Robotics in healthcare

Application examples, trends and potential

A joint study by

Messe Düsseldorf

MEDICA

SPECTARIS
German Industry Association for Optics, Photonics, Analytical and Medical Technologies

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SPECTARIS – German Industry Association
for Optics, Photonics, Analytical and Medical
Technologies e. V.
Werderscher Markt 15
10117 Berlin
(from 01/12/2025: Robert-Koch-Platz 4, 10115 Berlin)
Germany
Phone: +49(0)30 41 40 21-0
info@spectaris.de
www.spectaris.de

Messe Düsseldorf GmbH
Messeplatz, Stockumer Kirchstrasse 61
40474 Düsseldorf
Germany
Phone: +49(0)211 45 60 01
info@messe-duesseldorf.de
www.messe-duesseldorf.de

Idea, concept, editing
Mike Bähren | SPECTARIS e. V.

Layout and design
WUM Werbeagentur GmbH | www.werbeagentur.wum.de

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CONTENT

Robotics – a boost for innovation in healthcare and for Germany as a business location

Jörg Mayer | Managing Director of the German Industry Association SPECTARIS

Robotics and artificial intelligence are among the key technologies that will fundamentally change healthcare in the coming years. Following the initial phase of digitalization, which focused on interfaces and software, a new stage of development is now beginning: robotics and AI – and especially their interaction – are opening up completely new dimensions. This is not just about process optimisation, but about genuine innovations in diagnostics, therapy, care and rehabilitation.

Although robotics already provides a wide range of applications today, we are only at the beginning of this development. In the coming years and decades, robotics will unleash enormous potential in production processes for medical devices, analytical or laboratory technologies, as well as in healthcare services. Patients will benefit from greater safety and more personalised treatment, while doctors and nurses will benefit from less stress in their daily work and more time to interact with patients. In addition, robotic systems will perform routine cleaning or laboratory automation tasks — thereby reducing the burden of monotonous work on skilled personnel.

The industries represented by SPECTARIS – optics, photonics, analytical and medical technology – are among the top 10 future industries in Germany. They have been drivers of innovation for decades and strengthen our country's competitiveness. Photonics in particular plays a key role as an enabler for robotic systems – from imaging and sensor technology to precision control. It is a central building block when it comes to successfully anchoring robotics and AI in healthcare.

As an association, we see ourselves not only as the voice of our industries, but also as a partner to companies on their journey into this new era. We promote exchange between industry, science, politics and society, acting as a catalyst so that innovations from our industries can realise their full potential.

In this publication, we are highlighting the potential of robotics in healthcare – for the benefit of patients, to reduce the workload for healthcare professionals and to strengthen Germany as a business location. Its purpose is to act as a catalyst, enabling Germany to fully embrace the opportunities of this key technology and to enhance its innovative strength on the global stage.

JÖRG MAYER

Managing Director of the German Industry Association SPECTARIS

SPECTARIS
German Industry Association for Optics, Photonics, Analytical and Medical Technologies

Robotics in medicine – innovations shaping the healthcare sector of the future

Marius Berlemann | Chief Operating Officer Messe Düsseldorf

The future of medicine is digital – and increasingly robot-assisted. Robotic systems have long been used in numerous areas of healthcare and are opening up new possibilities in diagnostics, therapy and patient care. In applications such as high-precision surgery using robot-assisted systems, automated logistics processes in hospitals or AI-supported nursing robots, robotics is helping to improve the quality of care and reduce the workload of medical staff.

The applications are diverse: surgical robots allow minimally invasive procedures with maximum precision, while rehabilitation robots assist patients in regaining mobility. In nursing care, too, assistance systems could help take over physically demanding tasks, making the work of skilled personnel easier. At the same time, robotic systems are used in diagnostics for automated image analysis or robotics-assisted laboratory systems that process samples with unprecedented efficiency.

Despite these promising developments, we also face challenges: integrating robotics into existing patient care structures requires not only technological innovations, but also ethical and regulatory guidelines. It must also be ensured that the focus remains on people and that the use of robotics is a meaningful addition, rather than competing with human expertise and empathy.

This publication provides an insight into the current state of robot-assisted medicine and outlines perspectives for the coming years. We invite you to learn about the potential and challenges of these groundbreaking technologies and to gain future insights.

MEDICA, the leading international event for the medical technology industry, healthcare and politics, and REHACARE International, the leading trade fair for rehabilitation, prevention, inclusion and care, offer the perfect opportunity to do so every year in Düsseldorf. At these events, leading companies in the field of medical robotics demonstrate current applications at the interface with the work of research and development teams from a wide range of disciplines. Renowned expert forums such as the MEDICA TECH FORUM and the MEDICA INNOVATION FORUM focus on best practices and facilitate important exchanges, opening up further application opportunities for robotics in healthcare and addressing pressing questions about their use.

The many practical examples already show one thing: robots will not replace doctors and nurses in the future. Rather, they will work hand in hand with their human counterparts to increase the precision, efficiency and, above all, the availability of medical care. The solutions already on display at MEDICA provide an impressive preview of what will be possible in the future. Think, for example, robot-assisted telemedicine applications, which allow examinations to be carried out over distances of many hundreds of kilometres.

Stay informed about this exciting field with first-hand insights – it's well worth it!

MARIUS BERLEMANN

Chief Operating Officer
Messe Düsseldorf

Messe Düsseldorf

How robotics is changing healthcare - overview, classification and summary

MIKE BÄHREN

Head of Economics
and Market Research
SPECTARIS

ROBOTICS ON THE RISE – FIGURES AND FORECASTS

The global robotics market has been growing dynamically for years. According to the International Federation of Robotics (IFR), nearly 4.7 million industrial robots are already in use worldwide, and the trend is continuing to rise[1]. Service robotics is developing even more strongly: according to the IFR Report 2025, 200,000 robots were sold in 2024 – an increase of 9 percent over the previous year[2]. Looking at the regional distribution of service robot suppliers, 44% of companies are based in Europe, 29% in Asia and 25% in the USA[38].

THE INDUSTRY ASSOCIATION SPECTARIS

Did you know? SPECTARIS is the German industry association with 400 members in the innovative sectors of optics, photonics, analytical and medical technology. Our goal is to strengthen the competitiveness and innovative power of our member companies. We are involved in shaping policy to promote our members' interests. We are pooling the expertise of our members and taking a joint stance on relevant issues.

https://www.spectaris.de

Transport and logistics solutions dominated the service robotics sector (~102,900 sold units, +14%). Other important areas include hospitality and service (~42,000 robots, -11%), agriculture (~19,500 robots, -6%), professional cleaning (~25,000 robots, +34%) and search, rescue and security (~3,100 robots, +19%)[2].

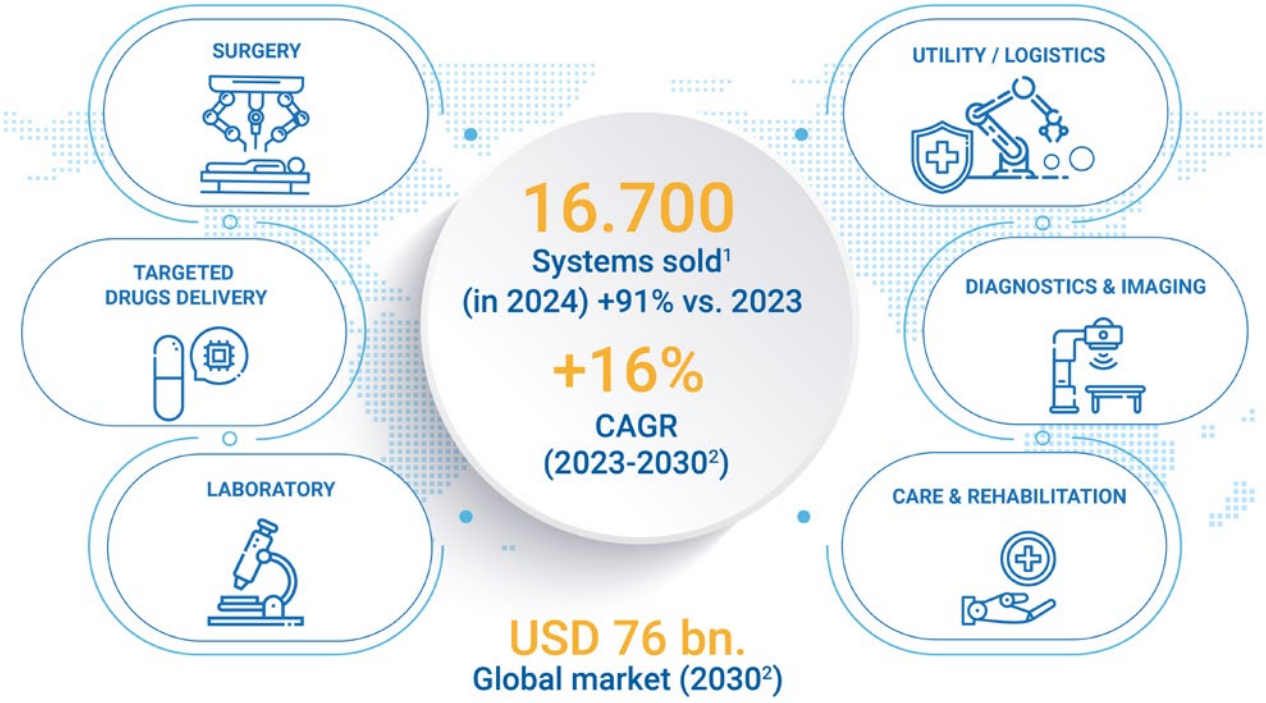
The medical robotics sector also saw strong growth: around 16,700 systems were sold worldwide in 2024 (+91%). Sales of rehabilitation and non-invasive robots have skyrocketed (+106%), surgical systems (+41%) and expecially diagnostics and medical laboratory analysis systems (+610%) also grew significantly, with double and even triple-digit growth rates[2]. There are around 80 service robot suppliers active in Germany, around 12% of which specialise in medical robotics[38].

