AUSTRIAN INSTITUTE OF TECHNOLOGY

SCIENTIFIC VISION DAYS 2024

SCIENTIFIC EXCELLENCE ON STAGE at Booth **8C50**

Tuesday, 8th October - Thursday, 10th October, 2024

TIMETABLE
DAY 1 – TUESDAY, 8TH OCTOBER, 2024

10:00
EVALUATION AND QUALIFICATION OF HIGH-PRECISION MEASUREMENT PRINCIPLES
Reitberger Thomas, MicroEpsilon

10:20
ULTRA COMPACT CONTROLLER PLATFORM FOR SMART LOGISTICS SORTING SYSTEM
Tran Nguyen Dung, NODKA

10:40
ADVANCED INDUSTRIAL INSPECTION USING ZERO GRAVITY 3D TECHNOLOGY
Soler Javier Perez, ITI

11:00
ZERO DEFECT MANUFACTURING FOR THIN FILM PHOTOVOLTAICS
Ginner Laurin, AIT

11:20
WHAT IS NEW ABOUT RELEASE 4.1 OF THE STANDARD EMVA 1288? – ADAPTION TO MODERN IMAGE SENSORS
Jähne Bernd, IWR Heidelberg University & EMVA

13:00
VISUAL INSPECTION OF TRANSPARENT OBJECTS WITH LIGHT FIELDS
Meyer Johannes, Fraunhofer IOSB

13:20
LOCALIZATION OF FABRICS WITH COMPUTER VISION FOR COMPOSITE MANUFACTURING
Frommel Christoph, DLR

13:40
SENSOR REALISTIC SYNTHETIC DATA GENERATION
Frommknecht Andreas, Fraunhofer IPA

14:00
PERCEPTION FOR LOGISTICS OPERATIONS IN THE UNSTRUCTURED WORLD
Murschitz Markus, AIT

14:20
3D METROLOGY OF AN UNDERGROUND MAN-MADE CAVE „ERDSTALL“ USING OPTICAL MOBILE SENSORS
Niel Kurt, FH Wels

10:00

EVALUATION AND QUALIFICATION OF HIGH-PRECISION MEASUREMENT PRINCIPLES USING DEFLECTOMETRY AND WAVEFRONT SENSORS FOR OPTICAL PARTS AND COMPONENTS

SPEAKER
Thomas Reitberger, MicroEpsilon

ABSTRACT
Particularly in the field of functional optical components, quality assessments based on manual inspection by a worker is still dominant today. Here, surface defects such as scratches, dents and bumps or even inclusions inside glasses or lenses must be found. The visual inspection by a worker, which is used in many areas, is extremely time consuming, resource- and employee-intensive. However, even with geometric surface qualification using gauges or dial gauges, high inconsistencies occur depending on the daily performance of the employee. In extreme cases, the contact measurement can even damage the surface and transform a component that has reached the end of its added value into scrap. In addition, if a defect is for the first time noticed by the end customer, the question often arises as to where in the value chain the defect occurred and who is subsequently responsible for it. The non-contact measurement of reflective or transparent optical components is an extremely challenging measurement task that requires special sensors. In this presentation, the focus will be on two measurement technologies that make it possible to measure various quality criteria on optical components with highest precision. The Shack-Hartmann wavefront sensor allows the qualification of surface and transmission qualities as well as the aberration of optical components. With the use of phase-measuring deflectometry, larger areas of highly reflective surfaces can quickly be measured geometrically and defects contained therein can be detected. In order to be able to compare both measurement principles with each other, measurement objects are required that can be recorded by both sensors to the same extent. Various smaller round mirrors with a diameter of up to 25 mm were selected for this purpose. Based on an evaluation of the measurement results, a decision matrix is created which makes it possible to select the appropriate measurement method for a specific application.

10:20

ULTRA COMPACT CONTROLLER PLATFORM FOR SMART LOGISTICS SORTING SYSTEM

SPEAKER

Dung Tran Nguyen, NODKA

ABSTRACT

A smart logistics sorting system leverages advanced technologies to streamline and optimize the process of sorting and handling goods within a logistics and supply chain environment. This system integrates various components such as automated machinery, artificial intelligence, and the Internet of Things (IoT) to achieve higher efficiency, accuracy, and scalability. NP-6132-H1BP controller platform is particularly designed to provide various functionalities and interfaces to the customers to do the All-in-One solution.

10:40

ADVANCED INDUSTRIAL INSPECTION USING ZERO GRAVITY 3D TECHNOLOGY

SPEAKER
Javier Perez Soler, ITI

ABSTRACT
Zero Gravity 3D technology represents a significant advancement in industrial inspection and non-destructive testing (NDT). Leveraging advanced machine vision and artificial intelligence algorithms, this technology conducts 360º inspections of 100% of production without object manipulation, detecting geometric and surface defects and ensuring GD&T compliance. This proposal outlines the key aspects of Zero Gravity 3D technology and its impact on quality assurance in manufacturing processes.

