Photogrammetry Helps Reduce Incident Clearance Time at Crash Sites, But Requires Investment in New Equipment and Training

Prepared by Ken Winter, May 2007

KEY SEARCH TERMS:

Photogrammetry
Accident Reconstruction
Accident Investigation

Research Synthesis Bibliography No. 8

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**Accident Reconstruction Product Overview**

ABSTRACT: This article lists books, software and other products useful to accident reconstructionists. While by no means a complete list, this listing should make the reconstructionist aware of the wide range of products and services available. The list is organized by the following categories: Encyclopedias/Databases; Books; Research/Reference Sources; Accident Reconstruction Computer Programs; Computer Animations; Measurement, Mapping Devices and Photogrammetry; Vehicle Performance Measuring Equipment; and Miscellaneous. Note: Page range: pp 28-30, 32-33, 35-40.
ACCESS: Available to VDOT employees through Interlibrary Loan.

**Accident Reconstruction. (Latest Citations from the Ei Compendex Plus Database)**

CITATION: NERAC, Incorporated, 1 Technology Drive, Tolland, CT, 06084-, USA., 1994.
ABSTRACT: The bibliography contains citations concerning modeling techniques and other methods of reconstructing traffic and aircraft accidents. Topics include photogrammetry, forensic evidence, impact computer programming, stereoscopic and video animation, and mathematical modeling. The accident of the space shuttle, Challenger, is specifically referenced. (Contains a minimum of 68 citations and includes a subject term index and title list.). Note: SO: 1994/07.; NT: 68 citations minimum. Updated with each order. Sponsored in part by National Technical Information Service, Springfield, VA.; SC: SAFETY (H51); SAFETY (A19); ACCIDENT-STUDIES (I80).
ACCESS: Available to VDOT employees through Interlibrary Loan.

**Accident Scene Diagramming Using New Photogrammetric Technique**

ABSTRACT: One of the challenges for accident reconstructionists is creating accurate accident scene diagrams from photographs. The biggest challenge is when only one photograph is available, and information about the camera that took the photograph is not available. A unique technique is presented that enables the user to create an accurate accident scene diagram from only one unknown photograph of the accident scene, by using a combination of processes called Inverse Camera Projection and Photographic Rectification. Inverse Camera Projection allows the user to determine the unknown camera characteristics, which then through Photographic Rectification, the photograph can be rectified and traced to create accurate scene diagrams. (A) For the covering abstract of the conference see IRRD 899758.
Note: SO: SAE PUBLICATION SP-1237.
ACCESS: Available to VDOT employees through Interlibrary Loan.

**Accident Scene Photogrammetry With Observations On The Use And Misuse Of Telephoto Lenses**

ABSTRACT: The camera reverse-projection method of accident reconstruction is utilized to determine the critical features of a particular accident scene at the time of the accident. Given one or more photographs of an accident scene, it is possible to measure precisely all topographical features in order to provide input for detailed computerized accident reconstruction, or to serve as a basis for vehicle/scene testing. In addition, evidentiary
photographs, as offered, may be either validated or discredited by means of careful comparison with cels of a given subject as it actually appears to the eye. By this means, it can be determined whether photographic manipulation has occurred, inadvertently or otherwise, and any interpretive misimpressions can be minimized.

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**Accuracy Of Three-Dimensional Photogrammetry As Established By Controlled Field Tests**

CITATION: M. D. PEPE, J. S. Sobek and D. A. Zimmerman. , Accident Reconstruction: Technology And Animation III, 1993. Pg. 20 P.

ABSTRACT: Photogrammetry is the science of obtaining spatial information from photographs given a set of key reference points. Vehicular accident reconstruction frequently requires using the photogrammetric process to obtain dimensions of such items as skid mark length, vehicle rest positions, or depth of vehicle crush. This paper briefly describes the generalized three-dimensional photogrammetric process. Findings show the accuracy of this process when applied to simulated reconstruction situations involving skid marks and vehicle crush. Three sets of photographs of simulated skid marks and one of vehicle crush were analyzed photogrammetrically, and results were compared to a blind set of survey data. The comparison between the survey data and photogrammetry calculations are presented in graphical form.

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**Adapting Three-Dimensional Animation Software For Photogrammetry Calculations**


ABSTRACT: A new method for computer-based photogrammetry in accident reconstruction is presented. CAD software is used to product three-dimensional models of the site, vehicles, and other objects important in the incident. Objects of known configuration are incorporated into the scene model, and a perspective view is created that corresponds to the photograph. Then the objects of unknown position are added, and these are translated and rotated until they match the photograph. The result is a three-dimensional computer model of the site geometry, from which positional information may be extracted by examining the top, front, and side orthographic views.

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**Advanced Accident Data Collection - Description and Potentials of a Comprehensive Data Collection System**

CITATION: Kamren B (Folksam Research And Chalmers University Of Technology, Sweden), V Koch M (Folksam Research And Chalmers University Of Technology, Sweden), Kullgren A (Folksam Research And Chalmers University Of Technology, Sweden), Et Al. , 1993. Thirteenth International Technical Conference On Experimental Safety Vehicles, November 4-7, 1991, Paris, France. Volume I. 1993/07. Pp41-45 (6 Refs.); ABSTRACT: The most important input for development and evaluation of crash protection is real life accidents data. The data is however time consuming to collect. The output is in relation to what can be measured in laboratory testing, primitive. Important parameters are often collected by untrained people as secondary task in the rescue work at the accident scene. The precision and accuracy of the data can therefore often be questioned and the possibilities to draw conclusions are often limited. The possibility of collecting high quality accident data can be dramatically increased by: (1) using modern technology, such as photogrammetric measurements of exterior and
interior of the vehicle deformations, cheap crash pulse recorders (CPR), and (2) training workshop and rescue personal. This presentation describes such a comprehensive system in terms of potentials and possible output, and a theoretical background for increasing precision of collected data. (A) For the covering abstract of the conference see IRRD 864606. SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91). ACCESS: Available to VDOT employees through Interlibrary Loan.

**Advanced Traffic Collision Investigation Course**

CITATION: California, Commission on Peace Officer Standards and Training and Training Delivery Services Bureau, 1990.

