

H. Trinh, N. Haas, Y. Li, C. Otto and S. Pankanti, "Enhanced rail component detection and consolidation for rail track inspection," *2012 IEEE Workshop on the Applications of Computer Vision (WACV)*, Breckenridge, CO, 2012, pp. 289-295.

doi: 10.1109/WACV.2012.6163021

Abstract: For safety purposes, railroad tracks need to be inspected on a regular basis for physical defects or design noncompliances. Such track defects and non-compliances, if not detected in a timely manner, may eventually lead to grave consequences such as train derailments. In this paper, we present a real-time automatic vision-based rail inspection system, with main focus on anchors - an important rail component type, and anchor-related rail defects, or exceptions. Our system robustly detects important rail components including ties, tie plates, anchors with high accuracy and efficiency. Detected objects are then consolidated across video frames and across camera views to map to physical rail objects, by combining the video data streams from all camera views with GPS information and speed information from the distance measuring instrument (DMI). After these rail components are detected and consolidated, further data integration and analysis is followed to detect sequence-level track defects, or exceptions. Quantitative analysis performed on a real online field test conducted on different track conditions demonstrates that our system achieves very promising performance in terms of rail component detection, anchor condition assessment, and compliance-level exception detection. We also show that our system outperforms another advanced rail inspection system in anchor detection.

keywords: {computer vision;distance measurement;inspection;railway safety;railways;real-time systems;video signal processing;video streaming;GPS information;advanced rail inspection system;anchor condition assessment;anchor detection;anchor-related rail defects;anchors;compliance-level exception detection;distance measuring instrument;physical defects;physical rail objects;rail component detection;rail components;rail track inspection;railroad tracks;real-time automatic vision-based rail inspection system;sequence-level track defect detection;speed information;tie plates;ties;train derailments;video data streams;Cameras;Global Positioning System;Image edge detection;Inspection;Rails;Safety;Vehicles},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6163021&isnumber=6162991>

X. B. Cao, H. Qiao and J. Keane, "A Low-Cost Pedestrian-Detection System With a Single Optical Camera," in *IEEE Transactions on Intelligent Transportation Systems*, vol. 9, no. 1, pp. 58-67, March 2008.

doi: 10.1109/TITS.2007.909239

Abstract: The ultimate purpose of a pedestrian-detection system (PDS) is to reduce pedestrian-vehicle-related injury. Most such systems tend to adopt expensive sensors, such as infrared devices, in expectation of better performance. In comparison, a low-cost optical-camera-based system has much potential practical value, including a greater detection range, and can easily be trained to detect other objects. However, such low-cost systems are difficult to design (e.g., little original information can be collected, and the scene is very complex). To address these problems, an effective and reliable classifier is needed. The classifier should have a proper structure, its features need to be well selected, and a large number of high-quality samples are necessary for training. In this paper, we present a low-cost PDS which only uses a single optical camera. We design a cascade classifier to achieve an effective and reliable detection. First, our system scans two sequential frames at each zoom scale with a sliding window. Second, with each window, both appearance and motion features are extracted. A well-trained cascade classifier, combining statistical learning with a decomposed support-vector-machine classifier, then determines whether the window contains a human body. At the same time, to provide as much information as possible about the pedestrian, a small-scale weighted template tree trained by a coevolutionary algorithm is adopted to identify each pedestrian's direction, and the distance of each from the vehicle is also provided using an estimation algorithm. During the training procedure, we select key features by using the AdaBoost algorithm and a large number of high-quality samples. Experimental results demonstrate that the system is suitable for pedestrian detection in city traffic: The detection speed is more than 10 ft/s, the detection rate reaches 80%, and the false positive rate is no more than $0.3/_{00}$.

keywords: {feature extraction;image motion analysis;image sensors;object detection;support vector machines;AdaBoost algorithm;appearance features;cascade classifier;coevolutionary algorithm;low-cost pedestrian-detection system;motion features;pedestrian-vehicle-related injury;single optical camera;statistical learning;support-vector-machine classifier;Cascade classifier;coevolutionary algorithm;decomposed support vector machines (SVMs);pedestrian-detection system (PDS);small-scale weighted template tree;statistical learning},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4391026&isnumber=4459084>

