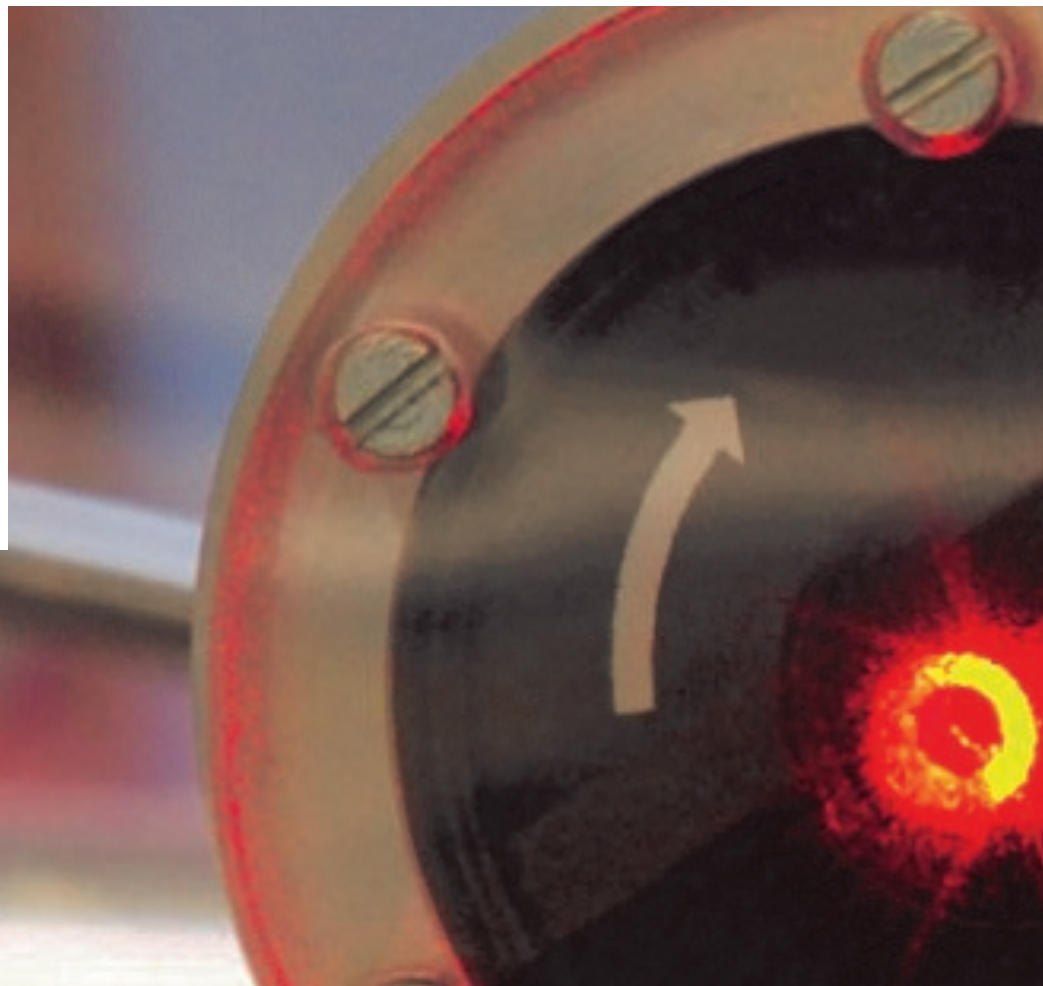
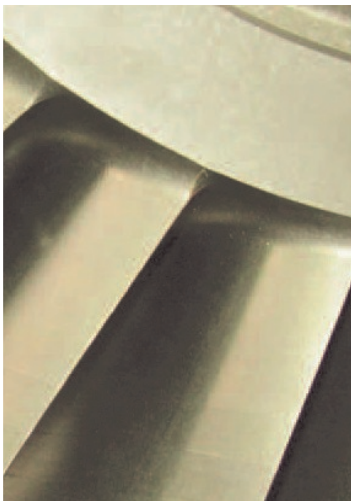


CSIR Pretoria Presents :

MEASURING BY LIGHT



International Meeting on Optical Measurement
Techniques and Industrial Applications

29 Nov - 1 Dec 2016

Pretoria, South Africa

In co-operation with :  **Polytec**



MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

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MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

WELCOME LETTER

Pretoria, 18 November 2016.

Dear Participant,

It is our pleasure to welcome you to the fifth edition of the "Measuring by Light" international meeting.

First held in 2013, the conference aims to provide a platform, where both industry and academics can discuss ground breaking optical measurement techniques and solutions, bridging needs and requirements for both.

