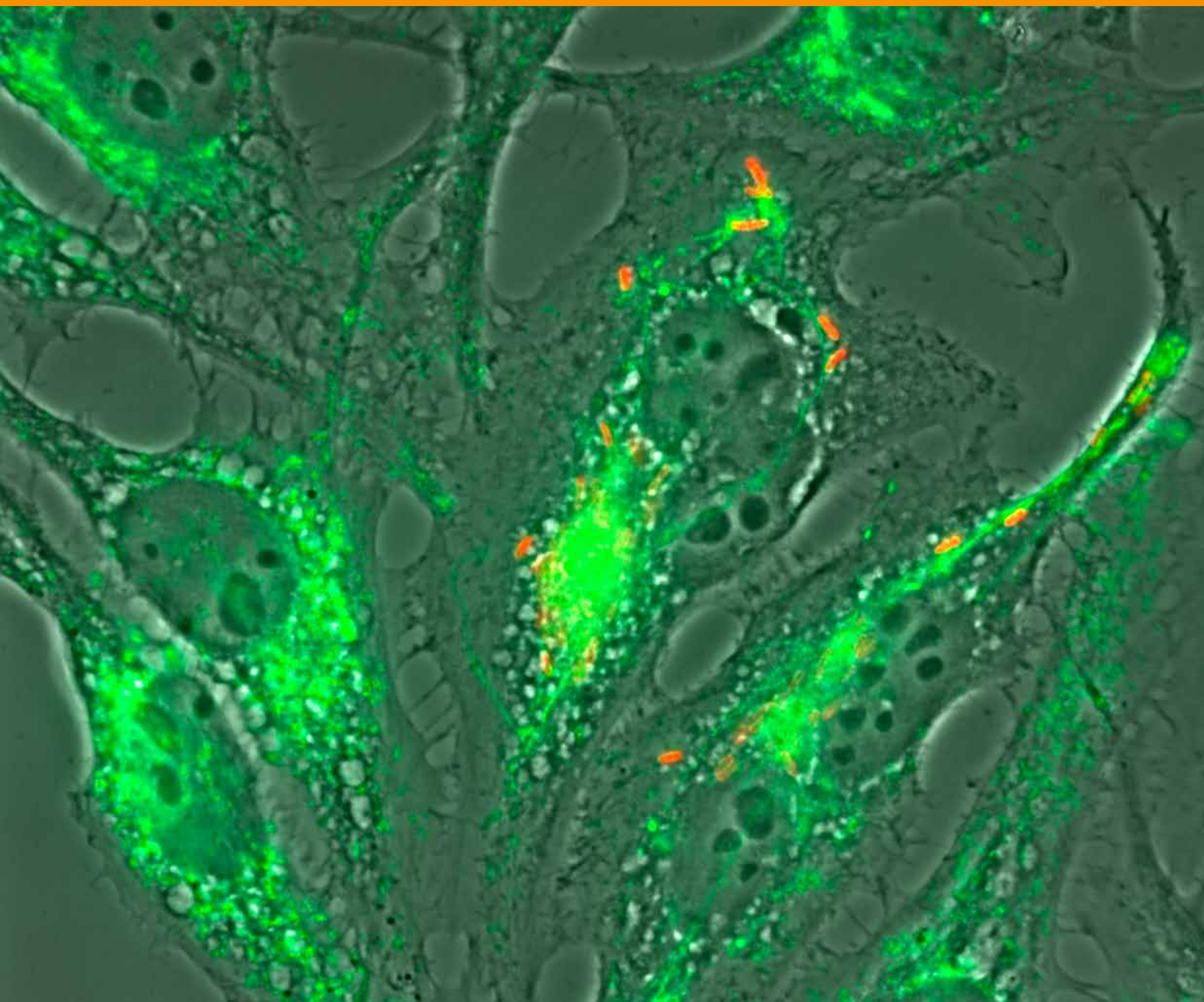
Fraunhofer
IIS

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS

MEDICAL IMAGE PROCESSING



WHO WE ARE

As part of the business field of Medical Engineering of the Fraunhofer Institute for Integrated Circuits IIS, the Department of Image Processing and Medical Engineering develops solutions for image-based analysis of medical, biological and pharmacological questions.

On the one hand, our focus is on the development and research of image analysis methods in order to support the physician when performing medical diagnostics, computer-supported early detection of tumors as well as follow-up control of therapy. With these technologies we have experience in the fields of microscopy, endoscopy and minimally invasive surgery, as well as mammography. On the other hand, we specifically develop methods and systems for analysis and interpretation of image data from pathology, general laboratory medicine and hematology as well as microbiology and biomedicine.

