

E. Di Stefano, C. A. Avizzano, M. Bergamasco, P. Masini, M. Menci and D. Russo, "Automatic inspection of railway carbon strips based on multi-modal visual information," *2017 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)*, Munich, 2017, pp. 178-184.

doi: 10.1109/AIM.2017.8014015

Abstract: Electric rail vehicles are driven by the current collected from the electrical lines of the railway catenary system. For this purpose, trains are equipped with a current collector (the pantograph) that comes in contact with the wires by means of a pair of carbon strips. The sliding movement along the wires subjects the carbon strips to wear and damage so that frequent inspection is essential to ensure the train and catenary safety. In this paper we describe an automatic visual inspection system, made of a 3D laser scanner and a 2D high resolution camera, which is able to automatically determine the health state of the railway contact strips thanks to a sophisticated data processing tool. The system collects color and geometrics information on the carbon strips and performs several automated assessments both on the 3D and 2D data. For each test, the system provides an index and decides between three different levels of wear (low, medium, high) to support the human operator in inspection and maintenance decisions. Experimental results reveal the effectiveness of the system, comparing the human judgment with the automated analysis.

keywords: {electric vehicles;geometry;image resolution;inspection;optical scanners;railway engineering;railway safety;2D high resolution camera;3D laser scanner;automatic visual inspection system;catenary safety;electric rail vehicles;geometrics information;multimodal visual information;railway carbon strips;railway catenary system;Carbon;Contacts;Inspection;Strips;Three-dimensional displays;Tools;Two dimensional displays},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8014015&isnumber=8013982>

C. Prasse, J. Stenzel, B. Rudak, F. Weichert, H. Müller and M. ten Hompel, "Low cost contour check of loading units using PMD sensors," *2013 Seventh International Conference on Sensing Technology (ICST)*, Wellington, 2013, pp. 477-482.

doi: 10.1109/ICSensT.2013.6727699

Abstract: In this paper, a novel approach for the detection of parcel loading positions on a pallet is presented. This approach realizes a substantial change in comparison to traditional system design of contour detection in de-palletizing processes. Complex 3D-vision systems, costly laser scanners or throughput decreasing local sensor solutions integrated in grippers are substituted by a low-cost Photonic Mixing Device (PMD) camera. By combining PMD technology and a predetermined model of loading situations, stored during the assembly of the pallet, this approach can compensate for the drawbacks of each respective system. An essential part of the approach are computer-graphics methods specific to the given problem to both detect the deviation between the nominal and the actual loading position and if necessary an automated correction of the packaging scheme. From an economic point of view this approach can decrease the costs of mandatory contour checking in automated de-palletizing processes.

keywords: {assembling;cameras;computer graphics;computer vision;grippers;image sensors;loading;object detection;optical scanners;packaging;palletising;PMD camera;PMD sensors;automated de-palletizing process;automated packaging correction scheme;complex 3D vision system;computer graphics method;contour checking;contour detection;grippers;laser scanner;loading units;pallet assembly;parcel loading position detection;photonic mixing device;throughput;Cameras;Load modeling;Loading;Robot kinematics;Robot sensing systems;PMD sensor;Photonic Mixing Device;contour check;de-palletizing;low cost;palletizing;time of flight},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6727699&isnumber=6727602>

A. Fooladivanda, N. Chehrerazi, S. Sadri, R. Amirfattahi and M. A. Montazeri, "Automatic segmentation of pallet images using the 2-D wavelet transform and YUV color space," *2010 18th Iranian Conference on Electrical Engineering*, Isfahan, Iran, 2010, pp. 209-214.

doi: 10.1109/IRANIANCEE.2010.5507072

Abstract: Segmentation is an important stage in automatic digital image processing. A special case of segmentation is to segment objects from their background. Among different segmentation algorithm for object detection, learning based approach is widely applied. In steel industry, pallets are moving on a rail. They have high resolution details in their structure and the image of a pallet taken by a camera in real time suffers from severe noise and illumination variations. The purpose of this paper is to segment the pallet from a frame of a sequence of video images, such that the pallet is segmented without degradation of resolution. We use the pallet image in YUV color space together with wavelet transform (WT) for detection. For classification Support Vector Machine (SVM) is incorporated to the images. It is shown that the above procedure segments the pallets successfully without degradation of resolution.