This technology is being applied in AIDEAS project „AI Driven industrial Equipment product life cycle boosting Agility, Sustainability and resilience" to assess the quality of products in 3D, specifically detecting defects in fruits.

The lecture will demonstrate, through applications, the scientific innovations introduced at each stage of the industrial inspection process to achieve comprehensive production inspection without hidden surfaces. Multiple cameras inspect the object while it is in the air, allowing for full-angle inspection without hidden surfaces or manipulation, enabling rapid inspection suitable for 100% production quality control.

The technology can handle different product references simultaneously, classifying the inspected objects while performing quality control. This capability allows for the detection of mixed similar products and the reuse of the same inspection machine for different products.

Thanks to multiple simultaneous views, objects are analyzed in 3D, detecting extra and missing material. Furthermore, specific GD&T verification's can be configured for precision measurements, ensuring each product meets strict industry standards.

Zero Gravity 3D is also capable of detecting surface anomalies such as scratches, stains, color differences, porosity, or any deviation from the expected surface appearance. This technology will be presented by showcasing various success stories that have guided the evolution of this industrial inspection device.

11:00

ZERO DEFECT MANUFACTURING FOR THIN FILM PHOTOVOLTAICS

SPEAKER

Laurin Ginner, AIT

ABSTRACT

The latest generation of PV technologies combine high performance with a strong flexibility for integration in buildings, vehicles, agrivoltaics and internet-of-things devices. However, their high-complexity makes them prone to the appearance of critical defects with just small deviations from standard manufacturing conditions, leading to significant production waste. Platform-ZERO addresses this challenge by developing a new customizable in-line process monitoring platform, supported by artificial intelligence, for achieving zero-defect manufacturing in the third generation PV industry to allow an early detection, correction and/or prevention of pre-critical production faults. The strategy will be tested in four pilot plants from PV and PV-related industrial partners in Spain, Germany, Austria and Poland. The pilots are devoted to smart coatings for PV, high-efficiency solar modules and flexible solar foils of different photovoltaic materials and processes.

11:20

WHAT IS NEW ABOUT RELEASE 4.1 OFTHE STANDARD EMVA 1288? – ADAPTION TO MODERN IMAGE SENSORS

SPEAKER

Bernd Jähne, IWR Heidelberg University & EMVA

ABSTRACT

The worldwide successfully used EMVA Standard 1288 for objective characterization of industrial cameras is evolving with the progress of modern image sensors. In this talk a preview is given to the new Release 4.1, which is close to be published.

To major extensions are planned. Firstly, a characterization of the parasitic sensitivity of global shutter CMOS sensors and, secondly, a more detailed pixel-wise analysis of the dark current. In addition, it is shown with several real-world examples how easy it is to characterize the quality of very different types of image sensors, if the focus is put on the signal-to-noise and signal-to-nonuniformity ratio including SWIR and HDR cameras.

13:00

VISUAL INSPECTION OF TRANSPARENT OBJECTS WITH LIGHT FIELDS

SPEAKER
Johannes Meyer, Fraunhofer IOSB

ABSTRACT
Objects made from transparent materials play crucial roles in humans' everyday life. They are employed as windshields for automobiles or airplanes, as cover glasses for automotive headlamps, as transparent containers for food or liquids, to build high precision optical instruments or even as plastic lenses to guide laser beams in an eye operation. Especially when considering the latter example, it is obvious, that such transparent objects must meet high quality requirements. Although there exist elaborated machine vision systems for inspecting flat glass plates or other objects with a simple geometry, the automated visual inspection of complex-shaped transparent objects still represents a challenging task with several open research questions. A transparent object itself and the material defects influence the direction of propagation of the transmitted light. Especially scattering material defects might only be visible under a certain angle. We introduced methods based on the concept of light fields for all main components of a visual inspection system, the illumination source, the sensor device and the signal processing algorithms. In this talk, we will present a novel sensor device, a laser deflection scanner, that acquires light fields of transparent objects with a high spatial and a high angular resolution. By means of suitable distance functions, a gradient is formulated for light fields that allows to detect discontinuities of the light's direction of propagation between spatially adjacent object points. This allows to reveal material defects even in complex-shaped objects in an inspection time feasible for industrial production lines.