Several renown speakers will illustrate that optical measurement techniques provide a means to advance the state-of-the-art in different technological domains.

This year's edition is hosted by the CSIR in Pretoria, in co-operation with the following partners :

- CSIR
- University of Pretoria
- NMISA
- Universiteit Antwerpen
- Polytec GmbH
- Polytec Benelux & South Africa

We are confident to provide you with a well balanced programme, introducing a variety of optical measurement techniques in different fields and applications.

Interaction and networking is an important element of the conference. Following the success of the first edition, there will again be a panel discussion and demo's showing different optical methods. In addition, this year we have short courses , explaining the basic principles and applications on Laser Doppler Vibrometry, Digital Image Correlation, Particle Image Velocimetry, Optical Coherence Tomography, Time of Flight Cameras and Optical Strain Gauges.

Finally, we would like to thank our exhibitors and co-organizers. Without them it would not be possible to keep the format of "Measuring by Light" free of charge to our participants.

We hope you will enjoy the programme.

On behalf of the MBL 2016 organizing committee.

Kris Peeraer.

MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

PROGRAMME OVERVIEW

Day 1 : 29th November

Short Courses / Lectures

- Basic principles & Applications of optical measurement techniques : Laser Doppler Vibrometry, Digital Image Correlation, Particle Image Velocimetry, Optical Coherence Tomography, Time of Flight Cameras, Optical Strain Gauges.

Demo Sessions

- Demo Sessions : Some of the discussed optical measurement techniques put into practice

Day 2 : 30th November Conference

09:00 - 09:30	Registration
09:30 - 10:00	Welcome & Opening
10:00 - 11:40	Keynote lecture 1
10:40 - 11:20	Coffee break
11:20 - 13:00	Presentations/Session 1
13:00 - 14:00	Lunch break
14:00 - 14:40	Keynote lecture 2
14:40 - 16:00	Presentations/Session 2
16:00 - 16:30	Coffee break
16:30 - 18:10	Presentations/Session 3
18:00 -	Reception & conference dinner

Day 3 : 1st December Conference

09:00 - 09:30	Welcome & Coffee
09:30 - 10:10	Keynote lecture 3
10:10 - 10:40	Coffee break
10:40 - 12:20	Presentations/Session 4
12:20 - 13:00	Panel discussion & closing words
13:00 - 14:30	Lunch break & Conference Closing

MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

DAY 1 DETAILED PROGRAMME

NOVEMBER 29

Short Courses : Lectures on the basics of different optical measurement techniques

9:00	9:20	Registration	
9:20	10:00	Basic principles of optical measurement techniques : overview	Steve Vanlanduit - Universiteit Antwerpen, Vrije Universiteit Brussel / Belgium
10:00	10:40	Basic principles : Digital Image Correlation & Particle Image Velocimetry	Alex Nila - LaVision / UK
10:40	11:00	Coffee break	
11:00	11:40	Basic principles : Laser Doppler Vibrometry & Laser Surface Velocimetry	Jochen Schell - Polytec GmbH / Germany
11:40	12:20	Basic principles : Material identification	Hugo Sol - Vrije Universiteit Brussel & Jun Gu - Bytec bvba / Belgium
12:20	13:20	Lunch break	
13:20	14:00	Basic principles : Optical Coherence Tomography	Aletta Karsten - NMISA / South Africa Ameeth Sharma - CSIR / South Africa
14:00	14:40	Applications : Condition monitoring & asset integrity management	Stephan Heyns - University of Pretoria / South Africa
14:40	15:00	Coffee break	

Demo Sessions : Rotation system in smaller groups/20-25 mins per session

15:00	17:00	Modal analysis	Elton Murison - ESTEQ / South Africa
15:00	17:00	DIC	Alex Nila - LaVision / UK
15:00	17:00	LDV	Jochen Schell - Polytec GmbH /
15:00	17:00	Rotational & tracking	Abrie Oberholster - University of
15:00	17:00	Time of Flight Cameras / Optical Strain Gauges	Elton Murison - ESTEQ / South Africa

MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

DAY 2 DETAILED PROGRAMME

NOVEMBER 30

Day 2 : Conference

9:00	9:30	Registration	
9:30	10:00	Welcome & Opening	Stephan Heyns - University of Pretoria / South Africa
10:00	10:40	Keynote lecture 1 Scanning Laser Doppler Vibrometer measurements for improved model validation of turbomachinery components	Martyn Maguire - Rolls Royce / UK
10:40	11:20	Coffee break	
11:20	13:00	Presentations : Session 1 Light and lasers as measurement tools in medical applications - a general overview Laser Doppler Vibrometry application overview Seismic imaging in laboratory trough laser Doppler vibrometry Time of Flight Cameras / Optical Strain Gauges	Aletta Karsten - NMISA / South Africa Jochen Schell - Polytec GmbH / Germany Daniel Brito - University of Pau / France Elton Murison - ESTEQ / South Africa
13:00	14:00	Lunch break	
14:00	14:40	Keynote lecture 2 Discovering Laser Doppler Vibrometry: 30 years of teaching and research	Enrico Primo Tomasini - Università Politecnica delle Marche / Italy
14:40	16:00	Presentations : Session 2 Photogrammetry as a verification tool for laser Doppler vibrometry Digital Image Correlation Sub-pixel in plane vibration measurements of structures without surface preparation	Abrie Oberholster - University of Pretoria / South Africa Alex Nila - LaVision / UK Dawie Diamond - University of Pretoria / South Africa
16:00	16:30	Coffee break	
16:30	18:10	Presentations : Session 3 Fully automated optical vibration measurements On the material property extraction using digital image and volume correlation CSIR develops a high speed OCT system for biometrics In situ quality control of beer bottles using LDV	Steve Vanlanduit - Universiteit Antwerpen, Vrije Universiteit Brussel / Belgium Thorsten Becker - University of Stellenbosch / South Africa Sharma Ameeth - CSIR / South Africa Hugo Sol - Vrije Universiteit Brussel & Jun Gu - Bytec bvba / Belgium
18:10	Conference dinner	

MEASURING BY LIGHT 2016

International Meeting on Optical Measurement Techniques and Industrial Applications

DAY 3 DETAILED PROGRAMME

DECEMBER 1

Day 3 : Conference		
9:00	9:30	Welcome and coffee
9:30	10:10	Keynote lecture 3 Taking Laser Doppler Vibrometry off the tripod Steve Rothberg - Loughborough University / UK
10:10	10:40	Coffee break
10:40	12:20	Presentations : Session 4 Calibration of Laser Vibrometers – Requirements from Industry and Metrological Solutions Holger Nicklich - Spektra Dresden / Germany & Ian Veldman - NMISA / South Africa Measuring free fall gravitational acceleration using optical interferometer on NMISA DFFG-01 Tlou Mokobodi - University of Pretoria / South Africa Use of statistical shape analysis as an optical non-contact technique for condition monitoring of rotating machines Benjamin Gwashavanhu - University of Pretoria / South Africa Optical shaft encoder geometry compensation during arbitrary shaft speeds Dawie Diamond - University of Pretoria / South Africa
12:20	13:00	Panel discussion & closing words
13:00	14:30	Lunch break & conference closing

Scanning Laser Doppler Vibrometer measurements for improved model validation of turbomachinery components

Martyn Maguire¹ and Ibrahim Sever²

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Considerable effort is put into generation and execution of aero engine component models for simulation of their dynamic behaviour. The results obtained from these simulations feed into critical decisions that will have to be made in defining operational boundaries. Therefore it is of paramount importance that these models are validated to the degree that they adequately represent the actual physics they are put together to simulate. Model Validation in this context refers to a structured process that uses carefully made measurements to gauge the proximity of the measured results to those predicted by the model, and, identifies corrections that need to be made to the model if the degree of correlation is not suitable.

When correlating predictions with measurements, most commonly the deflection shapes are used as they are much easier to measure. However, aforementioned critical decisions are made based on stresses and strains in the components. Although direct measurements of these quantities can readily be made via the use of strain gauges, they are very intrusive, provide average values, and can only be applied to a limited number of locations. This paper is concerned with improvements to the model correlation process and the recent application of 3D SLDV technology for the generation of full-field strain measurements. It is intended that the resulting strain maps are used for model validation of components, and towards that end, the measurements are performed on a range of components from large fan blades to smaller compressor and turbine blades. Very good agreement is obtained between measured and predicted strain patterns not only for low frequency modes but also for more complicated high frequency modes.

Key words: Model Validation, blades, aero-engine, turbo machinery, 3D scanning laser Doppler vibrometry.

ABSTRACTS

Light and lasers as measurement tools in medical applications - a general overview

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The use of light in medicine is not new. Light has been used in medicine for centuries. In many of the ancient cultures the god of light is also the god of medicine or healing. In the 18th and 19th centuries in Europe, TB patients were exposed to sunlight during their treatment.

Light offers the advantage that it can be used for both diagnostic and treatment purposes. Another advantage is the fact that light can be used in a “non-invasive” method.