Funding of the Fraunhofer Institute is granted both by governmental support programs and industrial contract research. Thus, we are active in a dynamic equilibrium of application-oriented basic research and innovative product development. Our most important goal is to transfer knowledge and results from science to practice. Governmentally financed research projects enable us to perform non-commercial initial research in future-oriented technology fields. The results are then used in cooperation with companies. Thus, above all small and medium-sized companies will be able to benefit from our innovative research results.

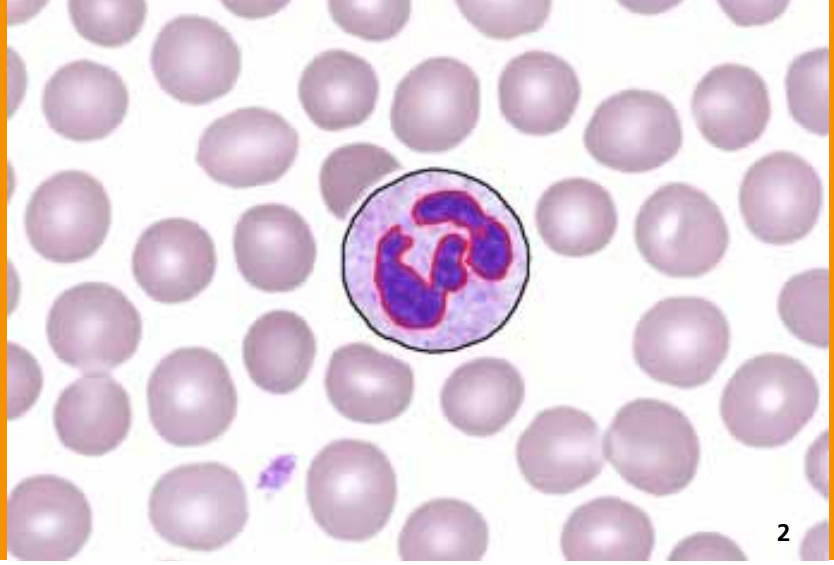
FIELDS OF ACTIVITY

COMPUTER-ASSISTED MICROSCOPY

Hematological examination of peripheral blood and bone marrow is the central and first step of medical diagnostics of anemia or blood diseases such as malignant lymphomas (lymph node cancer) or leukemias (blood cancer).
The HemaCAM® system was developed for use in hematological laboratories as supporting measure for generation of differential blood counts (see references). This certified system that is already used in practice is subject to continuous further development. Furthermore, we are also involved in other hematological research fields such as detection of malaria pathogens or automated analysis of bone marrow cells for differential diagnosis of leukemias and malignant lymphomas. Focus of work is on development of algorithms for safe detection, segmentation and classification of cells as well as integration into microscopy systems that can be used in practice.

Examinations in the fields of microbiology and life science often require microscopical evaluation of samples. For such evaluation, the transmitted-light method as well as various modalities such as phase contrast and often also several fluorescence channels are used to image and capture the various cell structures. Evaluation and interpretation of such – mainly comprehensive - datasets is still a very time-consuming, labor-intensive and often also manual process.
Fraunhofer IIS explores new methods for segmentation and analysis of multimodal cell imagery. Thanks to trainable models, our technologies are able to automatically adapt themselves to new problems.

Tissue sections of biopsies often represent the reference method for classification of pathological conditions particularly in the tumor staging. Visual control and sampling of histochemically stained tissue sections is a complex, time-consuming and labor-intensive process. In this case, automatic image-based methods for analysis may grant comprehensive time saving and objectification. Besides prepared tissue sections, methods for in-vivo tissue assessment such as confocal endomicroscopy are also examined.



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Automated microscopes allow for efficient and rapid digitalization of histological prepared specimens. This grants flexible, global and above all age-resistant conservation of such prepared specimens, and the prepared specimens are also available via Intranet and Internet anywhere and anytime. Such so-called ‚virtual slides' can be easily displayed and navigated on the monitor by using Internet-based systems. We develop fundamental technologies and software platforms for various applications that are required for efficient and safe digitalization of microscope slides. We also developed an Internet-based training system for educational purposes in pathology and anatomy that can be easily adapted to other tasks.