keywords: {Degradation;Digital images;Image resolution;Image segmentation;Metals industry;Object detection;Rails;Support vector machine classification;Support vector machines;Wavelet transforms;SVM;Segmentation;Wavelet Transform;YUV Color Space},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5507072&isnumber=5506939>

K. Ishikawa, Y. Amano, T. Hashizume and J. i. Takiguchi, "A study of precise road feature localization using mobile mapping system," *2007 IEEE/ASME international conference on advanced intelligent mechatronics*, Zurich, 2007, pp. 1-6.

doi: 10.1109/AIM.2007.4412541

Abstract: In the near future, precise digital map data is said to be applied to the next generation car navigation system as well as ITS to increase the driving safety. It is important to maintain digital map data's freshness and accuracy. A MMS (Mobile Mapping System) can acquire this highway database, while offering unbeatable productivity with the combination of navigation and videogrammetry tools. The proposed MMS, featuring a GPS/DR combined navigation system, a GPS-Gyro/IMU, nearly horizontal cameras, laser scanners, high sampling rate road data measurement logger, and the network-based RTK-GPS PAStrade can acquire road feature location like snow-poles, guard-rails, road signs and road line precisely at normal cruising speed considering 3D road surface model. The carrier phased D-GPS/DR combined navigation system and GPS-Gyro/IMU performs highly accurate positioning performance at a few centimeter and posture estimation at 0.073 [deg rms] for heading and 0.064 [deg rms] for pitching, and 0.116 [deg rms] for rolling. Furthermore, the proposed road feature digitizing method, featuring 2D camera image projection to the 3D road surface model, allows users to understand complicated 3D point-cloud data intuitively and to designate desired road feature with few mistakes. The accuracy comparison between the static RTK-GPS/Total-Station measurement with the dynamic MMS mobile measurement reveal that the system allows 0.3 [m] road feature measurement accuracy with unbeatable productivity when sufficient GPS visibility is obtained.

keywords: {Global Positioning System;automated highways;cartography;computerised navigation;feature extraction;mobile computing;road safety;solid modelling;visual databases;2D camera image projection;3D point-cloud data;3D road surface model;GPS-DR combined navigation system;GPS-Gyro/IMU;ITS;digital map data;driving safety;guard-rails;highway database;laser scanners;mobile mapping system;nearly horizontal cameras;network-based RTK-GPS PAS;next generation car navigation system;road feature digitizing method;road feature localization;road line;road signs;sampling rate road data measurement logger;snow-poles;videogrammetry}

tools;Cameras;Global Positioning System;Laser modes;Navigation;Productivity;Road transportation;Sampling methods;Spatial databases;Vehicle safety;Velocity measurement;FKP;GPS-Gyro/IMU;Mobile Mapping System;Point-cloud data},
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D. Lecking, O. Wulf and B. Wagner, "Variable Pallet Pick-Up for Automatic Guided Vehicles in Industrial Environments," *2006 IEEE Conference on Emerging Technologies and Factory Automation*, Prague, 2006, pp. 1169-1174.
 doi: 10.1109/ETFA.2006.355424

Abstract: This paper presents two laser scanner based approaches to locate and pick-up pallets with the aim of automating forklift trucks. In contrast to camera based systems our approaches are independent of luminance conditions which can be highly variable in industrial environments. Whereas one approach uses pallets modified with adhesive reflectors which enables very flexible handling of pallets, the second approach detects pallets based on geometric characteristics without any modifications to the environment. Experimental results are also reported including a run of an autonomous fork-lift truck presented at the logistics fair CeMAT 2005 in Hannover.

keywords: {automatic guided vehicles;fork lift trucks;geometry;industrial robots;mobile robots;optical scanners;palletising;automatic guided vehicles;forklift truck automation;geometric characteristics;industrial environments;laser scanner based approaches;variable pallet pick-up;Automotive engineering;Calibration;Cameras;Laser noise;Laser theory;Lighting;Logistics;Real time systems;Systems engineering and theory;Vehicles},

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R. Majeski *et al.*, "A toroidal liquid lithium limiter for CDX-U," *Proceedings of the 19th IEEE/IPSS Symposium on Fusion Engineering. 19th SOFE (Cat. No.02CH37231)*, 2002, pp. 341-344.