After the demonstration of the first laser in 1960, medical applications of lasers were quick to bridge the gap between a “solution looking for a problem” to real solutions for medical problems. Lasers have penetrated many medical disciplines e.g. dermatology, ophthalmology, dentistry, gastroenterology, urology, and neurosurgery.

One of the newer technologies in laser diagnostics is Optical Coherence Tomography (OCT). This technology is based on a Michelson interferometer where laser light penetrates into a biological medium or tissue (skin, eye or any other soft tissue). The light scattered back from the tissue is analysed and used to build up a 3D image of the tissue. The image can then be used to determine thickness of layers as well as imaging sub-dermal fingerprints. In ophthalmology OCT imaging is used to view the retina and detect possible damage on the retina.

Diffuse reflectance spectroscopy is a method where light is used to illuminate tissue. By analysing the backscattered light from the tissue, the optical properties of the tissue can be determined. These values may then be used to determine light or laser penetration depth into the tissue.

Key words: laser, medical, optical coherence tomography, diffuse reflectance spectroscopy.

Laser Doppler Vibrometry: Application overview

Jochen Schell

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Laser Doppler Vibrometry is a well established technique for non-contact vibration measurement. It is widely used in a multitude of different application fields.

In this talk, some example applications will be presented. Examples will be from the automotive industry, aerospace, mechanical engineering, buildings and the field of MEMS. Applications include modal test and model updating, vibration analysis of buildings, trouble shooting for NVH purposes, measurement of stress and strain and non-destructive testing by using Lamb Waves.

Key words: Laser Doppler Vibrometry, Application overview, non-contact, modal test, model updating, vibration analysis of buildings, NVH, stress and strain, non-destructive testing, Lamb Waves.

Seismic imaging in laboratory through laser Doppler vibrometry

Daniel Brito¹, Chengyi Shen¹, Julien Diaz², Stéphane Garambois³ and Clarisse Bordes¹

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Mimic near-surface seismic field measurements at a small scale, in the laboratory, under a well-controlled environment, may lead to a better understanding of wave propagation in complex media such as in natural rocks. Laboratory experiments can help in particular to constrain and refine theoretical and numerical modelling of physical phenomena occurring during seismic propagation, in order to make a better use of the complete set of measurements recorded in geophysical field acquisitions.

We have developed a laser Doppler vibrometer platform designed to measure non-contact seismic displacements (or velocities) of a surface. Our experimental set-up is particularly suited to provide high-density spatial and temporal records of displacements on the edge of any vibrating material. We will show in particular a study of MHz wave propagation (excited by piezoelectric transducers) in cylindrical cores of typical diameter size around 10 cm. The laser vibrometer measurements will be first validated in homogeneous materials cylinders by comparing the measurements to a direct numerical simulation. Special attention will be given to the comparison of experimental versus numerical amplitudes of displacements. In a second step, we will conduct the same type of study through heterogeneous carbonate cores, possibly fractured. Tomographic images of velocity in 2D slices of the carbonate core will be derived based upon on the time of first arrival. Preliminary attempts of tomographic attenuation maps will also be presented based on the amplitudes of first arrivals. Experimental records will be confronted to direct numerical simulations and tomographic images will be compared to x-ray scanner imaging of the cylindrical cores.

Key words: Geophysics, seismic tomography, laser vibrometry, seismic heterogeneities.

Discovering Laser Doppler Vibrometry: 30 years of teaching and research

Enrico Primo Tomasini

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Laser Doppler Vibrometers have been used in many different applications at Università delle Marche. From single point measurements to continuous scanning vibrometry in mechanical engineering, structural analysis, bio-medical applications and many more.

In this presentation we will cover 30 years of LDV applications at the Università Politecnica delle Marche.

Key Words : vibration testing, structural damage detection, noise source identification, medical applications.

ABSTRACTS

Photogrammetry as a verification tool for laser Doppler vibrometry

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When one is faced with a difficult vibration measurement scenario, laser Doppler vibrometry is typically one of the default options to obtain the required information. One such scenario is where measurements need to be recorded on rotating turbomachinery blades. In such a case, tracking and Eulerian laser Doppler vibrometry can give valuable insights into dynamic blade behavior. However, determining the precise temporal location of the vibrometer measurement position can be problematic. In this paper, photogrammetry is shown to be a viable solution to this problem as experimentally demonstrated for two applications.