The figures illustrate the enormous potential for robotics in healthcare, which is further boosted by its interaction with artificial intelligence. Market research institutes confirm this dynamic: Grand View Research, for example, expects the global market for medical robotics to grow from USD 25.6 billion in 2023 to over USD 76 billion in 2030 – compound annual growth rate (CAGR) of more than 16%[3].

CURRENT AND FUTURE APPLICATIONS FOR ROBOTS

Robotics in healthcare now encompasses a wide range of rapidly developing fields of application. Some systems are already an integral part of clinics, while others are on the verge of a breakthrough. The overview on page 9 shows the main areas of application.

ROBOTICS IN HEALTHCARE: GLOBAL MARKET FOR MEDICAL ROBOTICS



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SPECTARIS ROBOTICS TREND FORUM

The Forum, which took place on December 2024 at the Karl Storz Visitor Centre in Berlin, highlighted the latest developments and challenges in robotics. With around 100 participants from industry, research and politics, the event provided a platform for inspiring insights and lively discussions.

https://www.spectaris.de/verband/themen/trendforum-robotics


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AREA	TYPICAL APPLICATIONS
Surgery	• Minimally invasive procedures • Specialised operations (neurosurgery, orthopaedics) • Image-guided navigation • Collaborative robotics
Targeted drug delivery	• Microrobots in the body • Automated preparation and delivery
Laboratory	• Pipetting and analysis machines • Flexible process chains • AI-supported assistance systems • Robotic centrifuges
Utility/logistics	• Sterile goods reprocessing • Transport of materials and medicines • Cleaning and disinfection
Care & rehabilitation	• Rehabilitation robots • Exoskeletons for patients • Assistance for nursing staff
Diagnostics & imaging	• Tele-ultrasound • Robot-assisted biopsies • Automated endoscopies • Magnetically controlled capsule endoscopies

SURGERY

Robots have long been used in surgery. Minimally invasive systems facilitate procedures and increase precision. In addition to established complete systems, specialised solutions are gaining in importance – for example, in brain or knee procedures. New developments combine imaging and robotics to control surgical procedures even more precisely. Examples include the Da Vinci system from Intuitive Surgical[4], the Laserosteotom from Fraunhofer ILT[5], the Robin knee assistance system from KUKA[6], modular systems such as Cirq and Loop-X from Brainlab[8], the HEARO system from MED-EL[24], the Asensus integration at Karl Storz[26], the KINEVO 900 S robotic visualisation system from ZEISS[30] or the SOLOASSIST II from AktorMed.[39]

TARGETED DRUG DELIVERY

Robotics is also opening up new possibilities in targeted drug delivery. In the future, magnetically controllable microrobots will deliver drugs directly to diseased areas in the body. At the same time, clinics and pharmacies are working on automated systems for preparation and dispensing that reduce errors and save time. Examples include research work at TU Darmstadt[11] and automated systems such as the XR2 system from Omnicell[20].

LABORATORY

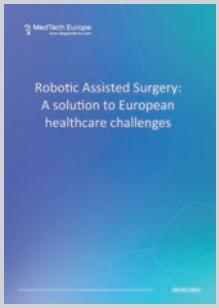
Robotics is already part of everyday life in the laboratory. From pipetting machines and robotics centrifuges to flexible process chains, robotics systems are taking over entire analysis steps. AI-supported assistance solutions make processes more efficient and enable faster diagnostics. Examples include developments at Fraunhofer IPA[12], laboratory solutions from Diabots[13], intelligent assistance systems from ITK Engineering[14], the uLab Series of United Robotics[34], robotic centrifuges from SIGMA[35] or Herolab[36] and robotic automation from ABB combined with laboratory instruments from METTLER TOLEDO[37] or the AuxQ from AEM August Elektrotechnik[40].

UTILITY AND LOGISTICS SOLUTIONS

Utility and logistics solutions reduce the workload for on hospital staff. Robots clean operating theatres, transport medicines or take over the preparation of surgical instruments. This leaves more time for patients. Examples include the MAV+ 1500 from NEURA 41, the SteriBot, developed at Fraunhofer IPK and TU Berlin[15] or the uClean Series from United Robotics[33].

MEDTECH EUROPE POSITION PAPER ON ROBOT-ASSISTED SURGERY

In May 2025, MedTech Europe published a position paper on robot-assisted surgery (RAS). It highlights that RAS can increase patient safety, improve treatment outcomes and reduce the workload for on healthcare systems. At the same time, the paper calls for better reimbursement and more political support to accelerate access in Europe[27].



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PATIENT CARE AND REHABILITATION

Robots are opening up new opportunities in patient care and rehabilitation. Exoskeletons help patients regain mobility after accidents or operations. Rehabilitation robots perform standardised exercises, while other systems assist nursing staff with heavy lifting tasks. Examples include the mobile rehabilitation robots from TEDIRO[25], the Apogee+ and ULTRA exoskeletons from German Bionic[17] and the ReWalk system from Lifeward[18].

DIAGNOSTICS & IMAGING

Diagnostics is also increasingly benefiting from robotics. Tele-ultrasound makes examinations possible over long distances. Robotic arms assist with targeted sampling in radiology, and magnetically controlled endoscopy capsules could soon replace traditional examinations of the gastrointestinal tract. Examples include telemedical ultrasound systems from MGI Tech[19] and the nuEndo project being implemented by Sensodrive[29], which is researching robotically controlled magnetic capsule endoscopy.

NEW DEVELOPMENTS AND FUTURE PERSPECTIVES

In addition to established applications, there are numerous research approaches. These include autonomous surgical systems that have already successfully performed operations on pig organs in preclinical studies[21]. Humanoid robots such as the Unitree G1 have been tested in San Diego as remote-controlled clinical assistants[22]. In China, surgical procedures have been successfully performed via satellite connection over several thousand kilometres[23]. These examples illustrate that medical robotics is continuously evolving – some applications are already a reality, while others are still a long way off.

Robotics in healthcare has a lot of potential – but will there come a time when we are treated by robot doctors?

TRADE FAIRS AS A DRIVER OF DEVELOPMENT

The rapid pace of development is also evident at the major trade fairs. Robotics has long been a focus topic at MEDICA in Düsseldorf. Every year, the MEDICA Tech Forum and Innovation Forum present the latest trends – from surgical robots to telemedicine applications. COMPAMED broadens this perspective by incorporating the viewpoint of suppliers: microcomponents, sensors and precision technology are the building blocks without which many robotic systems would be inconceivable. Trade fairs are therefore not just showcases, but genuine platforms where research, industry and clinics come together.

WHY ROBOTICS IS SO PROMISING

For patients, robotics means greater precision, fewer complications and shorter recovery times. Studies also show a reduction in the duration of surgery[31] and a significantly shorter hospital stay[32]. For staff, it reduces

MEDICAL ROBOTICS AT MEDICA TECH FORUM 2025

From 17 to 20 November 2025, SPECTARIS, in cooperation with MedicalMountains GmbH, will once again invite visitors to the MEDICA TECH FORUM — a central platform for sharing ideas on the latest developments and challenges in medical technology. Experts from business, technology, science, and politics will present fascinating insights into current trends, innovative solutions and regulatory frameworks. Visitors will also be able to learn about the latest advances in the field of medical robotics.

https://www.medica-tradefair.com/en/Program/Forums/MEDICA_TECH_FORUM

the burden of monotonous or physically demanding tasks – an important factor given the shortage of skilled workers. Hospitals benefit from more efficient processes and, in the long term, lower costs. Last but not least, the combination of robotics and artificial intelligence opens up new possibilities: telemedical interventions, personalised therapies and intelligent assistance systems are just a few examples.