13:20

LOCALIZATION OF FABRICS WITH COMPUTER VISION FOR COMPOSITE MANUFACTURING

SPEAKER
Christoph Frommel, DLR

ABSTRACT
Using fiber reinforced polymers (FRP) in industrial applications typically provides structures with lower weight compared to metals. Investment costs for automated processes are high and so far getting established in aviation applications. To introduce automation solutions together with low investment costs, the European funded project DrapeBot uses industrial robots to assist the worker in the manufacturing of FRPs. The robots are equipped with grippers that can pick up fabrics. Dependent on the size, they are either transported and placed fully by the robot, cooperatively by two robots or cooperatively with one robot and the worker. With this flexibility the automated system can be used for other manufacturing processes which raises machine utilization and thus lowers amortization time.

In DrapeBot this approach will be used for aviation, automotive and maritime use cases that all use pick and place processes. To pick up the fabrics the location of the individual cut piece is needed. Computer vision is used to find the cut piece on the respective material carrier. A computer vision system using a monochrome industrial camera to find dry carbon fiber fabrics for aviation use cases was developed in earlier projects at DLR. In DrapeBot the automotive and maritime use cases introduce dry glass fibers as well as carbon fiber prepregs. To find these materials and calculate their positions, changes in the existing system had to be done. Due to the changing environments and materials the monochrome camera with optimized flash for carbon fibers was changed to a color camera using ambient lighting for image acquisition. Each color space of the color image is evaluated individually and contrast optimizations are done to use the existing algorithms for coordinate calculation. With this adapted computer vision system the localization of carbon fiber prepreg materials for the automotive use case was established and experiments with dry glass fibers showed promising results.

13:40

SENSOR REALISTIC SYNTHETIC DATA GENERATION

SPEAKER

Andreas Frommknecht, Fraunhofer IPA

ABSTRACT

Developing machine learning-based algorithms for automatic optical quality control usually requires a large amount of data for training. This can entail high costs in terms of time, material and energy. However, one possible approach to tackle the problem of lack of data, is the generation of synthetic data. By using this approach, the amount and variety of data can be significantly increased. To really improve the training of the machine learning model the synthetic data needs to be sensor realistic, meaning it should be as close as possible to the real data coming from the sensor. For achieving this we propose a generative neural network for semantic image synthesis using a limited amount of starting dataset. The network generates new data instances by receiving as input a semantic map of the image to be represented. As practical example the welding context has been addressed. This area is a typical example for high costs in terms of time, material and energy in data generation. In the presentation the performance improvement is analyzed on a segmentation network. Experimental results show how adding synthetic data to the original data can ensure significantly improvements in network performance.

14:00

MASTERING THE LAST MILE DELIVERY IN THE WILD - PERCEPTION FOR LOGISTICS OPERATIONS IN THE UNSTRUCTURED WORLD

SPEAKER

Markus Murschitz, AIT

ABSTRACT

Logistics operations, and in particular loading and unloading operations, are still carried out to a large extent in uncontrolled outdoor situations and are therefore prone to harsh weather and other environmental conditions. To succeed in the chaotic and ever-changing world of outdoor logistics operations, an autonomous system must be robust to a wide range of environmental factors and adaptable to new situations.

We show how an automated off-road forklift and its perception systems can be designed and tested in order to be reliable in such challenging conditions.

14:20

3D METROLOGY OF AN UNDERGROUND MAN-MADE CAVE „ERDSTALL“ USING OPTICAL MOBILE SENSORS

SPEAKER
Kurt Niel, FH Wels

ABSTRACT
We scanned a manmade underground cave “Erdstall” (ca. 800 years in age), located in Unterstetten/Upper Austria, by a mobile 3D sensor system. The aim of the scan is to get a 3D model of such objects to support archeological sciences (evaluate topological similarities of different objects, how the cave has been built, what may be the purpose). By this measurement, several details of the object have been detected and evaluated, like all the topology, and details as niches for oil lamps, defense doors, resting benches. Main objectives of such caves are diffuse surface features, narrow space, and huge humidity. The handheld capturing device is a tablet with 3D-capturing feature, and a diffuse illumination. The tablet Lenovo Phab2 pro consists of a depth-camera, RGB-camera, and gyroscope. The SW-architecture is based on the Google Tango project with RTAB (Real-Time Appearance-Based Mapping App). Several techniques are in operation: depth sensor fusion with RGB data, stereo of motion, evaluation of the sensor trajectory, registration of different parts of 3D surface elements. We are on to compare the quality of the depth-data with the laser scanner Leica BLK360. Next step will be a further development of MOBES (Mobile Erdstall Scanner).