G. Serra, R. Cucchiara, K. M. Kitani and J. Civera, "Guest Editorial Special Issue on Wearable and Ego-Vision Systems for Augmented Experience," in *IEEE Transactions on Human-Machine Systems*, vol. 47, no. 1, pp. 1-5, Feb. 2017.

doi: 10.1109/THMS.2016.2646600

Abstract: The papers in this special section focus on the deployment of wearable computing technologies and ego-vision systems for augmented reality applications. Rapid progress in the development of low-level component technologies such as wearable sensors, wearable displays, and wearable computers is making our digital lives grow, connect, and play a relevant role in reality. To name a few examples, body-mounted sensors and displays help athletes in training by presenting real-time performance metrics such as speed, distance, and heart rate. Wearable systems allow medical staff in hospitals to consult specialists located anywhere in the world, in real time, providing optimal patient care. And within the context of assistive technologies, a head-mounted camera can be used to identify and convey the presence of objects, people, or text to a visually impaired user.

keywords: {Assistive technologies;Augmented reality;Machine vision;Special issues and sections;Tactile sensors;Wearable computers;Wearable sensors},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7818100&isnumber=7818054>

D. Frost, D. Murray and V. Prisacariu, "Using Learning of Speed to Stabilize Scale in Monocular Localization and Mapping," *2017 International Conference on 3D Vision (3DV)*, Qingdao, China, 2017, pp. 527-536.

doi: 10.1109/3DV.2017.00066

Abstract: Monocular visual localization and mapping algorithms are able to estimate the environment only up to scale, a degree of freedom which leads to scale drift, difficulty closing loops, and eventual failure. This paper describes an image-driven approach for scale-drift correction which uses a convolutional neural network to infer the speed of the camera from successive monocular video frames. We obtain continuous drift correction, avoiding the need for explicit higher-level representations of the map to resolve scale. We also propose a novel method of including speed estimates as a regularizer in bundle adjustment which avoids the pitfalls of sudden imposition of scale knowledge. We demonstrate our approach using long-distance sequences for which ground truth is available, and find output that is essentially free of scale drift. We compare the performance with number of other methods for scale-drift correction from

monocular data, and show that our solution achieves more accurate results.

keywords: {Bundle adjustment;Cameras;Geometry;Network architecture;Sensors;Training;Camera-tracking;Scale-drift;Visual-SLAM},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8374607&isnumber=8367729>

C. Nicodeme, B. Stanciulescu, R. C. Onera, C. Nicodeme and S. E. Fassi, "Wheel-rail contact analysis system using spectral signatures for train automation and traffic management," *2017 IEEE International Symposium on Robotics and Intelligent Sensors (IRIS)*, Ottawa, ON, 2017, pp. 347-351.

doi: 10.1109/IRIS.2017.8250146

Abstract: The transport industry is subject to a lot of improvement aiming to autonomous transportation systems. Railway is also concerned. An autonomous vehicle must be able to perceive and analyze its environment with a view to being able to adapt its driving. In this paper we focus on the wheel-rail contact analysis, and the adherence evaluation, as it conditions loads of variables such as braking, traction and maximum speed. It also has an impact on security distance between trains. Adherence can be degraded by the presence of pollution on the rail surface. We present an imaging system, using a multispectral camera, capable of detecting and recognizing pollutant. The pollution is then associated to an adherence coefficient.

keywords: {cameras;hyperspectral imaging;image recognition;mobile robots;object detection;rail traffic;railway engineering;railways;traffic engineering computing;transportation;wheels;adherence coefficient;adherence evaluation;autonomous transportation systems;autonomous vehicle;imaging system;multispectral camera;pollutant recognition;rail surface pollution;railway;spectral signatures;traffic management;train automation;trains;transport industry;wheel-rail contact analysis system;Cameras;Pollution;Rail transportation;Rails;Robot sensing systems;Safety;Surface contamination;Intelligent Transportation System;Multispectral imaging;adherence;environment perception;hierarchical clustering},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8250146&isnumber=8250084>