ABSTRACT: Course outline -- Advanced traffic collision investigation.; This document contains the legal reference, background, certification information, and course outline for the advanced traffic collision investigation course. The course outline provides basic guidelines for lesson plan preparation and course presentation. This course is designed to improve the students' skills and knowledge of the advanced techniques used to determine the sequence of events that result in a traffic collision and how to properly document the available information. The students will have the opportunity to become proficient in the following areas: Advanced collision photography and photogrammetry; Environmental examinations and collision scene measurements; Techniques for preparing scale diagrams; Vehicle systems and vehicle related collision factors; Human factors and mechanisms of injury; Mathematics, time-position analysis and freefall analysis. Note: Note(s): Caption title./ "June 1990."/ This course outline should be retained in the 1990 POST prescribed training courses manual.; Other Titles: POST prescribed training courses.; Entry: 20050622; Update: 20050622.

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**Advances in Safety Technology 1999**


ABSTRACT: This Society of Automotive Engineers (SAE) Special Publication is a collection of 15 papers from the Safety Technology session of the 1999 SAE International Congress and Exposition. Individual titles include the following: Equations for Speed, Time and Distance for Vehicles under Maximum Acceleration; A Validation Study for the Force Balance Method in Determination of Stiffness Coefficients; A Method to Evaluate the Energy Capability of Seat Belt Pretensioners; Digital Photogrammetry in Analysis of Crash Tests; Development of Simulation Model and Pedestrian Dummy; Reverse Engineering Method for Developing Passenger Vehicle Finite Element Models; Technological Evolution of the Airbag Safe Infant Seat; Injury Mitigating Benefits of an Inflatable Shoulder Belt for Seat Integrated Application; The Motor Vehicle in the Post-Crash Environment, An Understanding of Ignition Properties of Spilled Fuels; Field Investigation of Motor Vehicle Collision-Fires; The High Mounted Brake Lamp--The 4% Solution; European Side-markers Effect on Traffic Safety; Analysis of Concrete Median Barrier Impacts; Determination of Crash Severity Using a Ball-In-Tube and Accelerometer Sensing System (BASS); and Further Results on the Use of Magnetostrictive Sensors For Vehicle Crash Detection. RN: 0768003652; Report Number: SP-1433; Sc: Safety (H51); Vehicle-Characteristics (H53); Facilities-Design (H21); Road-Safety-Devices (I85); Vehicle-Design-And-Safety (I91); Facilities-Design (H21).

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**Advances In Safety Technology 1999**


ABSTRACT: This Society of Automotive Engineers (SAE) Special Publication is a collection of 15 papers from the Safety Technology session of the 1999 SAE International Congress and Exposition. Individual titles include the following: Equations for Speed, Time and Distance for Vehicles under Maximum Acceleration; A Validation Study for the Force Balance Method in Determination of Stiffness Coefficients; A Method to Evaluate the Energy Capability of Seat Belt Pretensioners; Digital Photogrammetry in Analysis of Crash Tests; Development of Simulation Model and Pedestrian Dummy; Reverse Engineering Method for Developing Passenger Vehicle Finite Element Models; Technological Evolution of the Airbag Safe Infant Seat; Injury Mitigating Benefits of an Inflatable Shoulder Belt for Seat Integrated Application; The Motor Vehicle in the Post-Crash Environment, An Understanding of Ignition Properties of Spilled Fuels; Field Investigation of Motor Vehicle Collision-Fires; The High Mounted Brake Lamp--The 4% Solution; European Side-markers Effect on Traffic Safety; Analysis of Concrete Median Barrier Impacts; Determination of Crash Severity Using a Ball-In-Tube and Accelerometer Sensing System (BASS); and Further Results on the Use of Magnetostrictive Sensors For Vehicle Crash Detection.

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**Aggressive Driving on Urban Freeways : Research Sheds Light on Causes and Promising Solutions**


ABSTRACT: Researchers studied the elements that lead to aggressive driving on freeways. Surveys showed that over half the complaints by drivers centered on merge-related behaviors, such as weaving in and out of traffic, not allowing others to merge and not paying attention in merge areas. One technique being tested is a late merge, which uses signing to encourage drivers to use all available lanes to the merge point and then take turns. It suggests that late merging reduces onset of congestion and shortens the queue overall. Other techniques include speeding incident clearance by measure accident sites with photogrammetry, which is much faster than convention methods, and restriping one bottleneck section to make it into two lanes instead of one.

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**Analytical Applications of 3-D Imaging in Vehicle Accident Studies**


ABSTRACT: Three-dimensional (3-D) computer imaging and animation have been widely used in industrial design. The use of computer imaging and animation for illustration in the court room has been widely recognized. Three-dimensional computer animation also has analytical uses that apply to the accident reconstruction field. It can be used to evaluate visibility, timing of complex motions, and is helpful in correlating vehicle damage to ground strikes. Used in concert with photogrammetry, 3-D imaging can be very useful in determining the positions of objects pictured at the accident scene. (A) For the covering abstract of the conference see IRRD 898597. Note: SO: SAE PUBLICATION SP-1150.

ACCESS: Available to VDOT employees through interlibrary loan.
Application and Misapplication of Computer Programs for Accident Reconstruction


ABSTRACT: Several Computer Programs Are Used By Accident Investigators To Reconstruct Motor Vehicle Accidents. These Programs Are Seen As Valuable Tools By Most Investigators. However, It Is Also Clear The Programs Are Sometimes Misused. This Paper Addresses Five Different Types Of Computer Programs Used By Accident Investigators And Discusses Their Proper And Improper Use. Most Frequently, Misuse Is Due To The Lack Of A Thorough Understanding Of How The Programs Work. A Series Of Recommendations Is Presented To Help Investigators Properly Use The Programs.(A) For The Covering Abstract Of The Conference See IRRD 823668. Note: So: Rn: 0-89883-434-1; Sc: Accident-Studies (80).

ACCESS: Available to VDOT employees through interlibrary loan.

Application of Photogrammetry to Accident Reconstruction


ACCESS: Available to VDOT employees through Interlibrary loan.

Band Information Reconstruction from a Single Photo - a Superimposed Method


ABSTRACT: To interpret the information on a two-dimensional (2-D) image of a 3-D world in order to determine the displacement of the 3-D objects portrayed in the image, this study superimposes the 2-D image on another photo. This photo is taken from the same site and includes some additional objects with well defined dimensions. In this synthetic image, those added objects serve as a datum. Mathematical functions are then used to evaluate the true size of any object in the image. In the computerized photogrammetry method proposed, other than the need for an additional photo with known-dimension poles in it and the required adjustment on the direction and distance of this photo to suit for the target one, there is no extra field measurement necessary, nor is any adjustment introduced in the computational process. (A) For the covering abstract of the conference see IRRD 898597. RN: 1-56091-780-6; SC: ACCIDENT-STUDIES (80).