TIMETABLE
DAY 2 – WEDNESDAY, 9TH OCTOBER, 2024

10:00
3D SCANNING IN PLASMA ARC WELDING SCENARIOS
Eugui Pablo, AIT

10:20
THE LENS AS A KEY FACTOR IN CHALLENGING IMAGING APPLICATIONS
Mahler Steffen, Schneider-Kreuznach

10:40
LANDSCAPE OF SYNTHETIC IMAGES FOR MACHINE VISION
Gospodnetic Petra, Fraunhofer ITWM

11:00
ADVANCING 3D VISION FOR ROBOTIC HANDLING OF TRANSPARENT AND OCCLUDED OBJECTS
Stolc Svorad, Photoneo

11:20
DIGITAL TWINS IN MACHINE VISION APPLICATIONS
Wanner Sven, Artificial Pixels

13:00
A NOVEL, MULTISENSORIAL, ROBOTIC, HIGH-CONTENT SCREENING MICROSCOPE
Balas Costas, Spectricon & TUC

13:20
VISUAL QUALITY INSPECTION PLANNING: ENHANCING PERFORMANCE THROUGH ROBOTICS AND COMPUTER VISION SYNERGY
Staderini Vanessa, AIT

13:40
IMAGE-BASED METROLOGY THROUGH TALBOT-DIFFRACTED SHADOW IMAGING
Maamari Nadim, CSEM

14:00
MAXIMIZING INSPECTION ACCURACY-BRIDGING GAPS WITH ADVANCED AI ALGORITHMS AND GENERATIVE MODELS
Lee Hongsuk, Neurocole

14:20
SYNTHETIC DATA GENERATION FOR AI-BASED AUTOMATION IN QUALITY INSPECTION AND OBJECT DETECTION
Effenberger Ira, Fraunhofer IPA

DAY 2 – WEDNESDAY, 9TH OCTOBER 2024

10:00

3D SCANNING IN PLASMA ARC WELDING SCENARIOS

SPEAKER
Pablo Eugui, AIT

ABSTRACT
In the field of welding, 3D scanning is typically performed post-process in a controlled environment, free from the presence of plasma or laser interference. However, in the layer-wise deposition process of Wire Arc Additive Manufacturing (WAAM), deviations between planned and actual 3D weld geometry accumulate over the course of the build. Early detection and correction of these deviations are crucial to ensure the quality and geometric accuracy of the final part.

Various optical 3D scanning systems for industrial usage are available, each with its own technical approaches and limitations. Common methods face significant challenges when dealing with dark or shiny surfaces, such as weld seams, and in harsh environments like those encountered in plasma welding.

In this presentation, we will discuss the limitations of current scanning methods and share the progress of our ongoing research on 3D inline scanning in welding applications. Our efforts focus on improving real-time monitoring and adaptive control during the WAM process, addressing the difficulties of achieving precise and reliable measurements in challenging conditions.

10:20

THE LENS AS A KEY FACTOR IN CHALLENGING IMAGING APPLICATIONS

SPEAKER
Steffen Mahler, Schneider-Kreuznach

ABSTRACT
The presentation covers the challenges that modern image processing systems in science and industry pose for the imaging optics and how both the lens and the system manufacturers can meet these.

The trend towards higher resolution sensors continues unabated. A larger sensor area in conjunction with smaller pixels require an ever-higher resolution of the lens. It is explored how this can be achieved with innovative development, production and quality control.

When designing the lens and the system, it is becoming increasingly important to take other significant influencing factors such as mechanical stability, compensation for temperature influences, size and weight into account. Physical limits, such as the diffraction limit, are also playing an increasingly important role, especially in close-range applications.

What this means in practice is illustrated using practical examples, including from the particularly challenging area of 3D measurement.

10:40

LANDSCAPE OF SYNTHETIC IMAGES FOR MACHINE VISION

SPEAKER

Petra Gospodnetic, Fraunhofer ITWM

ABSTRACT

We are surrounded by virtual worlds with different levels of realism. Just about every movie today has stunning computer graphics footage which is nearly impossible for us to distinguish from real life footage. There are apps allowing us to place virtual objects in real environments to help us envision how changes in environments could look like. We have tools which allow us to digitally plan, design and recreate scenes and objects which will later on be produced according to the design. At the same time, we are developing extremely powerful AI models whose performance is heavily dependent on the real data we train them on. Given that the amount and balance of the data is often the main source of the problem when developing a model, it is only logical that we said "Hey, why don't we create synthetic data instead and feed that to the network?". With that seemingly innocent and completely justified question, we have uncovered a whole new world of challenges such as when is realistic, realistic enough? Which features of the image must be realistic, and what can we get away with? Which methods should we use? Do we really want pixel-perfect annotations? How do we measure dataset balance? And finally, as a customer, which questions do I want to ask when buying industrial synthetic image data?