doi: 10.1109/FUSION.2002.1027707

Abstract: Attention has focused recently on flowing liquid lithium as a first wall for a reactor because of its potentially attractive physics and engineering features. In order to test the suitability of liquid lithium as a plasma facing component, the Current Drive eXperiment - Upgrade (CDX-U) at the Princeton Plasma Physics Laboratory has recently installed a fully toroidal liquid lithium limiter. CDX-U is a compact ($R = 34$ cm, $a = 22$ cm, $B_{\text{toroidal}} = 2$ kG, $I_p = 100$ kA, $T_e(O) \sim 100$ eV, $n_e(0) \sim 5 \times 10^{19} \text{ m}^{-3}$ short-pulse (< 25 msec) spherical torus (ST) with extensive diagnostics. The limiter, which consists of a shallow circular stainless steel tray of radius 34 cm and width 10 cm, is filled with lithium to a depth of a few millimeters, and forms the lower limiting surface for the discharge. Heating elements beneath the tray are used to liquefy the lithium (melting point = 180.5°C) prior to the experiment. The total area of liquid lithium exposed to the plasma is approximately 2000 cm^2 . The design of the limiter, modifications to CDX-U to accommodate in-vessel inventories of approximately 1 liter of liquid lithium, techniques for loading lithium onto the limiter, and other preparations will be described. CDX-U has previously been successfully operated with a smaller area (cm^2) liquid lithium rail limiter. Diagnostics specific to lithium operations include multichord spectrometry of the $135 \text{ \AA}$ LiIII line in the core plasma, monitors for neutral lithium light at the lithium limiter, and a fast (10,000 frame per second) camera which monitors motion of the liquid during the discharge. First results of plasma operations with the toroidal liquid lithium limiter will also be given.

keywords: {fusion reactor design;fusion reactor limiters;lithium;plasma toroidal confinement;stainless steel;180.5 degC;CDX-U;Li;diagnostics;liquid Li;spherical torus;toroidal liquid Li limiter;Heating;Inductors;Laboratories;Lithium;Physics;Plasma diagnostics;Rails;Steel;Surface discharges;Testing},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1027707&isnumber=22072>

G. Di Leo, C. Liguori, A. Pietrosanto and R. Lengu, "Uncertainty of line camera image based measurements," *2017 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)*, Turin, 2017, pp. 1-6.

doi: 10.1109/I2MTC.2017.7969698

Abstract: Line Camera has been emerging as an effective approach to contactless measurement systems. Line cameras are preferred to area scan cameras in specific applications where the object to be scanned has one dimension much greater than the other two (e.g. train). In this paper, a line camera analytic model and its calibration procedure, are described. A significant part of the paper is dedicated to measurement uncertainty. Simulation and experimental results are reported to describe how uncertainty due to the calibration procedure influences the final uncertainty of dimensional measurements.

keywords: {calibration;cameras;image scanners;image sensors;measurement uncertainty;calibration procedure;camera scanning;contactless measurement system;line camera analytic model;line camera image uncertainty;measurement uncertainty;Calibration;Cameras;Matrix decomposition;Measurement uncertainty;Monitoring;Rail transportation;Uncertainty;Monte Carlo method;calibration;line camera;uncertainty},

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Y. Lei, J. Fan and J. Liu, "A multi-scale approach to extract meaningful annotations from document images," *2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Shanghai, 2016, pp. 1951-1955.

doi: 10.1109/ICASSP.2016.7472017

Abstract: We propose a multi-scale approach to extract annotations from document images in a meaningful way. It compares the rectified captured image with original image, which can be obtained through image retrieval technology, at various resolutions, in order to remove the noise caused by nonuniform distortions, such as camera lens distortion and document surface curvature, while preserving the true annotations. It also provides users lots of flexibility with a voting scheme and potentially different weights at different resolution levels. In addition, we analyzed the final annotation image and found the meaningful pieces out of it, such as an image patch of a handwritten paragraph. This broadens the application of annotation extraction, and makes it easier to share the notes. It can be applied to various imaging systems, such as flatbed scanner, mobile phone camera, or fixed camera etc. Experimental results are presented and compared with previous approaches.

keywords: {document image processing;feature extraction;image denoising;image resolution;image retrieval;document images;final annotation image;image denoising;image resolutions;image retrieval technology;meaningful annotation extraction;multiscale approach;Decision support systems;Indexes;Rail to rail outputs;Annotation extraction;document imaging;multi-scale},