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Brief Communications and Research Notes: Photogrammetry for Documentation of Vehicle Deformations - a Tool in a System for Advanced Accident Data Collection


ABSTRACT: Vehicle deformations are important sources for information about the performance of safety systems. Photogrammetry has developed vastly under recent years. In this study modern photogrammetrical methods have been used for vehicle deformation analysis. The
study describes the equipment for documentation and recording in the field (semi-metric camera), and a system for photogrammetrical measurements of the images in laboratory environment (personal computer and digitizing tablet). The material used is approximately equal to 500 collected and measured cases. The study shows that the reliability is high and that accuracies around 15mm can be achieved even if the equipment and routines used are relatively simple. The effects of further development using video cameras for data capture and digital images for measurements are discussed. (Author/publisher). SC: ACCIDENT-STUDIES (80).
ACCESS: Available to VDOT employees through Interlibrary loan.

A Case Comparison Of Single-Image Photogrammetry Methods
ACCESS: Available to VDOT employees through Interlibrary loan.

A Close-Range Photogrammetry Data Acquisition System For Traffic Accidents
CITATION: M. T. Obaidat. , Publication of: Swedish National Road and Transport Research Institute, 2000. Pg. p. 143-156.
ABSTRACT: This paper describes a stereometric, close-range photogrammetry data acquisition system developed to collect and process traffic accident data using a digital image-based format. The system was developed for processing and analysis of data through the use of off-the-shelf hardware components and video technology. It is capable of rapidly transferring field data to a personal computer and producing accurate 3-D measurements and graphical display.
ACCESS: Available to VDOT employees through Interlibrary loan.

Computer Assisted Single-View Photogrammetry For Accident Scene Documentation
ABSTRACT: Accurate documentation of traffic accidents is a prerequisite for accident research as well as traffic jurisdiction. As an important part of accident documentation, stereo-photogrammetry is recognised to be an excellent tool for providing accurate and complete scaled maps of accident scenes. However, due to its relatively high expense, it is usually only applied in cases of severe accidents. In contrast, single-view photogrammetry which is based on photographs taken with "non-metric" cameras and on on-the-job calibration requires little installation at the accident scene and provides adequate accuracy, because camera calibration and plotting of scaled maps can be performed by making use of computer-assisted image analysis. As the method basically consists in a simple perspective rectification single-view photogrammetry as such is restricted to plane accident sites. In this paper the method is
Digital Photogrammetry in Analysis of Crash Tests

CITATION: Rentschler W and Uffenkamp V. , 1999. This paper was presented in the Safety Technology session of the 1999 SAE International Congress and Exposition and is included in the SAE Special Publication, "Advances in Safety Technology 1999" (SP-1433).; Sponsored by: Society of Automotive Engineers. Held: 19990301-19990304. SAE Special Publications. 1999/03. pp31-41 (8 Phot., 9 Fig., 3 Ref.).
ABSTRACT: A new optical system to analyze three-dimensional deformations on crashed vehicles is in use at Porsche's Crash Test Facility. This technology is based on the mathematical law that the spatial location of a point is clearly definable if it is represented by at least two images. With the help of a high resolution digital camera, highly developed image processing, and photogrammetric algorithms, an automated deformation analysis system is realized. This new measurement technology has numerous advantages over conventional devices, such as coordinate measurement machines, multisection arms, and analog photogrammetry. In one example of crash tests, the application of this system is described. Comparisons with conventional measurement devices regarding accuracy, costs, and process optimization are presented. An outlook to further innovations in analysis of safety tests, if photogrammetry is used as a basic technology, is given. Note: SO: Conference Title: 1999 SAE International Congress and Exposition. Location: Detroit, Michigan. NT: RN: 0768003652; Report Number: 1999-01-0081; SC: SAFETY (H51); ACCIDENT-STUDIES (I80).
ACCESS: Available to VDOT employees through Interlibrary loan.

Digital Rectification Of Reconstruction Photographs

ACCESS: Available to VDOT employees through Interlibrary loan.

Discussion of "Photogrammetry for Documentation of Vehicle Deformations - a Tool in a System for Advanced Accident Data Collection"

CITATION: Smith Gc (Collision Safety Engineering, Utah). , 1992. So: Proceedings Of The Thirty-Sixth Annual Conference Of The Association For The Advancement Of Automotive Medicine, October 5-7, 1992, Portland, Oregon, Usa. 1992. Pp75-82 (27 Refs.); ABSTRACT: The aspects of photogrammetry presented in the paper on "Photogrammetry for Documentation of Vehicle Deformation - A Tool in a System for Advanced Accident Data Collection" (See IRRD 857291) are not disputed. A brief discussion of past and present pursuits of photogrammetry in automobile accident data collection are given, along with a list of references. Some unsupported statements about accident severity measurement and passenger safety are challenged. For the covering abstract of the conference see IRRD 857287. Note: SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91).
ACCESS: Available to VDOT employees through Interlibrary loan.

Evaluating Driver Behavior And Safety With GPS Event Recorders And GIS

ABSTRACT: Georgia Tech is currently undergoing a 3-year project funded by the National Highway Traffic Safety Administration investigating the relationship between driver speed behavior and crash probability. Vehicles in Atlanta are currently being instrumented with an event data recorder that is collecting second-by-second digital global positioning system (DGPS) position (plus dead reckoning for urban canyons), and sub-second speed and accelerations. Given the nature of the intensive data collection plan (1000 vehicles for a two year period), the data will also be used to evaluate a number of other transportation issues including travel behavior, driver behavior, and road segment operations. The data will be summarized by household, person, vehicle, trip type, and road segment. Vehicle path and traveled road segments will be identified through a combination of vehicle heading change and shortest path routines between known crossings. This paper will present the management, geographic information system (GIS) processing, and analysis of the positional information.