11:00

ADVANCING 3D VISION FOR ROBOTIC HANDLING OF TRANSPARENT AND OCCLUDED OBJECTS

SPEAKER
Svorad Stolc, Photoneo

ABSTRACT
Integrating 3D vision-guided robotics (VGR) into industrial processes is gaining momentum, driven by the need for more sophisticated automation solutions. As the industrial 3D camera market expands, it becomes critical to accurately and reliably handle diverse objects irrespective of their shape, material, or orientation.

The key challenge has been the effective 3D scanning of transparent and occluded objects, often encountered in complex industrial environments. Despite being recognized for years, these technical obstacles have posed significant barriers to the universal adoption of 3D VGR solutions.

Photoneo's latest innovations directly address and overcome these challenges. Our research and development efforts have led to the creation of a robust 3D VGR system (HW + SW) that excels in capturing high-fidelity 3D data from virtually any scene, regardless of object geometry (e.g., thin or intricate structures), positioning (e.g., random bin placement, compartmentalized storage, or suspended on racks), or material properties (e.g., glossy surfaces, dark finishes, or transparent materials).

The talk will delve into the scientific and technical breakthroughs underlying these advancements. We will touch upon the complex algorithms, sensor technologies, and software innovations that make this system viable, and explore its implications for the future scalability of VGR applications in sectors ranging from logistics to manufacturing.

11:20

DIGITAL TWINS IN MACHINE VISION APPLICATIONS

SPEAKER

Sven Wanner, Artificial Pixels

ABSTRACT

Digital twins have become a pivotal technology across various industries, offering numerous applications that enhance efficiency and innovation. This presentation focuses specifically on the utilization of digital twins in machine vision applications. We will explore the unique characteristics that define a digital twin in this context and the diverse range of applications it supports. Whether developing simulations to test unknown scenarios, virtually evaluating hardware configurations, or generating synthetic datasets, all these applications have in common the use of a digital twin that accurately replicates essential data streams with the desired level of realism. Our presentation will provide practical examples of what such digital twins might look like, emphasizing the critical considerations for each scenario. When using a digital twin as a data generator, a key factor for success is ensuring that the synthetically generated data matches the domain of your real-world data, which is crucial for successful model trainings. We will discuss the key factors that ensure the generation of high quality synthetic data and its potential use cases.

13:00

A NOVEL, MULTISENSORIAL, ROBOTIC, HIGH-CONTENT SCREENING MICROSCOPE FOR THE ULTRAFAST AND UNSUPERVISED MATERIAL CHARACTERIZATION AND MAPPING

SPEAKER

Costas Balas, Spectricon & TUC

ABSTRACT

High content screening (HCS) platforms have substantially evolved to encompass the ever-increasing needs for automation in the identification and analysis of vast populations of samples in microscopy. However, state-of-the-art technologies are limited in just performing analysis of biological samples, labeled with multiple fluorophores and therefore they are inefficient to identify unknown and unstained samples. We have developed a novel HCS platform for effectively addressing this unmet need. The system's design was based on the concept of drastically increasing the dimensionality of the acquired optical information, as a means for probing the composition of heterogeneous samples, at the pixel level. This concept was successfully implemented with the development of an innovative multisensorial camera system, capable of acquiring hyperspectral imaging in the transmission, reflection, multi wavelength excitation fluorescence and polarimetry modes, at a 3840X2160 pixels (4K) resolution. The multi-sensorial camera produces for every pixel not a scalar attribute, but a complete feature vector with 40 dimensions. A LUT-based, machine learning trainable pixel classifier transforms the vectorial image into a stack of binary class label images, and, finally, to a single composition map. The entire acquisition/analysis pipeline is accomplished within just 3s, for a single image field. A robotic platform translates and focuses the camera over an ultra large stage, onto which the samples are disposed. Unsupervised, frame-by-frame scanning of thousands of image fields and subsequent image stitching results on large material characterization maps, which comprise an indispensable tool for the automatic, identification, triaging and sampling of target materials. Applications in forensics and in histology will be presented for highlighting the analytical strength of this new technology.

13:20

VISUAL QUALITY INSPECTION PLANNING: ENHANCING PERFORMANCE THROUGH ROBOTICS AND COMPUTER VISION SYNERGY

SPEAKER
Vanessa Staderini, AIT

ABSTRACT
Quality industrial inspection is a critical aspect of manufacturing, ensuring product integrity and reliability. However, traditional inspection planning methodologies often concentrate solely on either robotics or computer vision, leaving room for improving the performance in terms of speed and coverage. Our research introduces a comprehensive approach that combines principles from both computer vision and robotics to enhance inspection capabilities. We developed a flexible and innovative algorithm that generates optimal inspection poses by considering the geometric characteristics of the inspected object and the kinematics of the robotic system. This approach can be applied across various types of robots and sensors, providing a versatile solution for industrial inspection challenges.