CONCLUSION AND OUTLOOK

The healthcare sector stands on the threshold of widespread robotic adoption. While surgical systems and rehabilitation robots are already established today, research projects into applications such as autonomous surgery and humanoid robots demonstrate the potential that still lies ahead. The numerous examples, interviews and guest contributions in this publication illustrate just how enormous that potential is. It is clear that robotics is finding its way into almost all areas of healthcare and that artificial intelligence is driving this development forward. Germany can play a leading role with its strong. research community and manufacturing sector, as well as leading trade fairs such as MEDICA and COMPAMED. Germany can play a leading role. This requires practical regulations, clear reimbursement models and social acceptance. Exciting developments still await us.

F.O.M.
Research Association Precision Mechanics, Optics and Medical Technology

THE F.O.M. RESEARCH ASSOCIATION

Did you know? The non-profit F.O.M Research Association Precision Mechanics, Optics and Medical Technology focuses on networking science and industry. It addresses industrial research needs by conducting innovation-oriented, pre-competitive research projects in fields comprising optics, photonics, optical metrology, robotics as well as analytical and medical technology. Find more information at:

https://www.forschung-fom.de

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The future of robotics: 5 questions for...

DR WERNER KRAUS

Head of Robotics at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA

SPECTARIS: What stage is robotics currently at – are we still in the early days or already in the midst of an industrial and social revolution?

Dr Werner Kraus: We are in a phase of transformation: robotics is evolving from classic, isolated industrial robotics to flexible, AI-supported solutions in new fields of application – including healthcare. This transformation is not yet a complete social revolution, but it is currently in full swing. Market data supports this trend, showing robust growth and a clear expansion in scope. Since 2019, industrial robotics has grown by an average of around seven percent per year, with one in eight industrial robots now being a cobot. Meanwhile, service and medical robotics continue to experience strong growth. On one hand, this reflects strong demand driven by social challenges, such as the shortage of skilled workers. On the other, it indicates that these systems are now ready for everyday use across a wide range of applications, rather than being limited to specific niche tasks.

Two levers are particularly crucial for further developments: Firstly, "automation of automation," in which systems increasingly configure themselves without the need for expert knowledge on the part of users. Secondly, robot systems are increasingly following the "ease-of-use principle". The focus here is on intuitive operation by end users on site without specialised knowledge. These principles are simplifying widespread use in previously untapped areas and thus contributing to the ongoing transformation of robotics.

SPECTARIS: In which areas do you see the most exciting fields of application for robotics?

Dr Werner Kraus: The fields of application for robots are virtually endless. Exciting areas of application include healthcare — from flexible automation in laboratories and hospital logistics to sterile goods processing and pharmacy operations. These innovations ensure high quality and patient safety while relieving staff of routine tasks. We work in a focused, customer-oriented way, using various funding formats to develop specific market knowledge and translate it into concrete automation projects. Our automation potential analyses (APAs) are a key tool in this process. They allow us to identify specific applications at end-user sites that can be automated in a technically and economically viable way, using modern, flexible systems and algorithms. Our expertise in the rapidly evolving fields of robotics and AI enables us to pinpoint the most promising areas and applications.

One practical example is the laboratory, and in particular mobile robotics for logistics tasks and the execution of everyday routines such as the dosing of liquids and solids. Modern algorithms help robots to cope with the conditions in the lab, so that it is no longer necessary to adapt the environment accordingly. Robotics is thus becoming a part of everyday work routines and reducing staff workloads without the need to change processes.

Robotics is also increasingly shifting to unstructured environments such as outdoor areas. This opens up new possibilities for logistics tasks, for example between

individual parts of buildings, allowing classic in-house delivery systems to be expanded and further transport tasks to be automated.

In general, the new flexibility makes it possible to respond to uncontrollable circumstances and, in particular, to process small batch sizes economically and efficiently. Instead of large, highly specialised systems, robotics is evolving towards more modular, scalable systems.

SPECTARIS: What role does robotics currently play in health-care, and where do you see the greatest opportunities for its use in the future?

Dr Werner Kraus: Thanks to our focus on the practical application of the latest technologies, we have already implemented a number of projects with users, which give us concrete insights into current developments. Therefore, aside from surgical and rehabilitation robots, robotics currently plays a significant but largely behind-the-scenes role in healthcare.

The solutions developed are less focused on patient care itself and more aimed at providing noticeable relief in areas such as cleaning, transport, material flow, sterile goods and sample logistics, without changing the bedside care process. This greatly reduces the workload on facilities and allows available staff to concentrate on more relevant tasks and interacting with people.

One of our current projects, for example, is the automatic, contactless recording of vital signs. We are testing methods for measuring heartbeat and pupil response in children using robots to enable regular checks and support nursing staff in this routine task.

Flexible robots are also becoming increasingly common in laboratories. Automated sample transport is already widely performed by robots, and the number of systems used for this purpose is growing steadily. Depending on the specific analysis steps, these systems can now perform additional tasks, including dosing, sample handling, and the transport of materials such as chemicals or consumables.

Dr Werner Kraus has been head of the Automation and Robotics research department at Fraunhofer IPA since 2019. He received his doctorate from the University of Stuttgart in 2015 and is an expert in cognitive robotics and machine learning and their transfer to applications in industry and commerce. Werner Kraus has participated in several national and international research projects and is involved in the national and international robotics community in various positions and memberships. He heads the Service Robot Group at the International Federation of Robotics (IFR).

Description of the Fraunhofer Institute for Manufacturing Engineering and Automation IPA

The Fraunhofer Institute for Manufacturing Engineering and Automation IPA, or Fraunhofer IPA for short, implements highly innovative and sustainable solutions in production engineering and automation for a wide range of future-oriented industries. These can range from methods, components and devices to complete machines and systems. The solutions are always linked to the institute's strategic cornerstones of "mass sustainability" and "mass personalisation". The institute sees its mission as the transfer of knowledge, innovation and technology from research results to applications in order to strengthen the competitiveness of companies. It sees itself as an independent partner that provides neutral advice and supports companies with project teams tailored precisely to their needs.

The "Automation and Robotics" research area is characterised by over 50 years of experience in all subject areas required for the development of robot systems and their key technologies. Among other things, the focus here is on the planning, design, implementation and optimisation of applications. Safety and cobots, usability and flexibility of application in the sense of "automation of automation" are also taken into account in order to make robot-based automation cost-effective even for small batch sizes. A key enabling technology for this is artificial intelligence (AI), which encompasses a wide variety of methods.

SPECTARIS: Looking at artificial intelligence and cognitive robotics, what particular opportunities and risks do you see for the use of intelligent, adaptive systems in the healthcare sector? How do you assess the acceptance of these systems among medical staff and patients?

Dr Werner Kraus: For us, AI and cognitive robotics are primarily enablers beyond standardised applications: they enable robots to react to unexpected sensor data and situations and to adapt themselves to unstructured circumstances instead of just working through rigid processes. This enables variable tasks in a wide range of practical applications to be carried out efficiently and economically.

Of course, special attention must be paid to data in AI, as stipulated in the EU AI Act. We need a lot of high-quality data to train intelligent systems, but in the healthcare sector in particular, the protection of sensitive information must be ensured at all times. Equally important are reliable validation, operational monitoring and the controlled handling of inaccuracies in model outputs. Acceptance is achieved when the systems demonstrate reliable performance and provide measurable support in practice. This enables medical personnel to apply their expertise where it has the greatest impact, rather than in time-consuming repetitive tasks or physically strenuous activities. It can be crucial for patients to provide feedback during the development process so that they can help shape the application. Transparent communication about benefits, limitations and responsibilities, as well as a social discourse that goes beyond pure technology, create trust and acceptance.

SPECTARIS: Where does German robotics stand today in terms of research and innovation as well as market-ready assemblies or systems? What role can robotics play in the future as a factor for innovation and location in Germany – also in comparison to the USA or China?

Germany continues to be very well positioned in terms of research and innovation in robotics, thanks in particular to application-driven excellence and strong technology transfer pathways. Germany's particular strengths are its domain knowledge in mechanical engineering and its proximity to the pharmaceutical industry. Both enable the identification and development of targeted, practical solutions with clear benefits, for example in laboratory automation and logistics. Humanoid robotics also receives significant media attention. We are currently working on its industrial classification and gaining practical experience with existing systems to evaluate potential applications on a solid foundation.