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ONLINE: http://www.gis-t.org/yr2002/gist2002sessions/4.2.2.pdf

Evaluation of Methods to Limit the Time Taken to Investigate Crash Sites


ABSTRACT: Highway crashes have significant direct and indirect costs associated with them. Substantial sources of indirect costs are the congestion and delays that result from lane blockages or road closures while the crash is being investigated and the site cleared. In many cases, vehicles could be moved and roadways reopened very quickly, but this does not occur because of the need (or perceived need) to conduct a detailed investigation of the crash site. The objective of this study was to identify opportunities to reduce the time required to investigate and clear crash scenes. This project includes a review of state and national best practices with a specific, detailed examination of the use of photogrammetry for reconstruction. Recommendations are presented to reduce time to investigate crash sites.

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ONLINE: http://www.ktc.uky.edu/Reports/KTC_05_15_SPR_280_04_1F.pdf

An Evaluation of Rectified Bitmap 2d Photogrammetry with PC-Rect


ABSTRACT: Without good-quality measurements taken at the time of an accident the analyst is faced with the need to extract measurement data from incident scene photographs. This paper discusses the history and development of the mathematical model for two-dimensional (2D) single exposure analytical photogrammetry, presents the PC-Rect software, and compares the analytical results obtained with PC-Rect to survey results. The sensitivity of the analytical results to the variation in such parameters as subject distance, camera height, digital photograph resolution, and bitmap density is discussed. The concept of using the directly rectified scanned photograph in the reconstruction task is introduced, and the utility of performing the dynamic simulation directly on the rectified photograph is discussed. (A) For the covering abstract of the conference see IRRD 899758. RN: 1-56091-949-3; SC: ACCIDENT-STUDIES (80).

ACCESS: Available to VDOT employees through Interlibrary loan.
Factors Affecting The Accuracy Of Non-Metric Analytical 3-D Photogrammetry, Using Photomodeler


ABSTRACT: In this study, specific variables affecting the accuracy of three -dimensional (3-D), non-metric, analytical photogrammetry were studied using the commercially available software package, Eos Systems' PhotoModeler. The 3-D coordinates of targets on a vehicle were first surveyed, and then photographed with standard 35 mm camera equipment. The knowledge of camera properties, the method of image generation, photograph cropping, use of fiducial markings, and the number of control points were investigated to determine their relative effects on the accuracy of the solved coordinates. The number of control points and the amount of image cropping had the largest individual effects on the overall accuracy. The most accurate cases were those with many control points, no image cropping, camera calibration, use of Kodak Photo CD image generation, and use of fiducial markings. For the covering abstract of the conference see IRRD E201455. RN: 0-7680-0339-3; SC: ACCIDENT-STUDIES (80).

ACCESS: Available to VDOT employees through Interlibrary loan.

Field Application Of Photogrammetric Analysis Techniques : Applications Of The FOTOGRAM Program


ACCESS: Available to VDOT employees through Interlibrary loan.

General Calculation Programs for Reconstruction


ABSTRACT: This paper describes and assesses two general calculation programs for performing simple general physics calculations, that are useful in reconstructing accidents from data. Collision Calculator is produced by Joe Coyle and Associates, USA, runs on the Apple Macintosh, and is compatible with Apple's System 7 operating system. It is designed for users trained in accident reconstruction. It can perform any of a range of calculations selected by its user. It is unfortunately based on Imperial units and seems to have no metric version. A-I-Calc Version 2.0 is produced by the Traffic Institute of Northwestern University, Evanston, IL, USA, for use on IBM-compatible personal computers under MS-DOS. In addition to basic accident reconstruction calculations, it can handle photogrammetry, kinetic energy, velocity from energy, energy from skidding, and barrier equivalent energy from 'C' measurements. Both programs have the following features: (1) use of equations supplied by the Northwestern University Traffic Institute; (2) very quick loading and calculations; and (3) cost of about US$ 75, which is good value for money. However, A-I-Calc has a much less friendly user interface. Note: SC: ACCIDENT-STUDIES (80).

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In-Situ Measuring Techniques for Road Traffic Accidents and the Development

CITATION: Wang Fengyuan (Shandong Engng Inst), Sun Zhuangzhi (Shandong Engng Inst), Gao Fan (Traffic Police, Zibo, Shandong Prov, China), Et Al. , 1998 Note: So: Journal Of
An Introduction To Desktop Photogrammetry
ABSTRACT: This article describes a method for making direct measurements from photographs. Off-the-shelf software may be used to transform a scanned photograph from an oblique view with perspective, to a bird's-eye or vertical view. Once the photograph is transformed one may make measurements directly from the bird's-eye image. This method can be used on personal computer systems typically found at home, in the office, or at desktop computer rental services. The accuracy of this method ranges from 1 percent to 5 percent typically and depends mainly on the quality of the photograph. This method is useful in two important areas. The first is when a photograph is the only information one has about parts of an accident scene. The second case is when it is difficult or impossible to enter the scene to make measurements.
ACCESS: Available to VDOT employees through Interlibrary loan.

A Method of Rapid Surveying and Mapping of Road Traffic Accident Sites
ABSTRACT: This paper introduces a photogrammetric method for the surveying of road traffic accident sites by using a common camera and the method for mapping them by using a microcomputer. It is based on the measurement theory of proportional photography. This method requires less time and energy than that of manual surveying, and overcomes the weakness of slow speed and poor quality of manual mapping. The method is cheap and easy to be used. The accuracy is in accordance with individual requirement and the map can be used as a proof in court. Note: SC: ACCIDENT-STATISTICS (81).
ACCESS: Available to VDOT employees through Interlibrary loan.

Motorway Fast Aid
ABSTRACT: Trials of equipment designed to reduce the time UK motorways are closed after accidents are being conducted by TRL on behalf of the Highways Agency. The equipment includes the latest version of Total Station, an electronic version of a surveyor's theodolite. This speeds up the measurement of distances and angles between vehicles involved in accidents. Also being trialled is a photogrammetry device which can take measurements from photographs of accident scenes. A new laser scanner previously used for investigating railway accidents is also under test. Data from the accident can then be processed in the laboratory rather than while the motorway remains closed, reducing the period of congestion and its associated costs. Trials of screens to prevent drivers on the opposite carriageway slowing
down to look at accidents are also described. Sc: Personal-Injuries (84); Accidents-And-The-
Human-Factor (83); Accidents-And -The-Road (82); Traffic-Control (73).
ACCESS: Available to VDOT employees through Interlibrary loan..