13:40

IMAGE-BASED METROLOGY THROUGH TALBOT-DIFFRACTED SHADOW IMAGING

SPEAKER

Nadim Maamari, CSEM

ABSTRACT

The CSEM spaceCoder technology has been recently improved with a patented Talbot-diffractive configuration which provides improved metrological performances. Such a diffractive spaceCoder has been implemented in a stereo configuration to accurately extract the distance of a metallic piece without contact.The system has been designed as follows: a point light source is focused on a device under test (DUT). The reflection of the collimated light on the DUT becomes the illumination source for the spaceCoder device, which is able to measure the distance to the DUT and extract its profile.

14:00

MAXIMIZING INSPECTION ACCURACY- BRIDGING GAPS WITH ADVANCED AI ALGORITHMS AND GENERATIVE MODELS IN DATA SCARCITY SCENARIOS

SPEAKER
Hongsuk Lee, Neurocole

ABSTRACT
The primary goal of the manufacturing industry is to achieve maximum efficiency with minimal resources. Neurocle provides a solution that easily accomplishes this objective in the manufacturing sector. What is most crucial for enhancing quality and expanding yield in manufacturing?
It is the 'inspection' process, ensuring that defective products are detected and eliminated.
While vision inspection is important, perfection in it has never been achievable. When performed by humans, flexibility is present, but there is a lack of consistency and speed. When performed by machines, it is fast and consistent, but unable to replace human intervention in case of exceptions.
Addressing this gap is the innovative application of deep learning technology to vision inspection, resulting in a revolutionary solution known as deep learning vision inspection.
However, implementing deep learning vision inspection poses numerous challenges in practical applications.
Firstly, to delve into the specialized field of deep learning and apply it to manufacturing, skilled experts are essential. Yet, acquiring such experts is both cost-intensive and challenging due to their scarcity.
Secondly, creating a deep learning model that conducts accurate inspections requires high-quality data. However, the manufacturing industry, aiming to maximize yield and minimize defects, lacks abundant fault data. For instance, how can one secure ample data when only a few defective items are produced over several days?
While there is a collective belief that deep learning technology will bring about a new revolution in the vision inspection sector of manufacturing, the reality is that successful adoption is achieved by only a fraction, approximately 10%.
Neurocle has taken on the challenge of overcoming these difficulties to enable accurate vision inspection under adverse conditions and has successfully achieved it! In this session, we will cover Neuro-T, the software developed by Neurocle, equipped with features that overcome all challenges in the implementation of vision inspection in manufacturing. We will introduce an Auto DL algorithm-based model training method that does not require experts, a Generative Adversarial Network (GAN) model that generates virtual defective images, and other outstanding features. Additionally, we will discuss successful cases created by Neurocle based on its two core technologies.

14:20

SYNTHETIC DATA GENERATION FOR AI-BASED AUTOMATION IN QUALITY INSPECTION AND OBJECT DETECTION

SPEAKER

Ira Effenberger, Fraunhofer IPA

ABSTRACT

AI-based image processing represents a key technology for digitization and automation in production. Since the image data sets required for quality assurance and object handling have to be acquired on real set-ups of the optical system and annotated in a time-consuming manner, considerable automation potential remains unused to date.

A sensor-realistic image simulation, which is based on a 3D model (e.g. a CAD model) of the object and physically correct rendering algorithms, makes it possible to synthetically generate image data sets for training AI-based optical inspection or handling systems. For quality control tasks different kinds of defects are simulated, for object pose estimation random object positions are simulated, taking into account the optical properties of the object and the production environment. Thus a representative and annotated database for training AI models is created. The availability of synthetic realistic data sets provides a significant time and cost advantage, resulting in cost-effective automation solutions for production. In the presentation the advantages of sensor-realistic synthetic data is shown on two examples, one in the field of quality inspection demonstrating a detection and classification of 4 different types of defects on metal objects, and one in the field of object detection for handling applications dealing with slightly transparent objects.

TIMETABLE
DAY 3 – THURSDAY, 10TH OCTOBER, 2024

10:00
2D MONITORING IN ARC WELDING SCENARIOS
Michno Tomasz,AIT

10:20
FROM RELIABLE SCENE UNDERSTANDING TO ENHANCED 3D RECONSTRUCTION
Gasperini Stefano, VisualAIs & TUM

10:40
MULTI-MODAL VISION SENSORS FOR PROCESS CONTROL OF CARBON FIBRE PARTS MANUFACTURING
Eitzinger Christian, Profactor

11:00
SENSOR-BASED SORTING TECHNOLOGY IN THE RECYCLING INDUSTRY – AN OVERVIEW
Eckert Alexander, AIT

11:20
ADVANCED VISUAL INSPECTION: DEEP LEARNING AND NEUROMORPHIC VISION
Malago Luigi, Quaesta