Robotics is a core topic at Fraunhofer IPA, where around 100 colleagues are working with companies to drive forward the robotic transformation. In this way, we are also accelerating dissemination through applied research and transfer. Initiatives such as the Robotics Institute Germany (RIG) and the RoX project, numerous other projects at state, federal and EU level, bilateral cooperation and regular spin-offs ensure that the latest technologies always make the leap into practice.

During my recent delegation trip to China, I visited numerous manufacturers of humanoid robots. The speed of development in China was truly impressive, even though some robots were still literally in their infancy.

Looking ahead, robotics should serve as a central pillar of innovation and a strategic location advantage for Germany, characterised by quality, safety, and specialist expertise. Emphasis should shift towards AI-driven, flexible systems suited to small-batch production rather than conventional monolithic systems. Compared to the USA with its high venture capital dynamics and focus on software, and China with its impressively high installation figures for new robots, we must above all improve our speed and scaling: transfer faster, standardise, build data-driven services and involve users at an early stage. In this way, our strengths can be consistently translated into marketable products and international competitiveness.

SPECTARIS: Dr Kraus, thank you very much for these fascinating insights


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Medical robotics at MEDICA 2025

SPECTARIS in conversation with...

MICHAEL DEGEN

Executive Director Trade Fairs at Messe Düsseldorf

SPECTARIS: How will the trend topic of medical robotics be addressed at MEDICA?

Michael Degen: A large number of exhibiting companies specialise in robotics. If you enter the terms "Robotik" or "robotics" in the search bar of the industry portal MEDICA.de, you will be shown exhibitors with relevant innovations. In addition, the stage programme will address interesting aspects of the topic. Companies will present best practices and opportunities, and challenges in relation to possible fields of application will also be highlighted and discussed. Examples include the MEDICA TECH FORUM, which we organise and develop in cooperation with SPECTARIS and the medical technology initiative Medical Mountains and the MEDICA INNOVATION FORUM. This is the central programme format for the entire spectrum of tech, digital and IT innovations.

SPECTARIS: Can you give examples of robotics innovations that have particularly fascinated you so far?

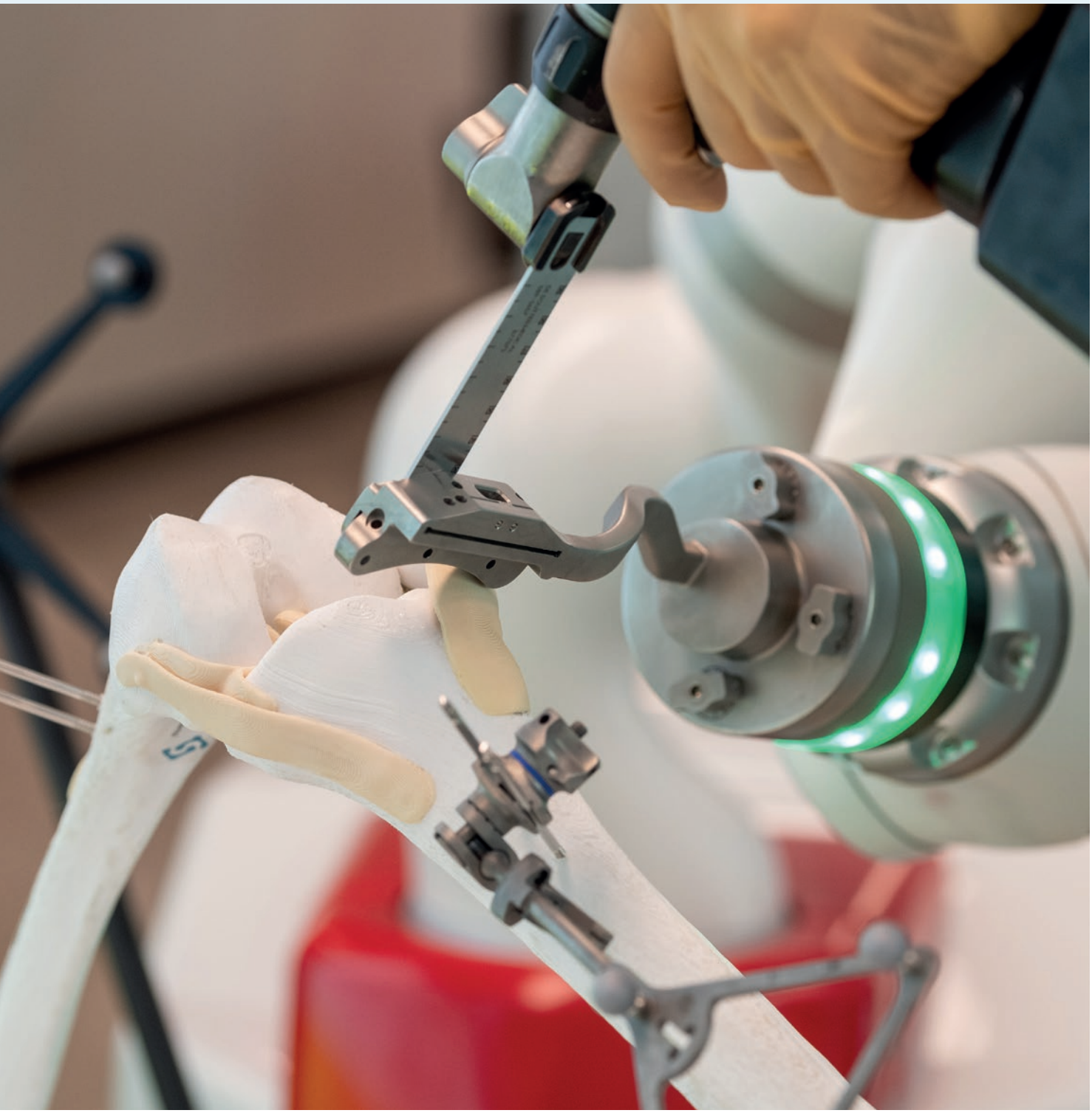
Michael Degen: Applications for many medical fields and disciplines have already been showcased at MEDICA. What's exciting is that medical technology companies work closely with research institutions and start-ups. Suppliers like KUKA provide robot components along with a software platform, which development teams then use to create specific solutions for medical applications—such as diagnostics, surgery or nursing care. I was particularly fascinated by a robotic telemedicine application. It allows doctors to examine their patients remotely, even over very long distances. The examining doctor uses a terminal with a kind of joystick to control a robotic arm to which an ultrasound transducer is attached. In this way, an ultrasound examination can be performed even if the doctor and patient are not in the same room. This could be extremely useful in the future for networked working and collaborative approaches involving specialists in hospital networks. The young start-up scene is also getting involved in medical robotics. The French medtech start-up Robeauté impressed at the MEDICA START-UP COMPETITION 2024 with a rice grain-sized neurosurgical microrobot and emerged victorious from the competition. The microrobot can move through the extracellular matrix of the brain and safely access areas that were previously almost impossible to reach with neurosurgery. It can perform targeted treatments, take samples or even implant sensors with precision.

SPECTARIS: A brief look into the future: As a trade fair organiser, you are in contact with many key players in the field of medical robotics. Where do you see particular potential?

Michael Degen: We learn a great deal from numerous discussions with our exhibitors, our trade fair partners and experts who appear in the stage programme. Good integration into clinical workflows is crucial. In future, robots will increasingly be used not only in traditional medical areas such as operating theatres, but also in laboratories and logistics. Examples include blood sample handling and medication preparation. The combination of robotics and artificial intelligence will also lead to many exciting developments including robot-assisted surgery based on AI-refined image data. In addition start-up Robeauté shows that microrobots are likely to gain importance in the medical sector when it comes to complex minimally invasive procedures. In this regard, the expertise of the medical technology suppliers at COMPAMED (parallel to MEDICA), will also be crucial. With their microcompon-

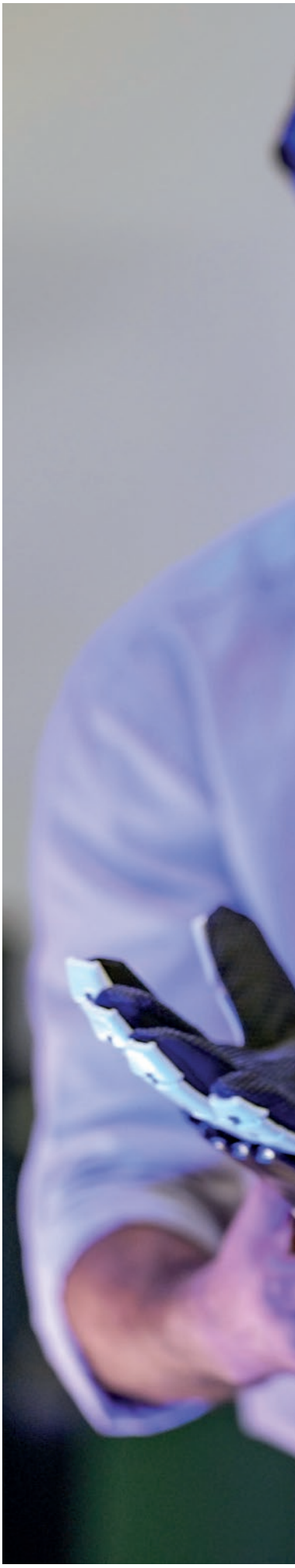
ents for microrobots, they are laying the foundation for further technical developments in this field. And we are almost in the realm of science fiction when it comes to advances in brain-computer interfaces (BCI). These make robots controllable by thought – heralding quantum leaps in neurorehabilitation.

