ImageHeadstart.eu

Breakthrough Computer Vision Applications in the Micro World: Consortium of Research Organizations for Industry 4.0

Interreg
EUROPEAN UNION
Austria-Czech Republic
European Regional Development Fund

ImageHeadstart news

The fact that the research in digital imaging methods such as light microscopy and x-ray tomography at partner institutions has reached a stage from which many practical applications can unfold is the main motivations of the project. The goal of the project is to help the companies in the region to translate this knowledge into the technology.

The established regional structure will, in the long term, even after the end of the project:

1) integrate regional firms into the research structure in the region,
2) direct regional research institutions to research in favor of regional firms and,
3) support further research development in the field of optomechanics, imaging, software development and other companies operating in the field of industry 4.0.

To this end, the consortium will:

1) organize regular information workshops every six months,
2) create a system for signing up for bi- and multi-lateral consultations, and,
3) publish regularly every six months information on the technical prograss of the consortium members (newsletter) to which regional companies may contribute.

ImageHeadstart news no. 1

Introductory message

ImageHeadstart is my heart project. As a scientist active in the basic research but at the same time being by family history strongly bound to (what is now called) a high-tech industry, I was always unhappy by the reality of what is called basic research. It is increasingly so that the scientist are no longer top technicians or engineers. How can they then claim that they unravel the secrets of Nature if any engineer who brings an analytical technique which exists but is by chance not accessible to the laboratory may prove them wrong? We, scientists paid from public funds, are permanently under the suspicion that we do not use them effectively. The more we follow the increasingly complicated rules, the more we lose the path to the secrets of the Nature. To avoid the fact that we eventually just burn the taxpayers money and do not get anything, we have to collaborate with those who are allowed to be at the forefront of the technology – the innovative companies. And this is what the ImageHeadstart is about.

Dalibor Štys, Institute of Complex Systems, FFPW, University of South Bohemia in České Budějovice

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Project partners

Institute of Complex Systems, FFPW, University of South Bohemia in České Budějovice, based in Nové Hrady. Since 2000, the Institute of Complex Systems of the FFPW USB in Nové Hrady and its predecessor, the Institute of Physical Biology, have been engaged in the development of new light microscopy imaging techniques. In academic research, the Institute has achieved a number of top results which are materialized in the software applications using original results in information theory and in construction of new approaches to digital light microscopy.

Project partners

Research and Development at the FH Upper Austria participates by two research centers in Linz and Wels.

The *Research Group Computed Tomography in Wels* currently has 16 staff members and 3 professors. In total, FHW has four powerful XCT systems: 1) for large parts and components (Rayscan 250E), 2) for high resolution scans up to 200 nm voxel size (Nanotom 180 and Easytom 160), and 3) for phase contrast imaging (Skyscan 1294). The main expertise of the CT Research Group involves the application of the latest CT-technologies in combination with advanced visualization techniques (e.g. virtual reality), image processing and CT simulation. Another focus is the development of quantitative CT methods for metrology and materials characterization for research and industry.

The *Linz optical microscopy group currently* consists of 10 project staff and 2 professors. It is equipped by two high-resolution fluerescent microscopes, 3 lithographic systems.