A. Savakis, R. Rudra and R. Ptucha, "Gesture Control Using Active Difference Signatures and Sparse Learning," *2014 22nd International Conference on Pattern Recognition*, Stockholm, 2014, pp. 3969-3974.

doi: 10.1109/ICPR.2014.680

Abstract: With the introduction of low cost depth sensors, gesture recognition systems for computer interface control are becoming a reality and require accurate recognition in real time. In this paper, we introduce a salient feature for gesture recognition called active difference signature, obtained by robust processing of depth maps and kinematic joint information. This feature is classified with variants of semi-supervised Linear extension of Graph Embedding and sparse representations to demonstrate advanced gesture control using depth cameras. Our active difference signature technique delivers highly accurate gesture recognition that is invariant to subject distance to camera, subject size, subject location within the camera field of view, and speed at which the subject performs the gestures.

keywords: {computer vision;gesture recognition;learning (artificial intelligence);user interfaces;active difference signature technique;active difference signatures;computer interface control;computer vision;depth cameras;depth maps;difference signature;gesture control;gesture recognition;gesture recognition systems;kinematic joint information;real time recognition;robust processing;sparse learning;Cameras;Dictionaries;Gesture recognition;Joints;Manifolds;Training;depth maps;gesture recognition;human computer interaction;sparse representation},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6977393&isnumber=6976709>

Kangmi Lee, Eunkyung Chae, Sechan Oh and Jonggwe Hwang, "Study on train collision avoidance system for securing safe distance between trains," *2013 International Conference on Electrical Machines and Systems (ICEMS)*, Busan, 2013, pp. 1342-1344.

doi: 10.1109/ICEMS.2013.6713274

Abstract: This paper is concerning the application of train collision avoidance system to secure the safety of two trains located at the close distance such as the case for change in train formation, relief wrecking drive, and operation with variable formation. In the operation method for fixed block system, close proximity driving of train in the normal operation situation is impossible according to the regulation of driving 1 train in 1 block section. Provided, however, in the special operational situation such as the change in train formation, relief wrecking drive, variable formation listed in the previous clause, the close proximity driving of train is indispensable, and a special driving mode which can be driven under the responsibility of engine driver is existed for this purpose. However, special driving mode can be a burden to the train operation since the engine driver is fully responsible for the safety of train, and the operation mode like this leads to the accident caused by the human error. This paper analyzed problems of current operation method for safe operation of two trains in the close distance, and draw the method to solve them.

keywords: {collision avoidance;computer vision;image recognition;image sensors;rail traffic control;railway safety;close proximity driving;distance recognition method;domestic train control system;fixed block system;operation-with-variable formation;radio-based distance recognition method;radio-based speed recognition method;relief wrecking drive;safe distance security;train collision avoidance system;train formation;vision-based image recognition method;Accidents;Collision avoidance;Couplings;Mobile communication;Safety;Vehicles},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6713274&isnumber=6713106>

T. Landry, L. Gagnon and D. Laurendeau, "A GIS-Centric Optical Tracking System and Lap Simulator for Short Track Speed Skating," *2013 International Conference on Computer and Robot Vision*, Regina, SK, 2013, pp. 288-294.

doi: 10.1109/CRV.2013.11

Abstract: This paper presents a GIS-centric computer vision system for tracking high-speed skaters in competition and training situations. This system outputs spatio-temporal trajectories that are analyzed through presented geometric, physical and power-based models in order to evaluate sports performance. Through spatial SQL and shared database access, the GIS enables the manipulation of the trajectories and offer, amongst other, selection, fusion and completion of tracks, as well as automatic computation of distances between competitors. We propose a new method for (1) calibrating the cameras using a GIS-like image rectification method; 2) simulating trajectories and their associated power profiles to model the sport's domain; 3) incorporating the instant center of rotation in both the particle filter's dynamic model and the simulator and 4) leveraging several GIS advanced capabilities in a client-server application. Experimental results show that our rectification methodology is very precise, that our tracking performance is acceptable and that the proposed power balance model is very close to the state of the art.