SPECTARIS: Thank you very much for the interview and all the information. We look forward to experiencing medical robotics live at MEDICA.



APPLICATION EXAMPLES

Application examples of robotics in healthcare



Robin – Innovative robotics system for knee surgery

The “Robin” robot system was developed by Italian medical technology company Orthokey. It is based on KUKA‘s LBR Med and, thanks to its navigation system, enables precise robot-assisted procedures for total knee replacement.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

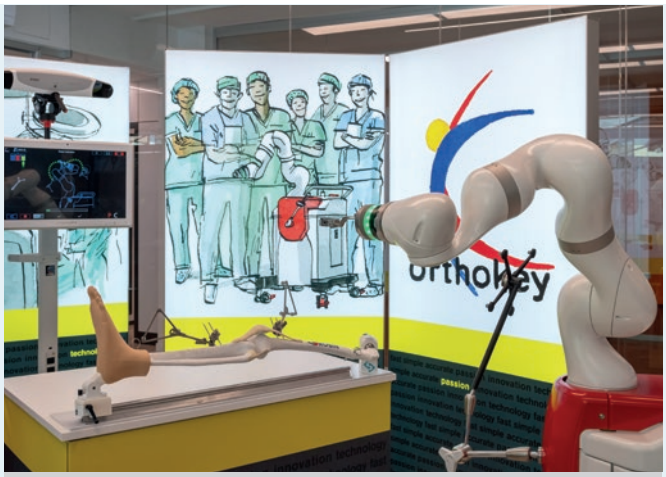
Orthokey has developed the “Robin” intraoperative robot system to assist orthopaedic surgeons in total knee replacement surgery. It is based on KUKA‘s sensitive LBR Med lightweight robot, which was developed specifically for use in medical devices. Robin uses a navigation system in which several trackers are attached to the patient and recorded by a camera with an accuracy of less than one millimetre. This allows the correct positioning of the implant to be planned and the bone resection to be performed with precision.

The solution is based on a modular approach that takes into account different implant manufacturers and clinic concepts. Orthokey developed the first prototype in collaboration with the University of Verona. A proof of concept was available after just eight months, and nine months later the hardware and software were ready and the certification process was started. Throughout the entire process, there was close cooperation with the KUKA development team.

The procedure involves capturing the patient‘s anatomy with infrared markers and visualising it in real time. The surgeon plans the bone resection on this basis. The robot arm moves automatically into position and then enables precise, collaborative processing. Each resection step is supported by a combination of automatic guidance and manual fine adjustment.

The system is currently undergoing certification in accordance with the Medical Device Regulation (MDR). Further approvals, including from the US Food and Drug

Orthokey from Italy presents its “Robin“ system. This is an innovative, collaborative robot solution for orthopaedic surgery.



"Robin" supports a wide range of orthopaedic procedures, including robot-assisted total knee replacements.
©KUKA/Orthokey

Orthokey relies on high-quality components for its surgical solution, including the sensitive LBR Med lightweight robot from KUKA.
©KUKA/Orthokey

"Robin" is used as an assistance system in the operating theatre and makes it easier for young surgeons in particular to get started.
©KUKA/Orthokey

During surgery, infrared markers are used to make the patient's anatomy visible to the robot system.
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©KUKA/Orthokey

Administration (FDA), are planned. Orthokey is working with international reference centres to achieve this. Feedback confirms the system's ease of integration, compact dimensions and intuitive operation. "Robin" is understood as an assistance system that expands the capabilities of surgeons, reduces variability between operators and improves the training of young doctors.

EFFICIENCY ADVANTAGES

"Robin" enables shorter operating times, more precise resections and less variability between surgeons. It reduces the workload of operating theatre staff, minimises misalignments and supports faster and better training of junior doctors.

TECHNOLOGICAL DESCRIPTION

Infrared markers are attached to the patient. These are detected by a camera, allowing the anatomy to be mapped in real time. On this basis, resections can be planned and performed with precision. The robot arm automatically guides the cutting tool and remains precisely positioned throughout the entire operation. At the same time, it enables collaborative work, as the surgeon can manually adjust and fine-tune the guidance at any time.

KUKA AG
Zugspitzstraße 140 | 86165 Augsburg | Germany

Jonas Micheler
Content Marketing Manager
Jonas.Micheler@kuka.com
www.kuka.com

A detailed case study on this example can be found at the following link: https://www.kuka.com/robotic-knee-surgery

Robot-guided laser osteotome for minimally invasive surgery

Robot-guided laser surgery procedure developed by Fraunhofer ILT in Aachen will enable precise and safe cutting of hard tissue in future and minimise the risks associated with neurosurgical procedures.

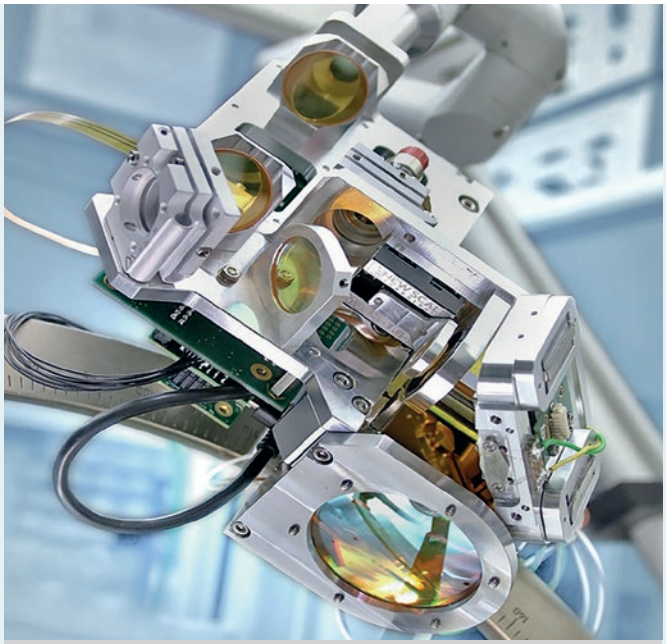
AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

In neurosurgical procedures, the surgeon must first gain access to the surgical site. This involves the use of mechanical drills and milling tools, which carry the risk of damaging functional structures such as the brain or spinal cord located beneath the bone. In particular, during decompression of spinal stenosis – the removal of bony narrowing of the spinal canal – approximately 1.5 percent of the 110,000 patients operated on in Germany each year suffer spinal cord injury with serious health consequences when the vertebral body is milled.

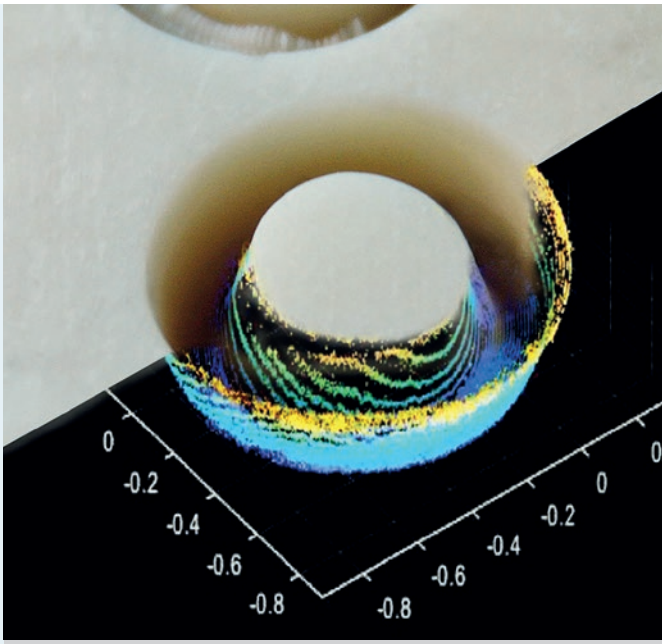
In addition, opening the skull during awake surgery places a high psychological strain on patients. Awake surgery is always necessary when complex brain functions such as speech or motor skills need to be tested during the operation. Patients are under local anaesthesia during the operation but suffer enormous stress due to the strong vibrations and noise.