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X. Liang *et al.*, "Forest Data Collection Using Terrestrial Image-Based Point Clouds From a Handheld Camera Compared to Terrestrial and Personal Laser Scanning," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 53, no. 9, pp. 5117-5132, Sept. 2015.

doi: 10.1109/TGRS.2015.2417316

Abstract: Stereo images have long been the main practical data source for the high-accuracy retrieval of 3-D information over large areas. However, stereoscopy has been surpassed by laser scanning (LS) techniques in recent years, particularly in forested areas, because the reflection of laser points from object surfaces directly provides 3-D geometric features and because the laser beam has good penetration capacity through forest canopies. In the last few years, image-based point clouds have become a more widely available data source because of advances in matching algorithms and computer hardware. This paper explores the possibility of using consumer cameras for forest field data collection and presents an application of terrestrial image-based point clouds derived from a handheld camera to forest plot inventories. In the experiment, the sample forest plot was photographed in a stop-and-go mode using different routes and camera settings. Five data sets were generated from photographs taken in the field, representing different photographic conditions. The stem detection accuracy ranged between 60% and 84%, and the root-mean-square errors of the estimated diameters at breast height were between 2.98 and 6.79 cm. The performance of image-based point clouds in forest data collection was compared with that of point clouds derived from two LS techniques, i.e., terrestrial LS (the professional level) and personal LS (an emerging technology). The study indicates that the construction of image-based point clouds of forest field data requires only low-cost, low-weight, and easy-to-use equipment and automated data processing. Photographic measurement is easy and relatively fast. The accuracy of tree attribute estimates is close to an acceptable level for forest field inventory but is lower than that achieved with the tested LS techniques.

keywords: {cameras;feature extraction;forestry;geophysical image processing;geophysical techniques;optical scanners;stereo image processing;vegetation;3D geometric feature;automated data processing;breast height;camera setting;consumer camera;easy-to-use equipment;forest canopy;forest data collection;forest field data collection;forest field inventory;forest plot inventory;forested area;handheld camera;high-accuracy 3D information retrieval;laser beam penetration capacity;laser point reflection;laser scanning technique;object surface;personal laser scanning;photographic measurement;root-mean-square error;stem detection accuracy;stereo images;stereoscopy;terrestrial image-based point clouds;terrestrial laser scanning;Accuracy;Cameras;Data collection;Laser beams;Measurement by laser beam;Three-dimensional displays;Vegetation;Forest inventory;Light Detection And Ranging (LiDAR);handheld camera;image-based point cloud;laser scanning (LS);point cloud;structure from motion;terrestrial},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7109840&isnumber=7119654>

Xiaowei Shao, Huijing Zhao, Katsuyuki Nakamura, Kyoichiro Katabira, Ryosuke Shibasaki and Yuri Nakagawa, "Detection and tracking of multiple pedestrians by using laser range scanners," *2007 IEEE/RSJ International Conference on Intelligent Robots and Systems*, San Diego, CA, 2007, pp. 2174-2179.

doi: 10.1109/IROS.2007.4399152

Abstract: We propose a novel system for tracking multiple pedestrians in a crowded scene by exploiting single-row laser range scanners that measure distances of surrounding objects. A walking model is built to describe the periodicity of the movement of the feet in the spatial-temporal domain, and a mean-shift clustering technique in combination with spatial-temporal correlation analysis is applied to detect pedestrians. Based on the walking model, particle filter is employed to track multiple pedestrians. Compared with camera-based methods, our system provides a novel technique to track multiple pedestrians in a relatively large area. The experiments, in which over 300 pedestrians were tracked in 5 minutes, show the validity of the proposed system.

keywords: {correlation methods;demodulation;image sensors;optical scanners;tracking;camera-based methods;feet movement;mean shift clustering technique;multiple pedestrians detection;multiple pedestrians tracking;single row laser range scanners;spatial-temporal correlation analysis;traffic flow analysis;Cameras;Intelligent robots;Laser modes;Laser theory;Legged locomotion;Particle filters;Particle tracking;Rail transportation;Streaming media;USA Councils},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4399152&isnumber=4398944>

H. Zhao and R. Shibasaki, "A Real-Time System for Monitoring Pedestrians," *Application of Computer Vision, 2005. WACV/MOTIONS '05 Volume 1. Seventh IEEE Workshops on*, Breckenridge, CO, 2005, pp. 378-385.