A New Application of Camera Reverse Projection in Reconstructing Old Accidents
CITATION: Main Bw (Miller Engineering, Inc.) And Knopf Ea (Miller Engineering, Inc.). , 1995. .
Note: So: Sae Publication Sp-1083. Accident Reconstruction: Technology And Animation V.
Proceedings Of The International Congress And Exposition, February 27-March 2, 1995,
ABSTRACT: Engineers frequently are faced with reconstructing vehicular accidents based on
limited information, especially when vehicles have been destroyed, witnesses are lost, etc.
Accident scene photographs are often the key independent record of what occurred in an
accident. One photogrammetry method engineers use to reconstruct accidents is camera
reverse projection. This paper presents an extension of camera reverse projection that can be
used for accidents where neither the accident scene nor the vehicle is accessible. The
 technique involves creating models of the vehicles and the scene which can then be used to
obtain measurements for reconstructing an accident. The technique is described in detail and a
 case study is used to illustrate the method. The primary benefits of the method include
flexibility in use, intuitive approach, and assistance in sorting out complex vehicular dynamics.
(A) For the covering abstract of the conference see IRRD 882390RN: 1-56091-633-8; SC:
ACCIDENT-STUDIES (80).
ACCESS: Available to VDOT employees through Interlibrary loan.

Photogrammetric Solution for Vehicle-Damage Investigation
ABSTRACT: Photogrammetry is found to be a practical solution for vehicle-damage
investigation. The paper describes a low investment cost, and low operational cost system
with simple operation, and requiring only minimal data processing procedures. It is based on
the stereo-camera concept and the enlarger -digitizer procedure. The system uses off-the
shelf components for both data acquisition and evluation. Note: SO: Journal of Transportation
Engineering. 1992/11. 118(6) pp850-865 (Figs., Tabs., Refs., 1 App.); SC: ADMINISTRATION
(H11); SAFETY (H51).
ACCESS: VDOT Research Library, Periodicals Section.

Photogrammetric Analysis Using A Personal Computer
ABSTRACT: N/A Note: Janet Brelin, M. Holcomb And W. Cichowski Ill., Charts Includes
Bibliographical References Note: Source Is Monographic, Not A Series North American
Conference On Microcomputers In Transportation 1987 : Boston, Mass Microcomputer
Applications In Transportation II.
ACCESS: Available to VDOT employees through Interlibrary loan.

Photogrammetric Measurement of Damaged Vehicles in Road Traffic Accidents
CITATION: Lie A (Metimur Ab), Tingvall C (Folksam), Johansson S, Et Al. , 1990. Twelfth
International Technical Conference On Experimental Safety Vehicles, Gothenburg, Sweden, 29
ABSTRACT: Measurements of damaged vehicles for description and classification of collision
types and accident severity is important in the field of vehicle safety. The measurements are
used in both descriptive as well as analytical research. It is essential that the measurements
are of adequate quality both in terms of the quality of measurements taken on each vehicle as well as the single value. It is however often impossible to get such data in a large scale data collection as the measurements must be conducted by only partly trained data collectors. Further more, it is normally impossible to get back to the damaged vehicle afterwards to add other measurements. In this paper a technique is described using arbitrarily taken photographs of damaged vehicles involved in road traffic accidents. By using modern picture evaluation of adequate quality it is possible to use fairly simple techniques based on personal computers. The damage to one car is analyzed together with manually taken measurements to assess the quality and time spent for the analysis. For the covering abstract of the conference, see IRRD 837684. Note: SO: SC: ACCIDENT-STUDIES (80).

**Photogrammetric Methods in Crash Investigation**


ABSTRACT: A new system developed in Sweden, jointly between Folksam Insurance and Chalmers University of Technology, allows photogrammetry to be conducted on vehicles to determine deformation. The system requires minimal training in both taking photographs and in their subsequent analysis. This paper outlines the photographic procedures used and developed for an indepth crash study using such a system, to minimise on scene inspection time and maximise data collection. It outlines the advantages and disadvantages, as well as future enhancements of the system. [A] For the covering abstract, see IRRD 896528. Note: SO: SC: ACCIDENT-STUDIES (80).

**Photogrammetric Model And Technology Used In Road Traffic Accident Scene Measurements**


**A Photogrammetric On-Orbit Inspection For Orbiter Thermal Protection System**


ABSTRACT: Due to the Columbia Space Shuttle Accident of February 2003, the Columbia Accident Investigation Board determined the need for an on-orbit inspection system for the Thermal Protection System that accurately determines damage depth to 0.25". NASA contracted the Spacecraft Technology Center in College Station, Texas, for a proof-of-concept photogrammetric system. This system involves a high quality digital camera placed on the International Space Station, capable of taking high fidelity images of the orbiter as it rotates through the Rendezvous Pitch Maneuver. Due to the pitch rotation, the images are tilted at different angles. The tilt causes the damage to exhibit parallax between multiple images. The tilted images are therefore registered to the near-vertical images using visually striking features on the undamaged surface of the Thermal Protection System that appear in multiple images taken at different tilt angles. The images become relatively oriented after registration, and features in one image are ensured to lie on the epipolar line in the other images. Features that do not lie on the undamaged surface, however, are shifted in the tilted images. These
pixels are matched to the near-vertical image using a sliding-window area-matching approach. The windows are matched using a least-squares error method. The change in location for a pixel in a tilted image from its expected location on the undamaged surface is called the pixel disparity. This disparity is linearly scaled using the tilt angle and the pixel sampling to determine the depth of the damage at that pixel location. The algorithm is tested on a set of damaged tiles at the Johnson Space Center in Houston and the photogrammetric damage depth is then compared to a set of truth data provided by NASA. The photogrammetric method shows promise, with the 0.25" error limit being exceeded in only a few pixel locations. Once the camera properties are fully known from calibration, this systematic error should be reduced. Note: Dissertation: Thesis (M. S.)--Texas A&M University, 2005.; System Info: Mode of access: World Wide Web.; System requirements: World Wide Web access and Adobe Acrobat Reader.; Note(s): "Major Subject: Aerospace Engineering"/ Title from author supplied metadata (automated record created on Apr. 14, 2006.)/ Vita./ Abstract./ Includes bibliographical references.; Responsibility: by Peter Paul Gesting.; Date of Entry: 20060502; Update: 20060502. ACCESS: Available to VDOT employees through Interlibrary loan.

Photogrammetric Recording Of Accident Scene Information
ACCESS: Available to VDOT employees through Interlibrary loan.