COMPUTER-ASSISTED ENDOSCOPY AND SURGERY

Endoscopy is used for more than 100 years in medical diagnostics and therapy of diseases and injuries inside the human body. Examination of esophagus, stomach, intestines, bladder or lungs is still a purely visual process that often requires biopsies (tissue sampling) for medical diagnostics. Interpretation of the endoscopic images is mainly based on experience and is correspondingly very subjective. The Fraunhofer IIS develops algorithms and procedures for use in diagnostic endoscopy for purposes of characterization and classification of tissue as well as detection of suspicious lesions such as intestinal polyps.

The so-called ‚keyhole' access of minimally invasive surgery reduces the trauma caused by the intervention, but simultaneously limits perception and orientation as well as accessibility and space of the surgeon. However, the current instruments of minimally invasive surgery do not tap the continuously increasing potential of mechatronics, microelectronics and information technology by far. This is where the Fraunhofer IIS gets involved to grant improved orientation and navigation inside the human body. This includes e.g. sensor-supported systems for image rectification with distal chip endoscopes, real-time endoscopic image panoramas for increases of field of vision and documentation as well as image processing and artifact suppression for any type of endoscopic system.

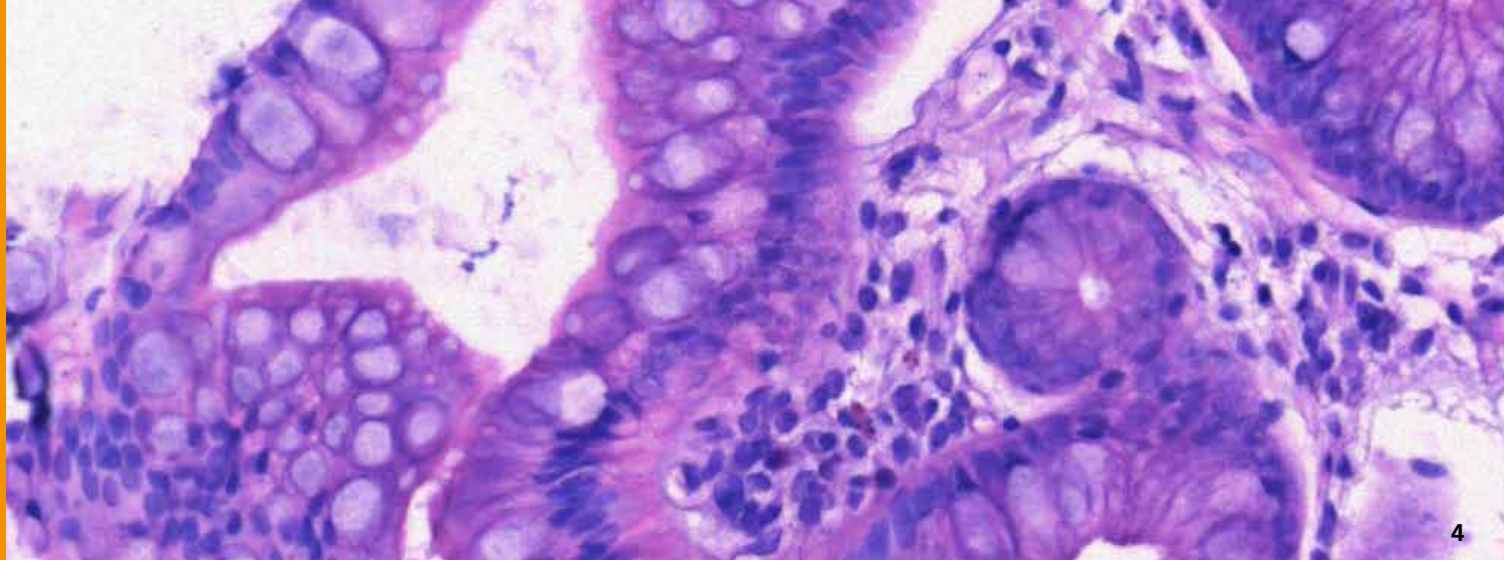
The growing partial automation of surgical interventions increasingly requires camera-based monitoring and control systems. Rapid camera systems and evaluation procedures allow for process control and general control. Fraunhofer IIS develops the process monitoring for a laser-based resection tool in neurosurgery that allows for continuous tracking of the laser beam. Real-time tracking algorithms allow for tracking and control of movements up to 100 Hz on complex imaging material.

REFERENCES

HemaCAM® – COMPUTER-ASSISTED MICROSCOPY FOR HEMATOLOGY

The differential white blood cell count (WBC) represents an important component of hematology. HemaCAM® allows for automated analysis of blood smears, and supports classification of cells. HemaCAM® reduces labor time, increases quality of diagnosis, and contributes to creation of a rapid and objective differential white blood cell count, also in case of suspicious blood samples.