doi: 10.1109/ACVMOT.2005.10

Abstract: In this research, we propose a novel system of monitoring pedestrians and tracking their trajectories in a wide and open area, such as shopping mall, exhibition hall, railway station and so on. A network of single row laser range scanners is exploited, which are set on the floor doing horizontal scan at an elevation of about 15cm above the floor. A pedestrian's walking model on the horizontal cross section of ground level is defined and a tracking algorithm is developed to detect and trace the rhythmic swing feet. On the other hand, video cameras are integrated with the network of laser scanners, which focus on some spots inside laser scanner's measurement coverage, and get image data for pedestrian's trajectories. An experiment for real-time monitoring visitor's flow was conducted in a large exhibition, which had totally 30,000 visitors during three exhibition days. Four LMS200 (by SICK) and a video camera were located near a crossing point, covering a floor area of about 30 m times 30 m and 5 m times 6 m respectively. Visitors inside and nearby video camera's vision field were tracked in a real-time mode. Their trajectories as well as the laser points on their feet were back projected onto the video images on the air. On the other hand, visitor's flow nearby the crossing point and its change along with time is examined by analyzing the motion behavior of each visitor in an off-line mode

keywords: {computer vision;computerised monitoring;optical scanners;traffic engineering computing;video cameras;laser range scanner;pedestrian monitoring;pedestrian walking model;real-time system;tracking algorithm;video camera;Cameras;Information science;Laser modes;Monitoring;Motion analysis;Rail transportation;Real time systems;Surveillance;Tracking;Trajectory},

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D. L. Williams and R. F. Nelson, "Use of Remotely Sensed Data for Assessing Forest Stand Conditions in the Eastern United States," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. GE-24, no. 1, pp. 130-138, Jan. 1986.

doi: 10.1109/TGRS.1986.289542

Abstract: The results of three interrelated research activities conducted by Goddard scientists in support of the AgRISTARS Renewable Resources Inventory (RRI) project are summarized. The central theme of the research conducted at Goddard was the development of techniques for the detection, classification, and measurement of forest disturbances using digital, remotely sensed data. Three study areas located in Pennsylvania, North Carolina, and Maine were investigated with respect to: a) the delineation and assessment of forest damage associated with two different forest insect defoliators, and b) an assessment of the improved capabilities to be expected from Landsat Thematic Mapper (TM) data relative to Multispectral Scanner (MSS) data for delineating forest stand characteristics. Key results include the development of a statewide MSS digital data base and associated image processing techniques for accurately delineating (approximately 90 percent correct classification accuracy) insect damaged and healthy forest. Comparison of analyses using MSS and

TM Simulator (TMS) data indicated that for broad land cover classes which are spectrally homogeneous, the accuracy of the classification results are similar. However, TMS data provided superior results (20 percent overall accuracy increase relative to MSS results) when detailed (Level III) forest classes were mapped. These studies also illustrated the utility of having at least one band in the visible, near infrared, and middle infrared portion of the electromagnetic spectrum for assessing specific (Level III) forest cover types. keywords: {Analytical models;Earth;Infrared spectra;Insects;NASA;Project management;Rail to rail inputs;Remote monitoring;Remote sensing;Satellites},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4072428&isnumber=4072408>

T. Hattori and T. Kato, "Analyses of propagation characteristics by VRML models along railway," *IEEE 60th Vehicular Technology Conference, 2004. VTC2004-Fall*. 2004, 2004, pp. 4233-4237 Vol. 6.

doi: 10.1109/VETECF.2004.1404877

Abstract: In this paper, we show simulation results on radio propagation characteristics of a train radio system using 3D VRML (virtual reality modeling language) models along railway tracks. Conventionally, we have studied the modeling technique by scanning actual environments along the railway. In this technique, we are able to obtain 3D coordinates of points along railway environments by installing laser scanners and line cameras on a train. Next, 3D coordinates are converted into polygon models, and in addition, camera images are pasted. Finally, the models which contain shapes of wayside structures and landforms are created. These models are available for calculating radio propagation characteristics. This modeling technique contributes to reducing the burden of radio measurements, and to design wireless systems precisely. Here, we show some calculated examples on received levels of a train radio system based on polygon models, compared with experimental results.