Photogrammetric Solution for Vehicle-Damage Investigation
Note: ill. ; 22 cm; (OCoLC)8674831; Note(s): Includes bibliographical references (p. 864-865).;
ABSTRACT: N/A.
ACCESS: Available to VDOT employees through Interlibrary loan.

A Photogrammetric System For Motor Vehicle Accident Investigation.
ABSTRACT: The study consisted of fabricating a twin camera stereometric unit mounted on a portable carrier with 36 in spacing for the camera lenses. The unit was calibrated and its net accuracy capabilities were determined. A variety of applications were studied including: Mapping the site of the accident both 'on scene' with evidence present, and 'on site' after evidence was removed; photographing a vehicle in an effort to determine the qualitative data (type of damage) and quantitative data (specific measurements) available for study at any time the photographs are to be reviewed; and photographing a victim of an accident seeking qualitative and quantitative data. Major emphasis for the study centered around utilization problems and potential contributions to multidisciplinary studies.
ACCESS: Available to VDOT employees through Interlibrary loan.
**Photogrammetry And Accident Reconstruction : Experimental Results**


ABSTRACT: N/A

ACCESS: Available to VDOT employees through Interlibrary loan.

**Photogrammetry and the Art of Motor Vehicle Analysis**


ABSTRACT: A brief description of the science and art of photogrammetry is presented and its application to the analysis of motor vehicle accidents highlighted. A review of overseas experiences with the use of photogrammetry to gather detailed evidence at crash sites is undertaken, with emphasis placed on the well-documented situation in Japan. The method of recording scenes using the photogrammetric technique is described and some practical hints and a check -list included. The non-acceptance of modern digital techniques by authorities in Australia is questioned and discussed. (a) For the record of the covering entry of this conference, please see IRRD abstract no 868510. RN: 0-86856-989-5; SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91).

ACCESS: Available to VDOT employees through Interlibrary loan.

**Photogrammetry for Documentation of Vehicle Deformations - a Tool in a System for Advanced Accident Data Collection**


ABSTRACT: Vehicle deformations are important sources for information about the performance of safety systems. Photogrammetry has developed vastly under recent years. In this study modern photogrammetrical methods have been used for vehicle deformation analysis. The study describes both the equipment for documentation and recording in the field (semi-metric camera), and a system for photogrammetrical measurements of the images in the laboratory (personal computer and digitizing tablet). The material used is some 500 collected and measured cases. The study shows that the reliability is high and that accuracies around 15mm can be achieved even if the equipment and routines used are relatively simple. The effects of further development using videocameras for data capture and digital images for measurements are discussed. (A) For the covering abstract of the conference see IRRD 857287. SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91).

ACCESS: Available to VDOT employees through Interlibrary loan.

**Photogrammetry For Traffic-Accident Investigation**

Photogrammetry used for Measurement in Field Accident Studies - Development of a New Simple System


ABSTRACT: A photogrammetrical system has been developed and used for a couple of years on a large number of cases. In this paper, further development of the system is presented, where the time used on the field and in the measurement phase has been reduced. It is also shown how measured points are stored in the photographs, enabling a follow up of earlier measurements. As a complement to the measurement photographs video films from the field can be used for measurement. The video film can also be used for analysis of restraint use and documentation of contact points between the vehicle and the occupant. (A) For the covering abstract of the conference see IRRD 894848. Note: SO: SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91).

ACCESS: Available to VDOT employees through Interlibrary loan.

PMCAD: Photogrammetric-Based Cad System for Traffic Accident Mapping


ABSTRACT: Photogrammetry and 3-dimensional computer graphic work in symbiosis. PMCAD represents a successful attempt at integrating 3-dimensional computer graphic and analytical photogrammetry at an affordable cost for police work, archaeology, and architecture. This paper shows how such a photogrammetric -based CAD (PMCAD) system can be put together using low-cost, general purpose microcomputer equipment and the appropriate software. SC: SAFETY (H51); ACCIDENT-STUDIES (I80).

ACCESS: Available to VDOT employees through Interlibrary loan.

A Relative Orientation for Motor Vehicle Accident Photogrammetry


ABSTRACT: This paper describes modifications made to existing stereometric photography of a motor vehicle accident scene to allow its use in the Adam Technology MPS-2 microphotogrammetric system and the development of existing MPS-2 software to cope with the basic problems of motor vehicle accident photography during the relative orientation phase. Two problems have to be overcome: a) the fact that large portions of the image are featureless (for example, road surface or sky); and b) poor base:height ratio of points greater than 15 m from the cameras. The photography used for the study was of a motor accident scene consisting of 8 stereopairs of photographs covering a total of 20 cones. Seven stereopairs were taken along the centre line of cones 1 to 18 and one stereopair was taken centred on cone 4 normal to the centre line and covering 2 additional cones. The distance between adjacent cones was 10.00 m except that the distance between cone 4 and cone 19 was 7.00 m. The photography was taken with Wild C120 stereometric cameras elevated to a height of approximately 2.8 m above the road. Each cone was numbered and had an apex which was used as the observing point in the photograph. The most consistent results for the relative orientations were achieved with 12 pass points - six around the extremities and six in
the centre of the format. Systematic errors in the direction normal to the photography were detected. Two methods to correct these errors were investigated: a) scaling of the camera base and b) computing a camera convergence correction. The best results were achieved using Convergence Correction. SC: ACCIDENT-STUDIES (80).
ACCESS: Available to VDOT employees through Interlibrary loan.

Review of Close-Range Photogrammetry Applications in Bridge Engineering
ABSTRACT: Close-range photogrammetry has found many diverse applications in the fields of industry, biomechanics, chemistry, biology, archaeology, architecture, automotive, and aerospace, as well as accident reconstruction. Although close-range photogrammetry has not been as popular in bridge engineering as in other fields, the investigations that have been conducted demonstrate the potential of this technique. The availability of inexpensive, off-the-shelf digital cameras and soft-copy, photogrammetry software systems has made close-range photogrammetry much more feasible and affordable for bridge engineering applications. To increase awareness of this powerful non-contact, non-destructive technique, this paper reviews the basic development of close-range photogrammetry and applications in bridge engineering including deformation and geometry measurement; structural test monitoring; and historic documentation. The major aspects of photogrammetry bridge measurement are covered starting from the late 1970s and include a description of measurement types, cameras, targets, network control, and software. It is shown that early applications featured the use of metric film cameras (specially designed for photogrammetry purposes), diffuse targets (non-retroreflective), stereoscopic photogrammetry network layout, and analog analytical tools, which transformed over time to the use of non-metric cameras, retro-reflective targets, highly convergent network layout, and digital imaging and analysis. 15p (6 Fig., 1 Tab., 30 Ref.); SC: STRUCTURES-DESIGN-AND-PERFORMANCE (H25); DESIGN-OF-BRIDGES-AND-RETAINING-WALLS (I24).
ACCESS: VDOT Research Library, CD ROM TA 1001.5 T71a 2006

