial resolution of digital aerial photography and high accuracy for coordinate definition of trees and tree stands' morphostructural parameters by satellite geopositioning systems allow to develop effective algorithms for research of forest resources structure and dynamics, guaranteeing a real-time automatic extraction of forest inventory parameters.

Computer modeling provides the building of 3D landscape scenes based on the data of laser and radar scanning and airborne images. The innovative methods of terrain and vegetation modeling are presented. Automatic fusion of data of different types is a non-solved problem requiring a development of future efficient methods. However, static modeling scenes will not be realistic if some natural effects are not imposed. The book is divided into four parts as follows:

Part I. Airborne LiDAR and Optical Measurements of Forest
Part II. Individual Tree Modelling
Part III. Landscape Scene Modelling
Part IV. Forest Eco-system Modelling

We are grateful to the researchers for inventing the tools and paradigms which laid the foundation for research and development reported in this book.

Our thanks are due to Springer-Verlag for the opportunity to publish our book.

This book is directed to the students, researchers, practitioners, and professors interested in remote sensing and geographic information systems and applications.

Krasnoyarsk, Russia — Margarita N. Favorskaya
Canberra, Australia — Lakhmi C. Jain

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His interests focus on the artificial intelligence paradigms and their applications in complex systems, security, e-education, e-healthcare, unmanned air vehicles, and intelligent agents.

Acronyms

AABB	Axis-Aligned Bounding Boxes
ABA	Area-Based Approach
ABRDF	Apparent BRDF
AGB	Above Ground Biomass
AGL	Above Ground Level
ALS	Airborne Laser Scanning
AMDIL	AMD Intermediate Language
API	Application Programming Interface
APSRS	American Society of Photogrammetry and Remote Sensing
ASF	Adaptive Surface Filter
B	Blue
BC	Branch Chain
BLUP	Best Linear Unbiased Prediction
BMP	BitMaP
BRDFs	Bidirectional Reflectance Distribution Functions
B-Rep	Boundary representation
BSG	Branch-Structure Graph
BTDFs	Bidirectional Transmittance Distribution Functions
BTF	Bidirectional Texture Function
CAD	Computer-Aided Drawing
CAGR	Compound Annual Growth Rate
CCA	Canonical Component Analysis
CCD	Charge-Coupled Device
CERL	Construction Engineering Research Laboratory
CG	High-level shading language for programming vertex and pixel shaders
CHD	Canopy Height Distribution
CHM	Canopy Height Model
CHP	Canopy Height Profile
CHQ	Canopy Height Quantile function

CIR	Consumer InfraRed
CLOD	Continuous LOD
CPU	Central Processing Unit
CSG	Constructive Solid Geometry
CSM	Cascaded Shadow Maps
CUDA	Compute Unified Device Architecture
CU-Structural Soil	CU-Structural Soil is a mixture of crushed gravel and soil with a small amount of hydrogel to prevent the soil and stone from separating during the mixing and installation process
DBH	Diameter-at-Breast Height
DEM	Digital Evaluation Model
DES	Digital Earth Surface
DHP	Density of High Points
DLOD	Discrete LOD
DMPs	Differential Morphological Profiles
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVM	Dynamic Vegetation Model
EDSS	Ecosystem Decision Support System
EM	Expectation–Maximization
ETEW	Elevation Threshold with Expanding Window
FAR	False Acceptance Ratio
FBX	FilmBoX
FFT	Fast Fourier Transform
FOV	Field Of View
FRR	False Rejection Ratio
FSA	Foliage Simplification Algorithm
FSP	Functional–Structural Plant
FTI	Feature Type Interpreter
FVVR	Free-Viewpoint Video Renderers
G	Green
GeoTIFF	Geo-referenced TIFF
GIF	Graphics Interchange Format
GLCM	Grey Level Co-occurrence Matrix
GLSL or GLslang	GL Shading Language
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite System
GPP/NPP	Gross/Net Primary Productivity
GPR	Ground-Penetrating Radar
GPS	Global Positioning System
GPU	Graphics Processing Unit
GRASS	Geographic Resources Analysis Support System
GSD	Ground Sample Distance
GSM	Global System Mobile
HBT	Hierarchical Bidirectional Texture