13:00
OPTICAL DETERMINATION OF ROTATION ANGLE AND TORQUE USING FEATURE-BASED IMAGE MATCHING
Lorenz Eike, IPH Hannover

13:20
SUPER-FAST LINE SCANNING WITH A VIRTUAL LINE RATE GREATER THAN 1 MHZ
Bodenstorfer Ernst, AIT

13:40
PROSPECTS OF DEEP LEARNING FOR SURFACE INSPECTION IN THE PRESENCE OF SYNTHETIC DATA
Fulir Juraj, Fraunhofer ITWM

14:00
INLINE DEFECT CLASSIFICATION USING PHOTOMETRIC STEREO IN BATTERY ELECTRODE PRODUCTION
Kapeller Christian, AIT

DAY 3 – THURSDAY, 10TH OCTOBER 2024

10:00

2D MONITORING IN ARC WELDING SCENARIOS

SPEAKER

Tomasz Michno, AIT

ABSTRACT

The welding industry is exploring various computer-aided strategies to improve weld and part quality. Incorporating inline 2D visual data has proven beneficial for real-time monitoring and controlling of welding processes. This can include measuring the shape of the weld pool, the width and height of the weld seam, or analyzing the surface to detect defects. In wire-arc additive manufacturing this is even more important as the build process is challenging to control.

However, the quality of the images captured by the camera can be very challenging, especially when using cameras without active illumination. Experienced welding operators can derive meaningful information from welding visualizations, that are not easy to read for non-experts. Automated image analysis even of challenging images, should thus be able to deliver process feedback.

In this presentation, the state of the art in 2D vision monitoring in the welding industry will be presented including current AIT research in the area of WAAM and Gas Metal Arc Welding.

10:20

FROM RELIABLE SCENE UNDERSTANDING TO ENHANCED 3D RECONSTRUCTION

SPEAKER

Stefano Gasperini, VisualAIs & TUM

ABSTRACT

Reliability is a fundamental characteristic we expect from vision systems in any application, such as in production environments. For learning-based models, reliability specifically affects generalization and robustness. Challenging conditions and corner cases pose significant issues for reliability. In scene understanding, low visibility or completely unknown objects can significantly degrade performance and make the output of the vision system unusable if not properly taken care of. In 3D reconstruction, few input views or reflective items can lead to erroneous depth maps. This talk explores common reliability issues that confront vision systems and presents mitigation strategies through a series of research works.

10:40

MULTI-MODAL VISION SENSORS FOR PROCESS CONTROL OF CARBON FIBRE PARTS MANUFACTURING

SPEAKER

Christian Eitzinger, Profactor

ABSTRACT

The manufacturing of carbon fibre parts has to fulfill tight quality constraints to ensure an optimal balance between low weight and high mechanical performance. There is substantial progress to proceed from end-of-line NDT to in-line process control. In addition to various kinds of random defects, also the fibre orientation and the exact placement of the carbon fibre in the mould have significant influence on the mechanical performance. However, the optical properties of carbon fibre, which is black and shiny, make it very difficult to apply conventional machine vision. To solve this problem a multi-modal sensor system is proposed, which generates several image modalities from which defects and fibre orientation can be robustly detected. AI-based methods are used for defect segmentation and classification. An experimental evaluation of such a sensor system on the example of a semi-automated, robotic draping process is presented. For this purpose, the sensor is directly integrated into the robotic gripper and is able to analyse the deformation of the carbon fibre fabric during the draping process.

11:00

SENSOR-BASED SORTING TECHNOLOGY IN THE RECYCLING INDUSTRY – AN OVERVIEW

SPEAKER
Alexander Eckert, AIT

ABSTRACT
Sensor-based sorting technologies revolutionized the recycling industry years ago by enabling unprecedented efficiency and accuracy in waste processing. Since then, existing sensor types have continuously been improved, and new sensor technologies have been introduced into the field of sensor-based sorting. This presentation provides an overview of the various sensor-based sorting systems currently employed in the modern recycling sector, including their operation and impact on material recovery.

By using sensors such as infrared, X-ray, optical sensors, and inductive metal detection systems, different material types can be accurately identified and sorted. These technologies make it possible to detect and separate metals, plastics, glass, and other materials, leading to higher purity in recovered resources while simultaneously speeding up the overall sorting process.

This presentation will showcase case studies and examples from the industry that highlight the benefits of these technologies. It will also address challenges, such as implementation costs. Finally, the presentation will offer a forward-looking perspective on the future development of sensor-based sorting technologies in the context of the circular economy and sustainable resource management. A special emphasis will be placed on the integration of artificial intelligence and machine learning to further enhance sorting accuracy and adapt to new challenges.