Key words: Tracking vibrometry, Eulerian vibrometry, photogrammetry, turbomachinery blades

ABSTRACTS

Digital Image Correlation and Particle Image Velocimetry Measurements of the Aeroelastic Behavior of Flexible Wings

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The study of Fluid-Structure Interaction (FSI) phenomena, such as aeroelasticity, has long been an important challenge for both academic and industrial communities. In recent years, the requirements for a better understanding of this phenomenon have become increasingly important, especially in the design of the next generation of autonomous airborne systems - such as Micro Air Vehicles (MAV). The high demand in expanding the flight capabilities of such systems has motivated new research projects to focus on the aerodynamics of biological-inspired wings, which are an attractive solution for MAV designs due to their improved flight capabilities at low to medium Reynolds numbers, and in challenging flight conditions.

The use of non-intrusive, full-field optical measurement techniques provides a unique tool in the description of this complex FSI problem. By simultaneously deploying Digital Image Correlation (DIC) for the characterization of structural motion and deformations, and Particle Image Velocimetry (PIV) for the synchronized description of the surrounding fluid flow, new insights into the dynamics of flapping and/or deformable wings can be achieved. Furthermore, the use of these optical measurement techniques is the required tool for experimental validation of numerical models, since classical sensor techniques cannot be applied because of their intrusive nature.

In this paper, the successful introduction of simultaneous PIV and DIC measurements for the description of both bird- and insect- inspired wing designs is presented.

Key words: Fluid-Structure Interaction, Particle Image Velocimetry, Digital Image Correlation, Aeroelasticity, Aerodynamics, Flapping Wings, Flight Dynamics.

ABSTRACTS

Sub-pixel in plane vibration measurements of structures without surface preparation

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Optical measurement techniques using video sequences are increasingly being used for structural dynamic measurements. Some of the most widely used methods are Digital Image Correlation (DIC) and Marker Tracking (MT). These methods identify a feature in the image, like a patch of pixels or a circular marker, and track that feature across the image frames. The displacement of the feature at each frame is a measurement of structural vibration. These techniques can be called Lagrangian techniques. A large disadvantage of Lagrangian techniques is that they often require visual surface preparation in the form of a speckle pattern or circular markers. Preparing a surface in this manner can be time consuming and impractical for large structures.

Recently, a new image processing technique referred to as Motion Magnification (MM), has become increasingly researched. The technique requires no surface preparation and can be used to measure extremely small vibration amplitudes. The method uses the optical flow of the image at a certain location, it is therefore an Eulerian technique. This paper presents the theory behind MM for vibration measurement. An experiment was conducted to determine the accuracy of MM in measuring small structural vibrations. It was found that the method is capable of measuring vibration amplitudes as small as $1/450$ the size of a single pixel.

Key words: Asset integrity, blades, electrical machinery, laser vibrometry, nuclear reactor.

ABSTRACTS

Fully automated optical vibration measurements

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In this paper we present a new methodology for vibration testing that integrates 3D imaging techniques with optical vibration measurements (obtained using a scanning laser Doppler vibrometer). The proposed methodology uses a 3D time-of-flight camera to measure the location and orientation of the physical test-object in space. The 3D image of the time-of-flight camera is then matched with the 3D-CAD model of the object in which measurement locations are pre-defined. This allows us to test prototypes in a shorter period and without any user interaction. Furthermore, using the proposed procedure it is possible to compare measurements and FEM simulations at exactly the same nodes.

Key words: scanning laser vibrometry, time-of-flight camera, CAD matching.

ABSTRACTS

On the material property extraction using digital image and volume correlation

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The reliability of power stations is mostly governed by the lifetime of critical components, such as steam pipework systems that are exposed to high stresses, elevated temperatures and corrosive environments. It is therefore of great importance to understand the degradation mechanism and material properties under such conditions. Conventional testing techniques for investigating material properties under such conditions, as for example stipulated in ASTM standards, are limited as these most often require sophisticated setups to obtain averaged material properties. This work presents alternate characterisation techniques have been developed with the use of optical measurement techniques that use 'digital images': Images are taken of damaged regions with the use of high resolution digital cameras for surface data or X-Ray Computed Tomography (XCT) for volume data. These surface or volume images are then processed algorithmically by combining several images taken over time using state-of-the-art correlation algorithms. The resultant deformation data is dense and accurate, covering the full-field of the inspected area. By using such techniques, it becomes possible to measure small mechanical movements and aberrations that are related to damage. This, linked with the knowledge of the applied stress, temperature, environment and time provide a vehicle for a unique measurement capability that can be directly connected to predictive models through an experimental-numerical approach.

Presented in this work are examples in the measurement of fracture properties, accelerated creep characterisation and stress corrosion cracking of power plant materials. The work focuses on test setup, acquisition of data and material property extraction techniques.

Key words: structural integrity, material properties, digital image correlation, digital volume correlation.