Project partners

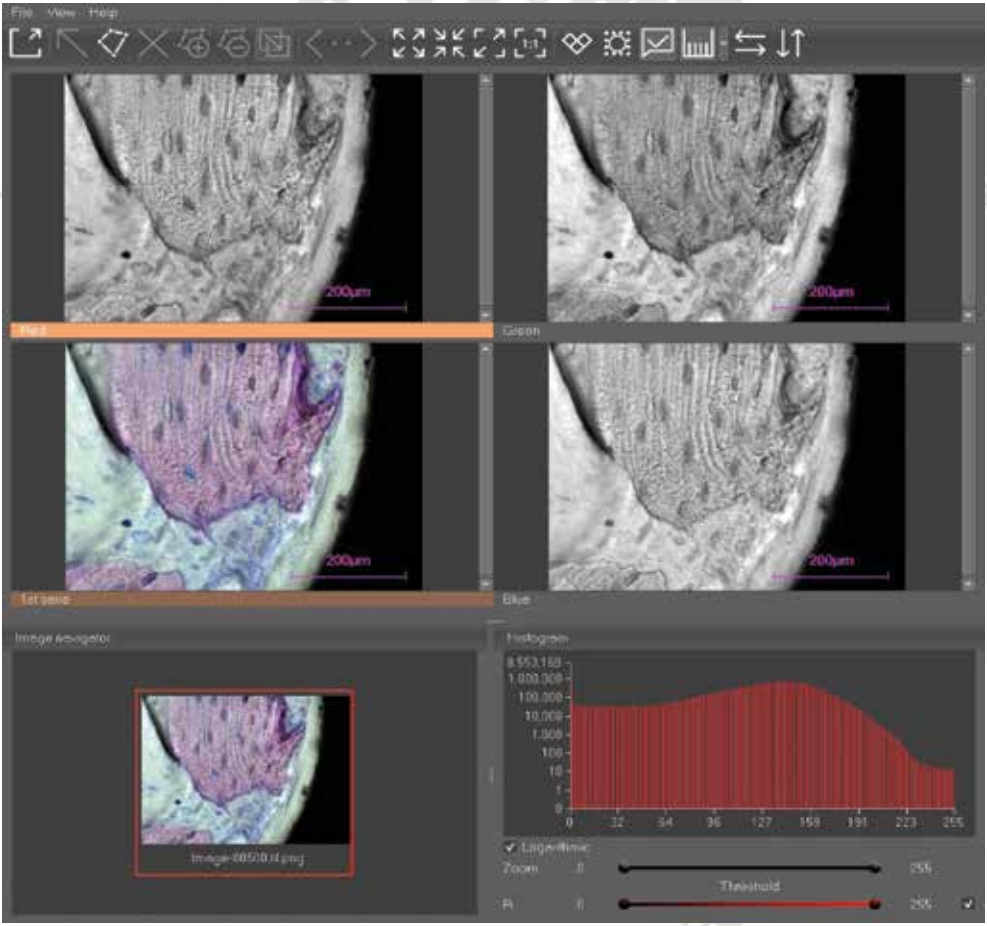
Danube university Krems (DUK) participates through the *Department of Biomedical Research* which specializes in stem cell biology, biomaterial development, tissue engineering, and imaging methods for imaging complex living cell processes. The DUK maintains cell culture laboratories with flow cytometry, an extensive laboratory of molecular biology, a laboratory for biomaterial characterizatwion, and sophisticated imaging methods. The DUK has basic equipment with a confocal laser microscope, plasmon resonance technology, electron microscope, micro particle analyzer and micro-CT. It also has an access to a biomechanics laboratory.

Partneři projektu

Telč Center of the Institute of Theoretical and Applied Mechanics of the Academy of Science (CET).
The CET has been dealing with optical and X-ray methods for obtaining the geometry and internal structures of objects, with the possibility of measuring displacements and deformations of samples under load. The team has many years of experience in preparing and solving a number of research and project tasks, especially in the field of materials research and biomechanics. When it was founded (supported by the European Fund for Regional Development), a unique tomography facility with two X-ray sources was built at the CET. The CET workplace is equipped, among other things, with a unique large-area X-ray pixel detector and a set of very fast spectroscopic detectors. The CET laboratories are equipped with many other devices for non-destructive examination of materials (optical microscopes, electron microscope, etc.).

Technology showcase – Image Explorer

Digital images are multidimensional matrices carrying values which, to a good extent, represent the amount of energy which reached the sensor after passing the color filter. Standard imaging software is designed to give the best visual impression of the captured image. This is achieved by manipulation with values in the matrix by which a majority of the image information is irreparably modified. The ***Image explorer (IMEX)*** was designed for scientists and technicians, who do not care about the visual impression but need to know the technical truth. The ***IMEX*** allows to work with original image datasets, sections and level-by-level inspections. Features may be highlighted and compared within a logical image series. Results may be exported. The ***IMEX*** *was created in collaboration of the Institute of Complex Systems, FFPW, University of South Bohemia in Nové Hrady and Image Code, Brloh.*