An interdisciplinary team of physicists and engineers at the Fraunhofer Institute for Laser Technology ILT, in cooperation with clinicians, has developed a robot-guided laser osteotome that can cut hard tissue without vibration and with low noise. The cutting process is monitored optically and stopped when a defined residual thickness of less than 50 micrometres is reached. A piece of bone cut down to a thin lamella can be safely removed from the compound with little force after the cutting process. The technology demonstrator for the laser osteotome is currently being further developed as a prototype and

Robot-guided laser osteotome with laser applicator on a robot arm in the operating theatre of the RWTH Aachen University Hospital. This innovative laser surgery system for minimally invasive surgery is intended to replace mechanical milling in future and minimise surgical risks.



The laser applicator guides the focus of the cutting laser and OCT measuring beam into the kerf via a compact planar galvanometer scanner system. © Fraunhofer ILT, Aachen



Circular laser cut in a bovine bone with superimposed point cloud from the measurement data of the OCT scan. © Fraunhofer ILT, Aachen

validated in preclinical trials with development partners from industry, the Fraunhofer Society and clinical partners. The medium-term goal is to bring the laser osteotome into clinical use for minimally invasive surgery.

EFFICIENCY ADVANTAGES

By combining robotics and preoperative planning, bone tissue can be removed automatically and with high precision. This reduces the duration of the operation and ultimately the costs of surgery. However, the reduction in serious injuries associated with the laser procedure is even more important. In addition to a higher quality of life for individuals, society benefits from the reduced injury rate in the surgical treatment of spinal stenosis and the associated cost savings resulting from fewer cases requiring long-term care.

TECHNOLOGICAL DESCRIPTION

The precise laser cutting process for hard tissue is based on thermomechanical ablation using 100 ns short laser pulses in the MIR range, which introduces little heat into the tissue and thus prevents thermal damage to the tissue at the cut edges. An OCT (Optical Coherence Tomography) measuring beam superimposed on the cutting laser beam measures the remaining thickness synchronously with the ablation starting at a bone thickness of 400 µm. The laser cutting process is controlled to a predefined residual thickness of less than 50 µm to prevent damage to the risk structures located beneath the bone. An applicator superimposes the cutting laser beam and OCT measuring beam and focuses them onto the bone surface. In the applicator, a compact planar galvo scanner distributes the laser pulses at repetition rates of 10 kHz in the cutting kerf to ensure an efficient cutting process. The applicator is mounted on the articulated arm of a collaborative robot and uses the scanner mirrors to perform the cutting process along a cutting line planned by the surgeon based on preoperative image data. To remove larger pieces of bone, the laser pulses are applied to the cutting line through a combined movement of the scanner mirrors and the robot arm.

Fraunhofer Institute for Laser Technology ILT
Steinbachstr. 15 | 52074 Aachen | Germany

Dr Achim Lenenbach
Head of Laser Medical Technology and Biophotonics

achim.lenenbach@ilt.fraunhofer.de

https://www.ilt.fraunhofer.de/de/technologiefelder/medizintechnik.html

Robots in the laboratory: automated laboratory processes for sustainable diagnostics

Automated solutions optimise laboratory processes, from pre-analysis to post-analysis. They increase productivity, reduce the workload on staff and make a decisive contribution to ensuring diagnostic care despite the shortage of skilled workers.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Technology instead of bottlenecks – how robotics relieves the burden on laboratory operations: The ongoing shortage of qualified laboratory personnel poses major challenges for medical facilities in the UK and worldwide. Unattractive working hours, stressful shift patterns and a declining number of young professionals are exacerbating the situation. In many regions, the bottlenecks are already noticeable, and forecasts show that the trend will continue to intensify.

Robotics solutions offer a forward-looking answer to this problem. They take over monotonous, time-consuming tasks, freeing up skilled workers to concentrate more on demanding diagnostic activities. At the same time, automation improves working conditions and increases the attractiveness of the profession – an important factor in counteracting the shortage of skilled workers in the long term.

EFFICIENCY ADVANTAGES

From necessity to innovation: The increasing implementation of robotic systems is a direct response to the need to ensure consistent diagnostics even when there is a shortage of personnel. These systems are used in many laboratories fully autonomously during night shifts and on weekends, or during the day in cooperative operation together with staff.

3 cooperative robots at Labor Berlin, Vivantes Klinikum Friedrichshain

Especially in regions where skilled workers are already in short supply, robotic systems make an indispensable contribution to maintaining laboratory operations. In addition, they counteract the causes of staff shortages by improving working conditions and modernising the professional field.
Added value through intelligent automation: Robotics solutions not only reduce the workload for on staff and increase job satisfaction, but also increase the efficiency of processes. Since robots work without breaks, holidays or closing time, they ensure continuous sample processing and operational reliability.

System-independent implementation enables the connection of existing analysis devices from different manufacturers, thus reducing the need for costly new purchases. This flexibility makes laboratory automation equally attractive for small and medium-sized laboratories.

Automation solutions are a crucial step in effectively addressing the challenges posed by the shortage of skilled workers. They not only offer a technological response to growing staff shortages, but also improve working conditions and ensure the quality of patient care.

Positive experiences from previous deployments show that robotic systems bring considerable structural and economic advantages. In view of demographic change and increasing demands in the healthcare sector, the importance of flexible, intelligent automation solutions will continue to grow and have a lasting impact on the laboratory of the future.

TECHNOLOGICAL DESCRIPTION

Technology and workflow at a glance: In addition to the structural advantages, laboratory robotics impresses above all with its precisely coordinated technology, which intelligently complements existing processes. Modern robotic systems automate the entire process – from sample order to archiving.

In the pre-analytical phase, integrated cameras recognise the samples, analyse the cap colour, check the fill level and read barcodes. Based on the cap colour and laboratory specifications, the samples are prioritised and prepared for analysis. Work steps such as centrifugation, decapping and distribution to different racks are carried out in a predefined workflow.

After preparation, the robot transports the samples to the analysers, starts the measurement if necessary and then takes care of the return transport. In the post-analysis phase, samples are archived and can be automatically retrieved from the archive in case of additional requests or disposed of after the archiving period has expired.

DIATRACK laboratory automation at Labor Berlin, Vivantes Klinikum Friedrichshain

Concept development for DIATRACK laboratory automation

One technical advantage is the bidirectional interface to the laboratory information system (LIS). It enables continuous communication, automatically activates orders and processes additional requests without manual intervention. The systems can be individually adapted to the existing device infrastructure, making implementation economical and flexible.

DIABOTS GMBH
Weststraße 27 | 09221 Neukirchen/Erzgebirge
Germany

Phone +49 (0) 5031-9697066
info@diabots.de
www.diabots.de

Innovative technology by Intuitive: robotic-assisted surgical system da Vinci 5

Da Vinci 5, which received the CE Mark in July 2025, is Intuitive's most advanced and integrated robotic-assisted surgical system. It is designed to transform surgery to enable better patient outcomes, efficiency and insights.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Da Vinci 5 is Intuitive's most advanced and integrated multiport robotic-assisted surgical system. It features more than 150 enhancements and joins a portfolio of da Vinci surgical systems that surgeons have used to treat more than 410,000 patients in Europe in 2024 and nearly 17 million patients worldwide to date.

The da Vinci 5 system contains enhanced surgical senses to support better patient outcomes, the most realistic 3D da Vinci vision system to date, and an ergonomic, immersive surgeon console to aid in surgeons' career longevity.

Additionally, operational efficiency is achieved through greater surgeon autonomy with the integration of key components that surgeons can control at their fingertips, and by streamlining workflow with an easy-to-learn system, a universal user interface for care teams and dynamic assistance integrated into the system to automate select tasks.

The system also delivers actionable insights through an intelligent platform with 10,000x more computing power (compared to da Vinci Xi. data on file at Intuitive). New sensors, software and advanced processors provide surgeons with more useable data to help quantify, understand and improve their surgical performance for patients.