ABSTRACTS

CSIR National Laser Centre develops a high speed OCT system

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The optical coherence technique (OCT) technique, which was demonstrated by Fercher and Huang in the early 90s, has made significant strides in bio-medical diagnostic applications in the fields of dermatology, dentistry and ophthalmology. Other impact areas and applications include polymer characterisation, surface and thin-film characterisation and biometrics.

The National laser Centre has developed a high speed, large area optical coherence tomography (OCT) prototype for fingerprint scanning. The system, which is not limited to this application, can image a large volume (25mm x 25mm x 11mm) and resultant 3-D images (512 x 512 x 2048 pixels) are acquired in less than three seconds.

The heart of the system is a swept laser source and a two-axis scanner. Signal acquisition is made possible through a high-speed analogue-to-digital converter capable of speeds greater than 1GS/s. The system has demonstrated the ability to capture live fingerprints making it a viable alternative for high security access control. Furthermore the ability to capture latent fingerprints, from plastic and glass surfaces, was also demonstrated making it applicable to forensics. This paper will present the system design and some of the initial results.

Key words: Optical coherence tomography, fingerprint, biometrics, 3-D imaging, swept source laser, high speed data acquisition.

ABSTRACTS

In situ quality control of beer bottles using Laser Velocity meters

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Every year 9 billion glass beer bottles are produced Worldwide. Beer bottles must be strong enough to resist common loads like internal pressure, bottle-to-bottle impacts and capping forces. This means that the glass wall thickness of the bottles must be large enough. On the other hand, the glass wall thickness may not be too large in order to keep the bottle weight as low as possible. Indeed, more weight means more glass material to melt and a higher transport costs.

Glass beer bottles are produced with a so-called press-blow process. The glass material is melted at 1200°C and gobs of molten glass are poured in a first mold to receive an initial shape ("parison") and next blown in the bottle shape in a final mold. This process is fast (several bottles in a second) but unfortunately not very accurate. The wall thickness varies from bottle to bottle and hence also the mechanical strength.

It has been found that the basic resonance frequency of a bottle is very sensitive for the wall thickness distribution. The resonance frequency can hence be considered as a fingerprint of each bottle. This property can be used for quality control of glass bottles. The resonance frequency of a bottle can be computed with an accurate finite element model. The frequency of a "perfect" bottle is taken as a center frequency. Frequencies of bottles with a poor thickness distribution, causing poor strength, are used to determine an acceptance interval round the center frequency.

In the production process, the bottles are automatically impacted with a small impact device and the impulse response function is recorded with a laser velocity meter. Bottles with a resonance frequency outside the acceptance interval are rejected from the conveyer belt.

Key words: quality control, glass beer bottles, resonance frequencies, laser velocity meter.

Taking laser Doppler vibrometry off the tripod

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Laser Doppler vibrometers (LDVs) are now well-established as an effective non-contact alternative to traditional contacting transducers. Despite 30 years of successful applications, however, very little attention has been given to sensitivity to vibration of the instrument itself. Mounting on a tripod with compliant feet is typically used to minimise ambient vibration transmitted to the instrument but application in a moving vehicle, handheld measurements and even drone mounting are all examples of where compensation for instrument vibration would be required. Where beam steering optics are used, for example to measure from a point on a structure that is difficult to access, there is also measurement sensitivity to any vibrations of these optics. In this presentation, sensitivity to instrument vibration and steering optics vibration is confirmed before development theoretically and experimentally of practical schemes to enable correction of measurements.

In the case of instrument vibration, the correction scheme requires a pair of sensors with appropriate orientation and relative location. In the case of a beam steering mirror vibration, the correction scheme requires a single measurement from an appropriate location on the back-surface of the mirror in line with the incidence point. In both cases, frequency domain processing conveniently accommodates inter-channel time delay and signal integrations. Error reductions in excess of 30 dB are delivered in laboratory tests with simultaneous instrument / steering optic and target vibration over a broad frequency range. Finally, the practical nature of the correction techniques is demonstrated by successful applications of each.

Key words: laser Doppler vibrometry, instrument vibration, beam steering, mirror vibration.

Calibration of Laser Vibrometers with mechanical Excitation

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For primary calibration of vibration sensors there are international standards available like ISO 16063-11 that describe calibration methods for frequencies up to 20 kHz. In such a primary vibration calibration system typically a laser vibrometer acts as the reference transducer.