keywords: {SQL;computational geometry;computer vision;geographic information systems;image fusion;image segmentation;image sensors;object tracking;particle filtering (numerical methods);sport;GIS-centric computer vision system;GIS-centric optical tracking system;GIS-like image rectification method;camera calibration;client-server application;competition situation;geometric model;high-

speed skater tracking;lap simulator;particle filter dynamic model;physical model;power-based model;shared database access;short track speed skating;spatial SQL database access;spatio-temporal trajectories;sport domain;track completion;track fusion;track selection;training situation;Calibration;Cameras;Computational modeling;Image color analysis;Optical imaging;Tracking;Trajectory;GIS;camera calibration;image rectification;segmentation;tracking},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6569215&isnumber=6569168>

V. Guizilini and F. Ramos, "Visual odometry learning for unmanned aerial vehicles," *2011 IEEE International Conference on Robotics and Automation*, Shanghai, 2011, pp. 6213-6220.

doi: 10.1109/ICRA.2011.5979706

Abstract: This paper addresses the problem of using visual information to estimate vehicle motion (a.k.a. visual odometry) from a machine learning perspective. The vast majority of current visual odometry algorithms are heavily based on geometry, using a calibrated camera model to recover relative translation (up to scale) and rotation by tracking image features over time. Our method eliminates the need for a parametric model by jointly learning how image structure and vehicle dynamics affect camera motion. This is achieved with a Gaussian Process extension, called Coupled GP, which is trained in a supervised manner to infer the underlying function mapping optical flow to relative translation and rotation. Matched image features parameters are used as inputs and linear and angular velocities are the outputs in our non-linear multi-task regression problem. We show here that it is possible, using a single uncalibrated camera and establishing a first-order temporal dependency between frames, to jointly estimate not only a full 6 DoF motion (along with a full covariance matrix) but also relative scale, a non-trivial problem in monocular configurations. Experiments were performed with imagery collected with an unmanned aerial vehicle (UAV) flying over a deserted area at speeds of 100-120 km/h and altitudes of 80-100 m, a scenario that constitutes a challenge for traditional visual odometry estimators.

keywords: {aircraft;distance measurement;image sequences;learning (artificial intelligence);regression analysis;remotely operated vehicles;Gaussian process;calibrated camera model;camera motion;coupled GP;function mapping optical flow;geometry;image features tracking;image structure;machine learning;nonlinear multitask regression problem;unmanned aerial vehicles;vehicle dynamics;vehicle motion;visual information;visual odometry learning;Cameras;Covariance matrix;Optical sensors;Training;Vehicles;Visualization},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5979706&isnumber=5979525>

P. C. Womble *et al.*, "A Pressurized Tank Car Inspection System for Railroad Transportation Security," *2007 IEEE Conference on Technologies for Homeland Security*, Woburn, MA, 2007, pp. 19-24.

doi: 10.1109/THS.2007.370013

Abstract: Pressurized rail tank cars transport large volumes of volatile liquids and gases throughout the country, much of which is hazardous and/or flammable. Our group is developing a trackside inspection system for these tank cars. It consists of five narrow frequency band pressure sensors with center frequencies of 40 and 75 kHz, a broad band microphone for sound normalization and three video cameras. In addition, a 5 cm times 5 cm NaI(Tl) radiation detector provides radiological data on the passing trains every 60 seconds. During operation, an audio frequency spectrum is associated with each frame of the video camera as the train passes by the system at normal speeds, and the spectra are inspected for high frequency sounds associated with leaks. A 10 m tall tower houses the system positioned approximately 10 m from the center of a rail line and siding located in Bowling Green, KY (USA). The system is controlled by a website and server located at the tower and the Internet connection utilizes WiFi (802.11 g) radios.

keywords: {Internet;automatic optical inspection;computerised monitoring;hazardous materials;pressure sensors;radiation detection;railways;security;wireless LAN;Internet connection;WiFi radios;audio frequency spectrum;broad band microphone;narrow frequency band pressure sensors;pressurized rail tank cars;pressurized tank car inspection system;rail line;railroad transportation security;sound normalization;trackside inspection system;video cameras;volatile liquids;Cameras;Flammability;Frequency;Gases;Inspection;Liquids;Poles and towers;Rail transportation;Road transportation;Security},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4227776&isnumber=4227766>