In 2024, the U.S. FDA cleared the da Vinci 5 surgical system for use during urology, general surgery, gynaeco-

logy and thoracic procedures in adults. In July 2025 the system received the CE mark for adult and pediatric use in Europe for procedures in the areas of urology, gynecology, thoracic surgery and general surgery, including colorectal surgery

Da Vinci 5 brings significant technology advances to help surgeons and care teams improve patient outcomes, and to improve surgeons' experience of surgery – from enhanced visualisation to transformative ergonomics. It is designed to transform surgery to enable better patient outcomes, efficiency and insights which as a result may help lower the total cost of patient care. The da Vinci Xi, X and da Vinci 5 surgical systems are designed for universal access in complex surgery using a minimally invasive approach. Furthermore, the single-port system with one arm, three multi-jointed, wristed instruments and an articulated scope, is suitable for use in narrow surgical spaces. Intuitive is committed to innovating minimally invasive solutions that reduce variability in surgery and help deliver better care.

Surgeon operating via da Vinci 5 console

These da Vinci surgical multiport systems, including the da Vinci 5, consist of an ergonomic surgeon console or consoles, a patient cart with four interactive arms and a high-performance vision system/tower equipped with imaging and energy technology to enable communication between the da Vinci system components.

Powered by innovative technology, the da Vinci surgical system scales, filters and translates the surgeon's hand motions into more precise movements. Da Vinci instruments with EndoWrist bend and rotate to a greater extent than the human hand and offer enhanced access to the surgical site. Da Vinci surgical systems have pioneered new capabilities in the operating room, transforming the field of minimally invasive surgery.

Intuitive not only manufactures the da Vinci systems, but also focuses on services to support customer needs. This support is referred to as the Intuitive Ecosystem, including

- professional education, structured as a multi-faceted and ongoing technology training programme;
- programme optimisation, including always-on-call service and maintenance that helps the systems stay fully operational and;
- advanced technology comprising a collection of digital tools and analytics that help track cost, use and outcomes and have the potential to do even more.

Intuitive Surgical Deutschland GmbH
Guerickestraße 1 | 79108 Freiburg | Germany

www.intuitive.com

The future of laboratory work: flexible robotics for everyday support

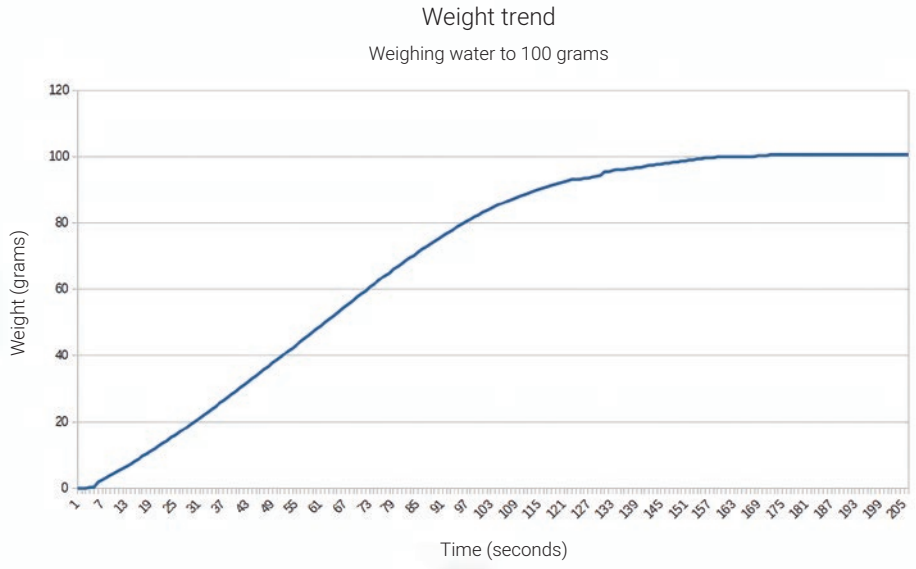
AI methods for gripping and motion planning enable robots to handle process objects and perform routine tasks in everyday laboratory work. The aim is to transfer and dispense using everyday tools (e.g. spatulas, pipettes).

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Fraunhofer IPA is currently looking at flexible lab automation using robots, which mainly handle the dosing of solids and liquids. So far, only high-throughput tasks like pipetting liquids with liquid handlers have been automated, but these are really hard to convert for small quantities. That's why a lot of lab work is still done by hand. Our robot system can handle substances by pouring or using established tools such as spatulas and pipettes, and can be easily adapted to new processes in the lab.

Above all, laboratory assistants benefit from reduced workloads, with shorter walking distances, less exposure to hazardous substances and the automation of routine tasks. Another valuable advantage is the capability to automatically process analyses at night and over the weekend. Iterative test series, in which slightly modified test protocols are tested, can thus be carried out without manual intervention. This results in effective utilisation of the existing infrastructure and reproducible test series with high data quality.

The drivers are the shortage of skilled workers and growing cost pressure. Automation compensates for staff shortages and increases efficiency. Obstacles arise from certification and cleaning regulations for necessary new hardware. Clear communication is also important: automation complements staff and does not replace them. Future developments will focus on automatic adaptation to new substances and laboratory conditions. Employees should be able to configure the system independently for



Exemplary weight curve during a water weighing process. The robot initially rotates faster until water flows into the container for the first time. Near the target weight, the tilt is less pronounced in order to achieve the target weight as accurately as possible.

Robot demonstrator at Automatica 2025 weighing water.

difficult substances such as highly viscous samples or for milligram-precise dosages. This will enable us to create a modular platform that supports both simple routine operations and complex applications.

EFFICIENCY ADVANTAGES

Efficiency advantages arise primarily from two factors. First, workstations and experiments can be prepared for experts in a way that allows them to perform their daily tasks without walking long distances. Second, experiments can run fully automatically, enabling efficient, around-the-clock execution.

TECHNOLOGICAL DESCRIPTION

The application was implemented using a collaborative manipulator mounted on a stationary robot workstation. Alternatively, it can also be easily installed on a mobile base to enable mobile use. An RGBD camera is attached to the flange of the robot. With the help of AI-based instance segmentation and 3D projection, common laboratory bottles can be identified in 2D and located in 3D. The neural network used for this purpose was trained with a specially generated data set, whereby the annotation of the data was automated using a developed software tool. New objects only need to be presented to the robot one after the other. By taking images before and after the object is placed, the exact object mask can be extracted, eliminating the need for manual annotation. After successful recognition, the robot picks up the bottle, moves it to the target vessel and begins the pouring process. Liquid dosing takes place in a closed-loop process with the aid of a scale and a PID controller and the pouring angle is continuously adjusted to precisely achieve the target quantity. The target quantity and desired liquid are defined, for example, via a user-friendly GUI.

Fraunhofer Institute for Manufacturing Engineering and Automation IPA
Nobelstraße 12 | 70569 Stuttgart | Germany

Florian Jordan
florian.jordan@ipa.fraunhofer.de

Miriam Schmelzer
miriam.schmelzer@ipa.fraunhofer.de

Andreas Traube
andreas.traube@ipa.fraunhofer.de

www.ipa.fraunhofer.de

Steri.Bot: Robot-assisted sterilisation of surgical instruments

The Steri.Bot research project is developing a mobile robot that uses voice control and situation-dependent sorting to sort, transport and, if necessary, open contaminated surgical instruments during preparation for complete cleaning

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

In hospitals, specialists have to manually sort and clean millions of contaminated surgical instruments every day. This time-consuming, repetitive task, which involves heavy loads and the risk of infection, is both physically and mentally stressful. Another reason why this process ought to be automated is the shortage of skilled workers. The project team is developing a mobile and collaborative robot that assists with the sterilisation of surgical instruments. In Central Sterile Supply Department (CSSD), it independently performs highly stressful tasks such as sorting contaminated surgical instruments and moving heavy loads. Personnel can intuitively assign situation-specific tasks to the robot with speech recognition. The robot understands verbal commands, including technical jargon. It also perceives its environment and reacts adaptively to it. The Steri.Bot robot is designed not only to interact with its working environment through voice control — allowing it to autonomously handle surgical instruments and trays — but also to automatically detect and respond to errors in complex processes. To achieve this, Steri.Bot connects seamlessly to local hospital IT systems, including the Instrument Management System (IMS). A consortium consisting of Fraunhofer IPK, TU Berlin, UKSH and NEXUS /IPS GmbH is working on this joint development, which was initiated and is coordinated by enamentis GmbH. Steri.Bot is based on modern technologies such as artificial intelligence (AI) and imitation learning, and uses flexible mobile manipulators. This enables human-robot collaboration in a long-neglected area of clinical practice, which can also be transferred to other areas of medical logistics.