For quality assurance reasons SPEKTRA applied for an accreditation as a primary calibration lab to be able ship such systems with valid DAkkS (formerly DKD) calibration certificates that will be accepted worldwide. To be able to do this there was to create by SPEKTRA experts a DIN standard that describes the procedure and conditions of such a traceable calibration of laser vibrometer. From this national standard later an ISO Standard 16063-41 was established that describes the calibration of laser vibrometer in a frequency range up to 50 kHz. In the presentation will be shown how such a calibration system, that is available at NMISA as well, works and how the reference laser vibrometer can be calibrated and compared with other reference laser vibrometer.

From the industry and some NMI worldwide there are extended requirements for vibrometer calibration up to 350 kHz. In the presentation there will be shown a method how to calibrate laser vibrometer in this extended frequency range. There is needed a special exciter that covers this frequency range. To achieve acceptable low measurement uncertainties the components and the complete system configuration have to fulfill special requirements that will be discussed.

Key words: metrology, calibration, laser vibrometer, ISO standard, measurement uncertainty.

ABSTRACTS

Measuring free fall gravitational acceleration using optical interferometer on NMSA DFFG-01

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National Metrology Institute of South Africa (NIMSA) is answering to the call in metrological sciences to redefine the current standard of mass "kilogram", the last SI unit defined using an artifact. The continuous observation on the kilogram shows drift of few grams each time it is measured. This instability resulted in a need to search for a method to measure mass other than using artifact comparisons. The redefinition of the kilogram will result in linking the last SI base unit to natural constants. The watt balance has shown the potential for achieving this goal, by achieving equilibrium between electrical force and mechanical force. As a metrology institute it is the organizational need to conform to global metrology and invest in the acquirement of necessary equipment to keep South African metrology relevant and equivalent to the rest of the world. In realization of mechanical force, weight is measured, of which the accurate measurement of gravitational acceleration is an essential parameter. Absolute measurements are required as one of the base subsystems in supporting of watt balance project. The project is aiming at achieving an uncertainty of measurement (UoM) better than 10^{-8} in mass measurements. To achieve this level of uncertainty, gravitational acceleration measurements must also have smaller uncertainty to improve the watt balance overall system uncertainty.

Acceleration is realized by measuring displacement and time, the first two base SI units, in which the meter is currently realized using the wavelength of light. A stabilized HeNe laser with $\lambda = 632$ nm is the defined length standard. Using a HeNe laser of known frequency provides direct traceability and a reduced UoM in determining the gravitational acceleration. These measurements are performed using laser light interferometer to measure displacement of free falling test mass in a vacuum. The optical laser interferometer using amplitude division interference principles to enable measurement of change in displacement of $\lambda/4$ can be achieved with observation of light wave phase shift.

The NMISA DFFG-01, is the first free fall gravimeter prototype at NMISA. It is designed and constructed to employ interference to measure the test mass displacement and maps the displacement history over time to allow gravitational acceleration computation using laser light.

Key words: Interference, Laser interferometer, gravimeter test mass, traceability and gravitational acceleration.

ABSTRACTS

Use of statistical shape analysis as an optical non-contact technique for condition monitoring of rotating machines

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The use of 3D point tracking and digital image correlation typically requires prior surface preparation. To expand the applicability of photogrammetry as a measurement technique for the condition monitoring of rotating structures, a 2D shape analysis approach that does not require any surface preparation is proposed. The approach involves the extraction of a contour of a shape formed between a shaft and the bearing housing. Principal component analysis of the Fourier shape descriptors of the contour is then used to extract information on how the shape varies as the shaft rotates. By monitoring the variation of these principal components, different machine faults that include rotor-stator shaft rub, static and uncoupled system unbalance could be detected. This paper presents the feasibility of shape analysis as a non-contact measurement technique for condition monitoring purposes.

Key words: Photogrammetry, shape principal component analysis, condition monitoring, turbomachines.

ABSTRACTS

Optical shaft encoder geometry compensation during arbitrary shaft speeds

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Torsional vibration measurements of rotors carry a lot of information about rotating machinery. Rotor health, as well as upstream and downstream components that act in the rotational direction, can be inferred from torsional vibration measurements. Torsional vibration is, however, notoriously difficult to measure and process. Incremental shaft encoders can be used to measure the time it takes for the shaft to rotate a specified rotational distance. The shaft encoder has discrete sections and these sections' rotational distances are used to determine the Instantaneous Angular Speed (IAS) of the shaft.

The cardinal difficulty in processing shaft encoder data for torsional vibration measurement is that section distances are unknown. The section distances are not uniform due to manufacturing tolerances and the installation effects. A compensation method is therefore required to determine each rotational section's distance. The state-of-the-art compensation methods can only be performed on a shaft speed that is perfectly constant or linear, which is not usually the case in practice. This paper presents a novel technique to perform shaft encoder geometry compensation on signals measured for any arbitrary shaft speed.