HIS	Hue Saturation Intensity
HLOD	Hierarchical Levels of Detail
HLSL	High-Level Shading Language
HMLS	Handheld Mobile Laser Scanner
HSR	Hidden Surface Removal
HUO	Hierarchical Union of Organs
IBR	Image-Based Rendering
IDT	Individual Tree Detection
IDW	Inverse Distance Weighed
IFF	Interchange File Format
IMU	Inertial Measurement Unit
INS	Integrated Navigation System
IP	Imaging digital Photography
IS	Imaging Spectroscopy
ISPRS	International Society for Photogrammetry and Remote Sensing
ISR	Intelligence, Surveillance, and Reconnaissance
JPEG	Joint Photographic Experts Group
KBDI	Keetche–Byram Drought Index
kd-tree	k dimensional tree
kriging	Geostatistical interpolation techniques
Lab	Litheness and a and b for the color-opponent dimensions, based on nonlinearly compressed
LAI	Leaf Area Index
LAN	Local Area Network
LAS	Log ASCII Standard
LDA	Linear Discriminant Analysis
LDAP	Lightweight Directory Access Protocol
LDI	Layered Depth Image
LES	Large Eddy Simulation
LiDAR	Light Detection and Ranging
LiPSM	Light-space PSMs
LM	Local Maxima
LMS	LiDAR Mapping Suite
LOD	Level Of Detail
LoFS	Local Fitting Surfaces
LogPSMs	Logarithmic Perspective Shadow Maps
LPs	Lowest Points
LPC	LiDAR Point Cloud
LRU	Least Recently Used
LSA	Least-Squares Adjustment
L-systems	Lindenmayer systems
LWO	LightWave 3D Objects
MAE	Mean Absolute Error
MAV	micro-UAV

MCC	Multi-scale Curvature Classification
MCMC	Monte Carlo Markov Chain
MCWS	Marker-Controlled Watershed Segmentation
MHC	Multi-resolution Hierarchical Classification
MLFMM	Multi-Level Fast Multi-pole Method
MLS	Maximum Local Slope
MLS	Mobile Laser Scanning
MPM	Material Point Method
MRF	Markov Random Field
MS	Mean Shift
MTOM	Maximum Takeoff Mass
MUAV	mini-UAV
NBR	Nuclear, Biological, and Radiological
NDVI	Normalized Difference Vegetation Indices
NED	National Elevation Dataset
NIR	Near-InfraRed
NUAV	nano-UAV
OC	Occlusion Culling
PCA	Principal Component Analysis
PDA	Personal Digital Assistant
PDF	Probability Density Function
PGM	Portable Gray Map
PICT	Macintosh PICTure
PKI	Public Key Infrastructure
PLU	Progressive Leaves Union
PM	Progressive Morphological
PMs	Progressive Meshes
PNG	Portable Network Graphics
PRF	Pulse Repetition Frequency
PRR	Pulse Repetition Rate
PSD	The PhotoShop Data
PSM	Perspective Shadow Map
PSSM	Parallel-Split Shadow Mapping
PTD	Progressive TIN Densification
PVS	Potentially Visible Sets
QA	Quality Assurance
R	Red
RADAR	RAdio Detecting And Ranging
RAM	Random Access Memory
RANS	Reynolds-Averaged Navier–Stokes
RANSAC	RANdom SAmple Consensus
RF	Random Forest
RGBA	Red, Green, Blue, Alpha
RMSE	Root-Mean-Square Error
RMSPE	Root-Mean-Square Prediction Error

ROAM	Real-time Optimally Adapting Meshes
ROI	Regions Of Interest
RPC	Rational Polynomial Coefficient
RST	Regularized Splines with Tension
RT	Radiative Transfer
RTM	Radiative Transfer Models
SBRDF	Spatial Bidirectional Reflectance Distribution Function
SDK	Software Development Kit
SLAM	Simultaneous Localization And Mapping
SPH	Smoothed Particle Hydrodynamics
SRTM	Shuttle Radar Topography Mission
SSD	Solid-State Drive
SUSC	Segmentation Using Smoothness Constraint
SUV	Suburban Utility Vehicle
SV	Soft Voxel
SVM	Support Vector Machines
t-ADT	tree Abstract Data Type
TDM	Textured Depth Meshes
TEN	TEtrahedral Network
TGA	Truevision Targa Graphic
TIFF	Tagged Image File
TIN	Triangular Irregular Network
TLS	Terrestrial Laser Scanning
TPS	Thin Plate Spline
TRAM	Transputer Random Access Memory
TSI	Timber Species Identifier
UAS	Unmanned Aerial System
UAV	Unmanned Airborne Vehicle
VDTM	View-Dependent Texture Mapping
VHR	Very High Resolution
VI	Vegetation Indice
VLS	Vehicle-based Laser Scanning
VNS	Visual Nature Studio
Voxel	Volume element
WCS	World Construction Set