The HemaCAM® is composed of a high-power microscope with a motorized stage that can be laterally and vertically moved by a computer. An insertable frame allows for simultaneous placement of up to eight slides per round. Such a table and the z-axis allows for movement and automated placement of the slides between the objective lens attached to a camera and the light source. The HemaCAM® software can be operated via a graphical user interface and controls all functions of the microscope and finally presents the results of the analysis. HemaCAM® is certified as in-vitro diagnostic device in accordance with the Medical Devices Act (Directive 97/79/EC, Annex I), and is distributed all over Europe by our industrial partner Horn Imaging GmbH since October 2010. The correspondingly required specifications, documents and the risk management up to design and performance of the legally required performance evaluation study were performed by the Fraunhofer IIS Medical Technology Test and Demonstration Center METEAN.



HRES ENDOCAM LARYNGOSCOPIC DIAGNOSIS SYSTEM

High-speed cameras are used to optically record the movement inside the larynx and specifically the oscillations of the vocal cords in order to assess and diagnose functional voice disorders. Fraunhofer IIS developed a digital high-speed camera system ‚HResEndoCam' in cooperation with Richard Wolf GmbH (Knittlingen) as well as the Department of Phoniatrics and Pedaudiology of the University Clinic of Erlangen.
The HREsEndoCAM system is distributed by Richard Wolf since 2005.

The human vocal cords usually oscillate with a fundamental frequency of approx. 120 Hz with males and 250 Hz with females when talking. Such rapid movement cannot be recorded with usual camera technology.
The developed digital high-speed recording system consists of camera head, camera control as well as an interface with a combined control, archiving and assessment computer. The CMOS image sensor in the camera head has a spatial resolution of 256 x 256 pixels. Maximum temporal resolution (frame rate) is 4000 images per second. The camera head provides of a detachable 90° magnifying laryngoscope for endoscopic viewing of the larynx, designed and produced by Richard Wolf.

Besides viewing of the recorded and archived vocal cord oscillations in slow mode, evaluation mainly focuses on two aspects: Visualization and assessment of motion by means of so-called digital kymographs, automatic movement and frequency analysis of the vocal cord oscillations. Both methods allow for data reduction of recording by approx. 90 percent. Besides visualization of vocal cord oscillations, parameter extraction of oscillations is also important. The movement analysis uses the recorded image sequences to calculate movement graphs (trajectories) and correspondingly derived significant and objective parameters such as phonatory fundamental frequency, transient time, amplitudes and period interval separately for both vocal cords.

All calculated and determined data can be directly integrated from the HResEndoCAM system into a digital patient record as well as into an individually configurable medical report.

1 *Computer-assisted creation of differential blood counts by using HemaCAM®.*
2 *Automatically detected segmented neutrophil in peripheral blood.*
3 *Functional laryngoscopic vocal cord diagnosis*
4 *Histological prepared specimen of esophagus (Barrett's mucosa).*

Title: HeLa cells with salmonella in multiple fluorescence.

OUR OFFER

The Department of Image Processing and Medical Engineering develops image based technical solutions for medical technology, laboratory diagnostics and biomedicine. Industry and service providers of any size benefit from contract research. We offer know-how to small and medium-sized companies without own R&D department and may serve as an ‚extended workbench'.

We are pleased to offer our services – from feasibility studies for your specific problem and customized evaluation of large amounts of image data to research and development projects.

Besides adaption and licensing of available algorithms and methods into existing systems, we also implement control software and user interfaces upon request. We provide support with technical documentation, performance of risk management as well as planning and performance of clinical studies and performance assessment studies in accordance with the applicable directives (DIN EN14971, 93/42/EEC, 98/79/EC) and the legal requirements as per Medical Devices Act, particularly via the Fraunhofer IIS Medical Engineering Test and Demonstration Center (METEAN), which is also located in and connected to the University Clinics of Erlangen.

- **TECHNOLOGY AND MARKET STUDIES**
- **FEASIBILITY STUDIES AND DEVELOPMENT OF CONCEPTS**
- **DEVELOPMENT OF ALGORITHMS AND SYSTEMS**
- **RESEARCH AND DEVELOPMENT SERVICES**
- **CUSTOMER-SPECIFIC EVALUATION OF IMAGE DATA**
- **TECHNICAL DOCUMENTATION AND RISK MANAGEMENT**
- **PLANNING AND PERFORMANCE OF CLINICAL STUDIES**

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