The Role Of ITS-Based Technologies In Incident Management
ABSTRACT: The Northern Ireland Roads Service has been reviewing developments in intelligent transport system (ITS)-based incident management techniques under the aegis of the EU-supported STREETWISE (Seamless Travel Environment for Efficient Transport in the Western Isles of Europe) project. Four examples of relevant technology improvements were identified. These include two hazard warning methods (COMPANION and intelligent road studs) and two developed for accident investigation (laser scanning and photogrammetry). The COMPANION hazard alert system uses electronic roadside beacons to warn drivers to slow down in advance of dangerous conditions ahead. Pilot sites at Munich, Germany, Verona, Italy and Edinburgh, UK characterised by a high proportion of heavy goods vehicles, congestion and a high risk of accidents are described. Trials of intelligent road studs from Astucia on a 3km test site on the approach to Junction 6 on the M8 in Scotland are described. Research by TRL on the potential of laser scanning in accident investigation is discussed. Photogrammetry, e.g. PMS's ELCOVISION system, enables the calculation of the real dimensions of an object appearing in a photographic image. SC: TRAFFIC-AND-TRANSPORT-PLANNING (72).
ACCESS: VDOT Research Library, Periodicals Section.
Safe And Quick Clearance Of Traffic Incidents: A Synthesis Of Highway Practice


ABSTRACT: This report is designed to assist transportation agencies in facilitating the safe and quick clearance of traffic incidents. These incidents range from vehicle disablements and minor crashes to major incidents requiring potentially significant clearance and investigation times. The report profiles laws, policies, and procedures for facilitating clearance of traffic incidents, primarily those initially blocking travel lanes and attended to by the vehicle operator, on highways in urban and rural areas. In recognizing the unique challenges faced by jurisdictions across the country, the study also reports on successful specific-site traffic incident clearance and investigative activities employed to quickly mitigate incidents of varying severity. The report discusses quick clearance legislation, hold harmless laws, and policies governing the removal of accident victims. Also discussed are the duties of private tow companies; various policies governing the rapid clearance of overturned semi-tractor trailers; appropriate actions to take when there is an accompanying fuel spill; and technologies used to provide for continual, uninterrupted flow of communications between agencies participating in incident clearance activities. Appendixes provide a copy of the survey questionnaire and various materials relating to quick clearance. Information for this report was derived primarily from a detailed survey questionnaire that was distributed to transportation and related agencies in all 50 states. The study also reports on an extensive literature review to identify laws, policies, and information campaigns supporting existing quick clearance practices.

ACCESS: VDOT Research Library, TA 1001.5 .N34 no.318

A Simple System For Data Acquisition And Photogrammetric Analysis In Traffic Accident Investigations


ABSTRACT: A simple method for the recording, documentation, and analysis of metric (measurable) traffic accident information using photogrammetric related techniques is presented. Using nonmetric cameras and perspective grid theory, this economical system will meet or exceed the quality of traffic accident diagrams prepared using conventional investigation survey techniques. Integrated procedures for stereoscopic coverage and extension from planimetric to three dimensional mensuration are developed. A literature review is included which describes the European use of stereometric systems applications to traffic accidents and their success with these systems. Reference is also made to courtroom admissibility of the accident diagrams and photography. Also, a pilot project conception is offered. This conception minimizes training burdens, can be initiated in phases and can be evaluated without disrupting current procedures. (Author). Note: Master’s thesis.
ACCESS: Available to VDOT employees through Interlibrary loan.

Simplified Photogrammetry For Traffic-Accident Investigation

ACCESS: Available to VDOT employees through Interlibrary loan.

Three Dimensional Computerized Photogrammetry and its Application to Accident Reconstruction
Three Dimensional Computerized Photogrammetry and its Application to Accident Reconstruction
ACCESS: Available to VDOT employees through Interlibrary loan.

A Three-Dimensional Visualization Approach to Traffic Accident Mapping
ABSTRACT: This paper describes the design and development of PMCAD II -- a system born out of an attempt to produce a low cost, simple to use, photogrammetric-based, three-dimensional (3D) computer graphics visualization system for traffic accident mapping. The traffic scene is restituted through the use of non-metric (or amateur) cameras, digitizing pad, and the direct linear transformation (DLT) algorithm. Object space coordinates driven are channeled to a microcomputer-based 3D drafting package to produce the shaded 3D traffic accident scene. Note: SOSC: VEHICLE-CHARACTERISTICS (H53).
ACCESS: Available to VDOT employees through Interlibrary loan.

ABSTRACT: This textbook has been expanded to provide current information on traffic accident investigation at the scene and in the technical follow-up stages. Included are elaborate step-by-step procedures for information gathering and recording, combined with 650 illustrations. Diagrams and forms are supplied to make work easier and more accurate. New sections cover lamp and tire examination, photogrammetry, and computer applications in
vehicle damage analysis. Law enforcement officers, attorneys, trainers, and students will find this volume to be the definitive guide to accident investigation.