keywords: {UHF radio propagation;computational geometry;image processing;land mobile radio;measurement by laser beam;optical scanners;railways;ray tracing;virtual reality languages;3D geometrical models;UHF band radio propagation;laser scanners;pasted camera images;polygon models;railway 3D VRML models;railway environments;ray tracing;train radio system;train-installed line cameras;virtual reality modeling language;wayside environment 3D coordinates;wayside landforms;wayside structure shapes;Cameras;Communication system control;Global Positioning System;Hardware;Image converters;Laser modes;Radio control;Radio propagation;Rail transportation;Ray tracing},

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T. Hattori and T. Kato, "The 3-dimensional modeling technique for calculating radio propagation characteristics along railway," *The 5th International Symposium on Wireless Personal Multimedia Communications*, 2002, pp. 291-295 vol.1.

doi: 10.1109/WPMC.2002.1088179

Abstract: The author propose a modeling technique by scanning actual environments along a railway. In this technique, they are able to obtain three-dimensional coordinates of points along railway environments by installing laser scanners and line cameras on a train. Next, the three-dimensional coordinates are converted into polygon models, and in addition, camera images are pasted. These models are available for calculating radio propagation characteristics. We show the measurement and processing technique for obtaining precise three-dimensional models.

keywords: {cameras;optical scanners;radiowave propagation;railways;3-dimensional modeling;3D coordinates;3D modeling;camera images;environments scanning;laser scanners;line cameras;polygon models;processing technique;radio propagation characteristics;three-dimensional coordinates;train;Cameras;Communication system control;Global Positioning System;Hardware;Laser modes;Radio control;Radio link;Radio propagation;Rail transportation;Ray tracing},

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S. Hese, "Segmentation of forest stands in very high resolution stereo data," *IGARSS 2001. Scanning the Present and Resolving the Future. Proceedings. IEEE 2001 International Geoscience and Remote Sensing Symposium (Cat. No.01CH37217)*, Sydney, NSW, 2001, pp. 1654-1656 vol.4.

doi: 10.1109/IGARSS.2001.977024

Abstract: Classification of forest stands is an important task in forest inventory and monitoring. The multi view angle data of the new digital stereo line scanner HRSC-A was used in this work to investigate the applicability of semivariogram textural parameters for a stand segmentation of variable aged spruce stands based on viewing angle related textural features. Results indicate a potential of directional semivariogram parameter in stand structure differentiation, especially when homogeneous stands are examined. Sensor viewing angles are used and Sun illumination angle is taken into account to increase the separability of texture features

keywords: {image segmentation;image texture;stereo image processing;vegetation mapping;395 to 1015 nm;HRSC-A;High Resolution Stereo Camera - Airborne;Sun illumination angle;digital stereo line scanner;directional semivariogram parameter;forest inventory;forest monitoring;forest stands classification;homogeneous stands;multi view angle data;semivariogram textural parameters;sensor viewing angles;spruce;stand segmentation;stand structure differentiation;textural features;very high resolution stereo data;Aging;Charge coupled devices;Digital cameras;Image resolution;Lighting;Monitoring;Pixel;Radiometry;Sensor phenomena and characterization;Sun},

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C. K. Cowan and P. D. Kovesi, "Automatic sensor placement from vision task requirements," in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 10, no. 3, pp. 407-416, May 1988.

doi: 10.1109/34.3905

Abstract: The problem of automatically generating the possible camera locations for observing an object is defined, and an approach to its solution is presented. The approach, which uses models of the object and the camera, is based on meeting the requirements that: the spatial resolution be above a minimum value, all surface points be in focus, all surfaces lie within the sensor field of view and no surface points be occluded. The approach converts each sensing requirement into a geometric constraint on the sensor location, from which the three-dimensional region of viewpoints that satisfies that constraint is computed. The intersection of these regions is the space where a sensor may be located. The extension of this approach to laser-scanner range sensors is also described. Examples illustrate the resolution, focus, and field-of-view constraints for two vision tasks

keywords: {computer vision;computerised picture processing;camera locations;computer vision;field of view;geometric constraint;sensor location;spatial resolution;Automation;Buildings;Cameras;Data processing;Inspection;Lakes;Machine vision;Optical sensors;Rail to rail inputs;System testing},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=3905&isnumber=218>