Sensor-based sorting technologies are a key component in the transition toward a more sustainable circular economy.

11:20

ADVANCED VISUAL INSPECTION: DEEP LEARNING AND NEUROMORPHIC VISION

SPEAKER

Luigi Malago, Quaesta

ABSTRACT

Quaesta AI delivers cutting-edge solutions using Deep Learning, excelling in anomaly detection, object detection, tracking, and more. We combine traditional and event-based cameras for high-speed and low-light environments. Our user-friendly systems ensure seamless integration into production lines.

13:00

OPTICAL DETERMINATION OF ROTATION ANGLE AND TORQUE USING FEATURE-BASED IMAGE MATCHING

SPEAKER
Eike Lorenz, IPH Hannover

ABSTRACT
The measurement of rotational speed and torque plays a vital role in many technical applications such as wind turbines, drive shafts in engines, or cardan shafts. Especially for predictive maintenance as well as intelligent monitoring and control, the accurate knowledge of these two quantities is crucial. Their measurement is usually carried out separately with rotary encoders and strain gauges (SGs) being most typical sensor types. However, non-contact sensors are more durable, as they are not subject to wear and tear. Sensors that need to be directly flanged to the shaft, in particular, represent a significant financial and design effort, as they scale with the size of the shaft. Due to these reasons, in the project "Modimo" at the Institut für Integrierte Produktion Hannover (IPH) gGmbH, a non-contact optical measurement method for simultaneous torque and rotational speed measurement is researched, where no modification of the shaft surface and no attachment of additional components to the shaft are necessary. The underlying hypothesis is that a CrMo-steel shaft surface already has local characteristics, such as grooves or defects due to its manufacturing and thus recognizable patterns. These patterns may then be compared with a previously captured 360° image of the entire surface and assigned to the absolute angular position. This allows the measurement of a rotation angle at one position of the shaft. Given two rotation angles at separate positions, the determination of an applied torque is possible by measuring the phase shift between the two angles. The pattern recognition is achieved through a feature based approach, which involves identifying distinct points on the surface of the shaft, that can be detected under various conditions. As feature detectors, SIFT and ORB features are tested and compared. Given the relatively small dataset, a brute-force matcher is currently used to accurately identify correspondences between an image and the preconstructed panoramic reference image of the shaft surface.

13:20

SUPER-FAST LINE SCANNING WITH A VIRTUAL LINE RATE GREATER THAN 1 MHZ

SPEAKER
Ernst Bodenstorfer, AIT

ABSTRACT
Traditionally, line-scan cameras have been used to meet the demanding speed and throughput requirements of an industrial production line for fast optical quality inspection of endless material. Unfortunately, the development of line scan cameras lags behind that of area scan cameras in terms of speed and pixel size. A promising approach is the use of modern illumination technology with its possibilities of fast strobing and overdriving of the LED's.

This presentation will showcase the development of an extremely fast scanner with a scanning speed that corresponds to a line rate of over 1 MHz. This scanner was enabled by AIT's fast strobing technology xposure:flash and by integrating a special FPGA module directly into firmware of an area-scan camera with a fast image sensor. This FPGA module stitches small blocks of a couple of lines seamlessly together in order to yield an image comparable to that at the output of a line-scan camera with 1.08 MHz line-rate. The FPGA module was designed at AIT using High-Level-Synthesis (HLS) design methodology.

13:40

PROSPECTS OF DEEP LEARNING FOR SURFACE INSPECTION IN THE PRESENCE OF SYNTHETIC DATA

SPEAKER

Juraj Fulir, Fraunhofer ITWM

ABSTRACT

AI has great potential for surface inspection. However, a common problem is the lack of data to ensure good model generalization to the desired deployment and interpretability of causes for model failure. Rule-based synthetic data shows to be an invaluable asset to the controlled model training in presence of surface defects and impurities. A novel transfer learning method for anomaly detection efficiently bridges the domain gap using only the pretrained models themselves. Both push the frontiers of automated inspection towards greater accuracy and better understanding of recognition models.

14:00

INLINE DEFECT CLASSIFICATION USING PHOTOMETRIC STEREO IN BATTERY ELECTRODE PRODUCTION

SPEAKER
Christian Kapeller, AIT

ABSTRACT
Battery technology is a fundamental pillar for our transition into an economy fueled by renewable energy.

The production of electrodes is an early step in battery manufacturing that is necessary for the successful creation of final batteries.

In this talk we will present how battery electrodes can be inspected inline at full production speed using high-performance photometric stereo-based sensors and how we can detect a variety of different battery defects to increase yield and conserve production resources.

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WORLD OF VISION

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