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Traffic Collision Investigation


ABSTRACT: Foreword / J. Stannard Baker -- Preface -- Acknowledgments -- Chapter 1. Preparation for traffic collision investigation -- Chapter 2. Information from and about people -- Chapter 3. Information from vehicles -- Chapter 4. Information from roads -- Chapter 5. Measuring and mapping the collision site -- Chapter 6. Photographing the collision scene and damaged vehicles -- Chapter 7. Lamp examination for "on" or "off" in vehicle collisions -- Chapter 8. Tire examination after motor vehicle collisions -- Chapter 9. Photogrammetry for collision analysis -- Chapter 10. Understanding vehicle behavior in collisions -- Chapter 11. Highway/rail grade crossing collision investigation -- Glossary -- Index.; This textbook edition is a collection of the most important techniques and definitions essential for developing an accurate picture of motor vehicle collisions. This textbook is intended to aid investigators by providing them with necessary techniques for collecting information to save lives and reduce monetary losses due to automobile collisions. It is the culmination of 73 years of progressive development of a body of information on systematic traffic-accident investigation. The book contains multiple illustrations, diagrams, and sketches showing the various aspects of data collection and interpretation. The information collected in a collision investigation is used by administrators to make the highway transportation system safer, as data show that motor vehicle collisions kill more Americans between the ages of 1 and 19 than any other cause. This book contains 11 chapters covering the subjects of preparation for traffic collision investigation, information from and about people, information from vehicles, information from roads, measuring and mapping the collision scene, photographing the collision scene and damaged vehicles, lamp examination for "on" or "off" in vehicle collisions, tire examination after motor vehicle collisions, photogrammetry for collision analysis, understanding vehicle behavior in collisions, and highway/rail grade crossing collision investigation. In conclusion, it is noted that this book will contribute to the improvement of the investigation of motor vehicle related collisions, the prosecution and defense of those related to such events, and the protection of the public welfare. Note: Note(s): Rev. ed. of: The traffic-accident investigation manual / J. Stannard Baker, Lynn B. Fricke. 9th ed. [sic]. 1986./ "The eighth edition, was the first to be printed in two volumes .... This edition, the ninth, is the second edition of the two volume set”

ACCESS: Available to VDOT employees through Interlibrary loan.

TRANS4: A Traffic Accident Photogrammetric System, Description Of The System And Its Inherent Errors


ACCESS: Available to VDOT employees through Interlibrary loan.

The use of Electronic Survey Equipment in the Creation of Accident Scene Diagrams

CITATION: Rudney Df (Rudney & Sallmann Engineering, Ltd.) And Sallmann Dw (Rudney & Sallmann Engineering, Ltd.). , 1995. Sae Publication Sp-1083. Accident Reconstruction:

ABSTRACT: Accurate scene diagrams are essential to most accident reconstructions. Moreover, the scene diagrams make useful trial exhibits. Electronically Aided Survey Equipment (EASE) can aid the investigator and reconstructionist because it provides the following advantages over traditional measurement techniques: it is faster, it is more accurate; it eliminates transposing errors; it provides evaluation measurements, and it permits data to be directly imported into Computer Aided Design (CAD) or animation programs. This paper describes the proces from survey to diagram. Furthermore, reconstructionists can load data into a spreadsheet for greater analysis. The paper also covers how electronic survey and data logging can be useful in photogrammetry, in photographic reverse projection, and in obtaining elevations, roadway grades, cross slopes and curve radii for use in speed analysis. (A) For the covering abstract of the conference see IRRD 882390. RN: 1-56091-633-8; SC: ACCIDENT-STUDIES (80).

ACCESS: Available to VDOT employees through Interlibrary loan.

Use Of Photogrammetry For Investigation Of Traffic Incident Scenes
ABSTRACT: This task examined how the Texas Department of Transportation and police agencies might use photogrammetry to assist in the clearing of major incident scenes. Using the literature and surveys of police agencies currently using photogrammetry, the research team learned some basic information about the technology and theory behind photogrammetry and its application in the field. This letter report documents the findings of this literature review, provides some basic information on photogrammetry, and documents its applications by several police agencies throughout the United States and the world. The researchers learned that, for the most part, the use of photogrammetry in incidents is still largely in the testing phase. Preliminary and anecdotal results from interviews with law enforcement agencies are that photogrammetry is cost-effective (compared to a Total Station) as long as the necessary training for basic proficiency is provided. Some drawbacks to photogrammetry include more processing time by officers in the office, difficulty photographing long scenes, and difficulty seeing skid marks and other evidence at the scene without enhancing the scene photos.

Using Computer Reverse Projection Photogrammetry To Analyze An Animation
ABSTRACT: Computer reverse projection photogrammetry (CRPP) is a technique of using computer software to obtain information from images. Use of this process can facilitate the analysis of a computer animation that depicts the reconstruction of an accident. This paper defines several digital image analysis techniques with a focus on CRPP, and illustrates methods of employing their procedures. Specific aspects of animation validation and a description of the information needed to accurately complete an analysis are also described.
The computer software and hardware required to perform analyses for a variety of platforms are mentioned. (A) For the covering abstract of the conference see IRRD E201455. RN: 0-7680-0339-3; SC: ACCIDENT-STUDIES (80).
ACCESS: Available To VDOT Employees Through Interlibrary Loan.

**Using Digital Photogrammetry To Determine Vehicle Crush And Equivalent Barrier Speed (EBS)**
ABSTRACT: This paper presents a method of determining a vehicle crush and equivalent barrier speed (EBS) using digital photogrammetry. A state-of-the-art documentation technique called close-range photogrammetry allows engineers and accident reconstructionists to create three-dimensional (3-D) computer models of damaged vehicles utilizing photographs. Utilizing photogrammetric software, engineers can digitize accident scene photographs to create accurate 3-D computer models of the vehicles, which can be used to quantify structural damage sustained by the vehicles. Crush deformation can be quantified utilizing this process, and the resulting crush dimensions can be input into engineering software to determine a vehicle's EBS. (A) For the covering abstract of the conference see IRRD E201455. RN: 0-7680-0339-3; SC: ACCIDENT-STUDIES (80); VEHICLE-DESIGN-AND-SAFETY (91).
ACCESS: Available to VDOT employees through Interlibrary loan.

**Vehicle Accident Analysis and Reconstruction Methods**
ABSTRACT: The goal of this book is to aid in solving the most complex vehicle accident reconstruction methods using practical analytical techniques and useful scientific methods. The book represents an improvement in the level of quality and the presentation of reconstruction techniques of light and heavy vehicle crashes. The chapters include: Uncertainty in Measurements and Calculations; Tire Forces; Straight-Line Motion; Critical Speed from Tire Yaw Marks; Reconstruction of Vehicular Rollover Accidents; Analysis of Collisions, Impulse-Momentum Theory; Reconstruction Applications, Impulse Momentum Theory; Crush Energy; Frontal Vehicle-Pedestrian Collisions; Photogrammetry; and Vehicle Dynamic Simulation.
ACCESS: Available to VDOT employees through Interlibrary loan.

**A Video Tracking Photogrammetry Technique To Survey Roadways For Accident Reconstruction**
ABSTRACT: N/A
ACCESS: Available to VDOT employees through Interlibrary loan.