Key words: Asset integrity, blades, electrical machinery, laser vibrometry, nuclear reactor.

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DIRECTIONS AND CSIR PRETORIA SITE MAP

CSIR - Pretoria Site

Physical address: Meiring Naudé Road, Brummeria
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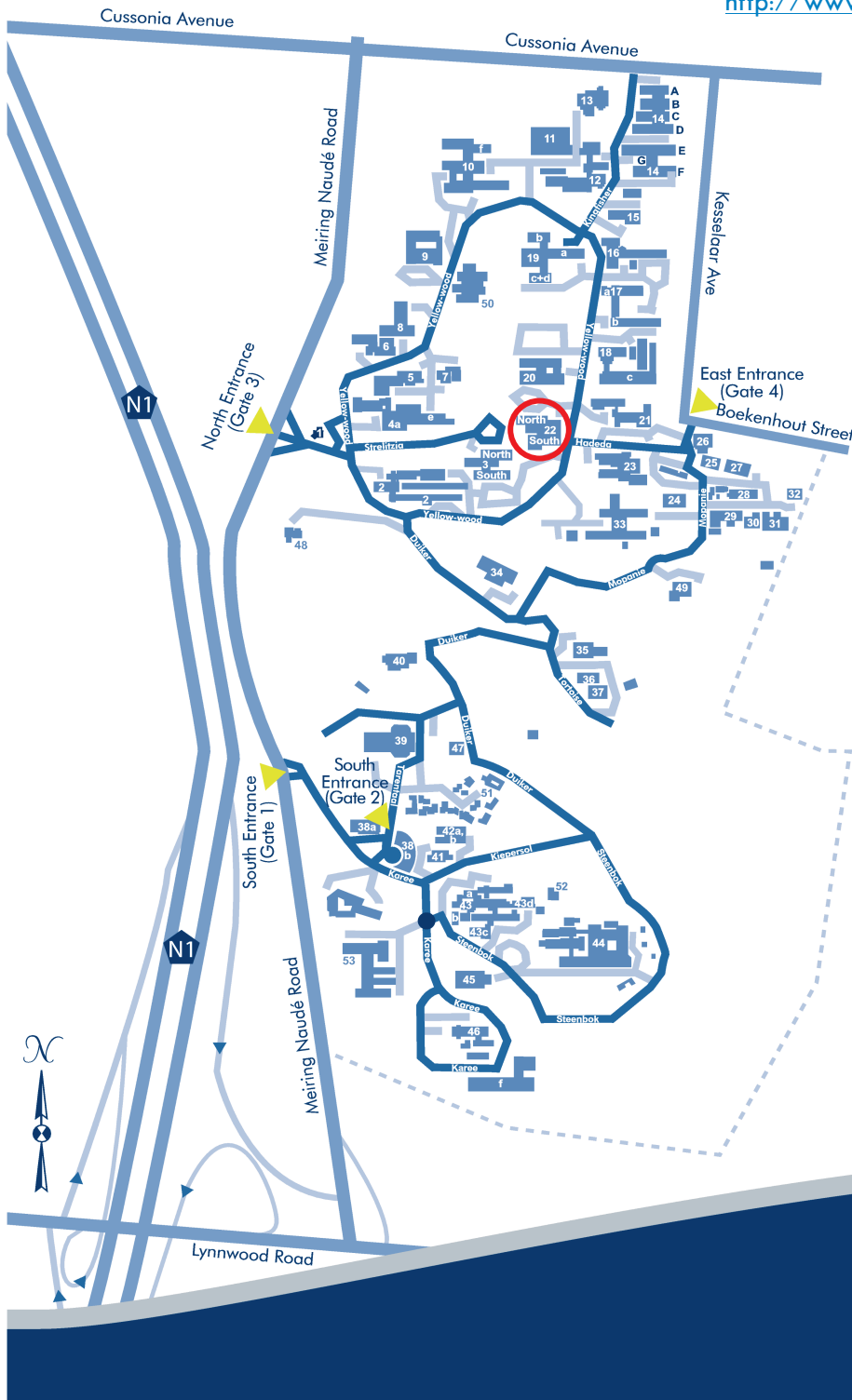
Gate	Longitude	Latitude
North	28° 16' 31.9" E	25° 44' 52.5" S
South	28° 16' 36.8" E	25° 45' 18.8" S
East	28° 16' 55.9" E	25° 44' 52.4" S

Building 22 - North

- Demo's - Room A30
- Plenary Sessions - Room A40
- Exhibition - Room A40

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