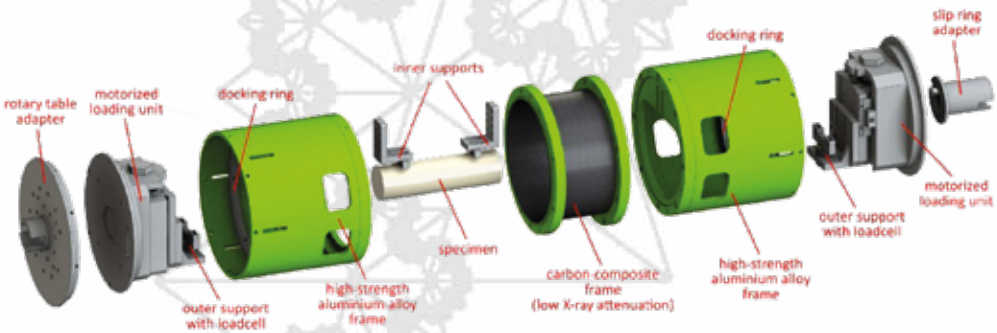


4D computer tomography

Four-point Bending Test Instrumentation for 4D computed tomography

High-resolution time-lapse micro-focus X-ray computed tomography (4D micro-CT) is a method for investigating the deformation processes and fracture propagation characteristics of non-homogeneous materials during loading. For this purpose, a unique experimental device (Czech national patent 307897) capable of four-point bending (4PB) testing during X-ray imaging has been developed. In contrast with standard bending setups, the proposed device is designed for vertical orientation of the investigated specimen, whose axis of rotation is identical to the rotational axis of the CT devices. The device is composed of three main components: a pair of a motorized loading units with integrated movable outer supports of the four-point bending arrangement, a pair of stationary inner supports of the four-point bending arrangement, and a cylindrical load bearing frame housing the loaded specimen together with the loading units and all the supports.

Proof of concept together with pilot experiments were successfully performed in the TOMATOM CT scanner. Based on results acquired, fracture-process zone and macroscopic crack propagation in a quasi-brittle material can be observed in 3D using an in-situ loading procedure and high resolution 4D micro-CT.



Concrete activities

Direct consultation and workshops:

The results of the consortium will be handed over to companies, which can then use them in the subsequent development and production of products for the world market. An electronic form will be established through which consultations between companies and consortium members will be arranged. The consultations will then take place to the extent necessary and may include technical demonstrations of the consortium members. This will ensure that the consultation has concrete outputs. A standardized record will be kept of the consultation process.

Workshops will be organized in the 2nd, 3rd, 4th and 5th semester of the project and will focus on partial technical outputs of the project. Regional companies and public institutions, which can use the results of the consortium, will be addressed.

Presentation on key conferences:

A standard presentation of the ImageHeadstart project will be created in the form of a booth and its equipment - presentation screen, computer, electrical wiring, etc. This booth will be used at 6 major conferences or fairs in the major industrial centers of the region, Vienna, Brno or Linz. The presentations on events outside the region will be organized jointly and not funded by the project. Regional companies may participate at these events together with the project partners.

RESEARCH

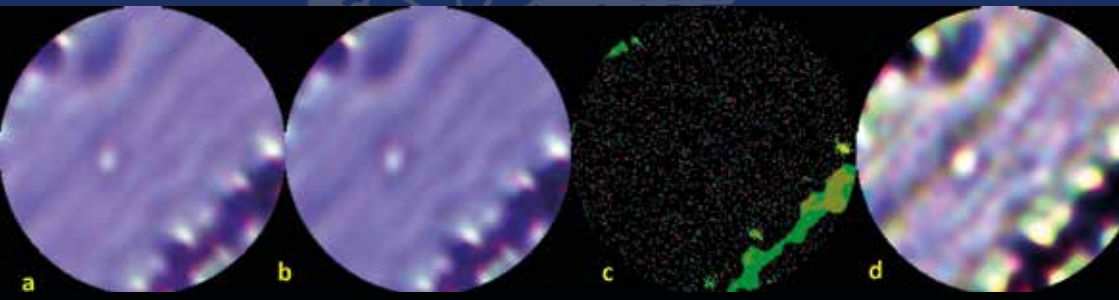
Technology research will be conducted in two main directions:

1) Associated equipment for surface electromagnetic radiation detectors and data processing therefor; and,
(2) Micro- and nano-positioning optomechanical devices and their control. In both cases, these technologies are a combination of technical solutions and new algorithms, software.

New marketable products are expected in following fields:

(1) Scientifically novel software tools for creating 3D tomographic maps from 2D detectors,
(2) Optomechanics and instrumentation,
(3) Microscopy and tomography of metal and non-metal materials for medicine and material research,
(4) Microscopy of living cells and tissues.

The scope of the research may change according to the results of company needs expressed during the consultations.



a) Original image from 47-Mpx light microscope camera.
b) Calibrated image, in which differences in responses of camera pixel chips were compensated. The calibration can be determined up to the level of energy reaching each camera pixel.
c) In-focus points, i.e., voxels (3D pixels) 46×46×10 nm³ showed in intensities of the given point.
d) Pseudosurface covering the in-focus points. Approximation to the case when a 10-nm optical cut would be performed on the observed object and there would be observed all phenomena such as, e.g., light diffraction, light absorption, and fluorescence.

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