The Smart.Camera Cir.Log is the Steri.Bot's "eyes"

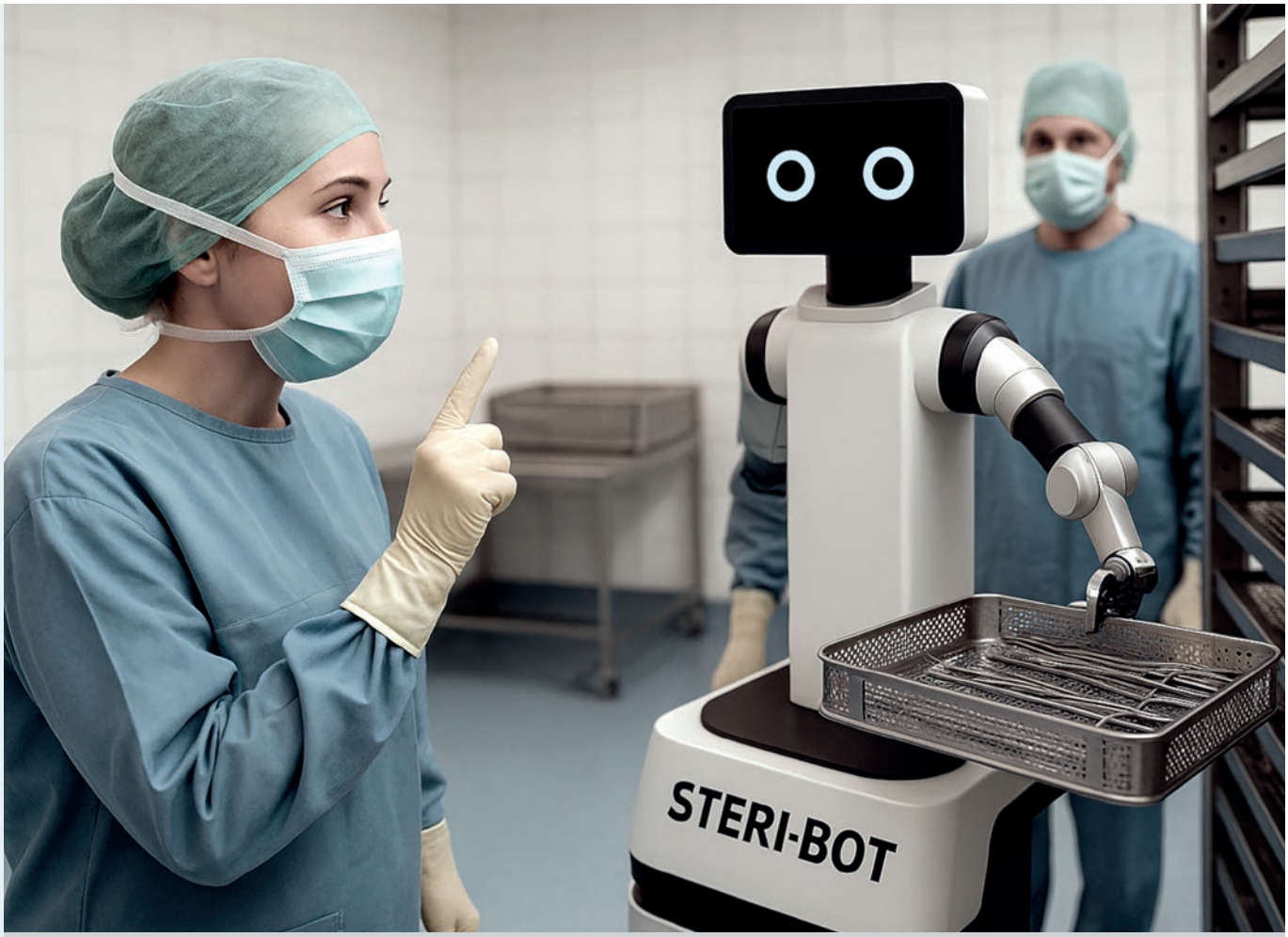
Source: enamentis GmbH

EFFICIENCY ADVANTAGES

Automated handling (sorting, opening, transport) relieves CSSD personnel of hazardous activities in accordance with the Technical Rules for Biological Agents (TRBA 250) and reduces manual heavy lifting (up to 3.5 tonnes per day). The mobile manipulator takes over collection/delivery tasks as well as sieve/container handling. AI-supported error detection and the connection to IMS optimise process and material flows prevent downtime. In addition to reducing the workload for employees, the Steri.Bot is also designed to enable faster training, higher processing quality and resilience in times of crisis.

TECHNOLOGICAL DESCRIPTION

Steri.Bot is a mobile gripping robot that works with cameras for colour and depth information and force sensors. AI-supported image analysis recognises instruments and sieves, determines stable points of intervention and



A robot assists in the sterilisation of surgical instruments

Source: enamentis GmbH (AI-generated with DALL-E, 2025)

tracks objects during movement. The robot's movements are continuously adjusted visually and based on force, so that even overlapping or sensitive parts can be safely separated, opened and deposited.

The system learns the necessary movements from demonstrations by specialists (e.g. using smart glasses or teleoperation). A domain-specific voice assistant understands the technical jargon of the CSSD, clarifies queries and integrates process and inventory data from hospital information systems (HIS). A modular system links voice, image and robotics functions and controls tasks, priorities and safety.

The robust computing unit in the protective housing of the Cir.Log Smart Camera processes data directly. Sensor fusion from cameras mounted on the gripper and stationary cameras creates a common environment model for navigation, as well as sieve and rinsing trolley handling. Safety functions such as emergency stop, person detection and defined intervention procedures are integrated. An anomaly detection system monitors force and movement profiles, detects blockages and specifically requests human-in-the-loop intervention. The modular approach allows for situation-dependent retrofitting into existing CSSDs.

Fraunhofer-Institut für Produktionsanlagen und Konstruktionstechnik IPK
Pascalstraße 8-9 | 10587 Berlin | Germany

Oliver Heimann
oliver.heimann@ipk.fraunhofer.de

Paul Koch
paul.koch@ipk.fraunhofer.de

www.ipk.fraunhofer.de

Holistic automation in surgical instrument reprocessing: combining process expertise, AI and robotics

We are revolutionising surgical instrument reprocessing by automating the entire workflow with AGVs and robotics. Our holistic approach integrates process expertise, AI, and an unified platform to ensure efficiency, safety, and consistency in hospitals.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Hospitals face increasing challenges in managing resources efficiently while maintaining high standards of patient care. One critical area is the reprocessing of surgical instruments in the Central Sterile Supply Department (CSSD). Previously, this process was highly manual, requiring significant staff time for repetitive tasks such as transporting, cleaning and sterilising instruments. This labour-intensive workflow often led to inefficiencies, staff fatigue and potential errors.

While there are already solutions on the market that automate individual steps of this process, our approach is fundamentally different. Drawing on extensive automation experience across various industries, we focus on the entire workflow rather than isolated tasks. Our holistic approach combines process expertise, artificial intelligence and a unified platform to deliver seamless automation of the complete reprocessing cycle.

We propose a solution that integrates Automated Guided Vehicles (AGVs) equipped with robotic arms. These AGVs automate key steps in the reprocessing workflow. They collect used instruments directly from operating rooms, perform pre-cleaning, and load them into cleaning and disinfection devices (RDGs). Afterward, the AGVs present the instruments to technicians for functional checks and maintenance. Once approved, the AGVs place the instruments into sterilisation containers, load them into sterilisers, and, after sterilisation, either store the containers or deliver them to the appropriate department. This solution is being developed in collaboration with robotics manufacturers and healthcare technology providers, ensuring seamless integration into hospital environments. The use of advanced sensors allows AGVs to mimic skilled employees by identifying inventory discrepancies, locating misplaced instruments and flagging workflow issues.

From the user's perspective, this automation reduces the physical and cognitive burden on staff, allowing them to focus on patient-centered tasks. For society, it ensures consistent, error-free reprocessing, enhancing patient safety and reducing infection risks. While market penetration is still in its early stages, pilot projects in select hospitals have demonstrated significant efficiency gains. Wider adoption is expected as costs decrease and awareness of the benefits grows.

Barriers to adoption include high initial investment costs and the need for staff training, while drivers include labour shortages, rising patient volumes and the demand for higher efficiency. Future developments may include AI-driven optimisation of workflows and integration with hospital-wide data systems, further enhancing the potential of robotics in healthcare.

EFFICIENCY ADVANTAGES

The solution offers significant efficiency benefits by automating repetitive tasks in the reprocessing of surgical instruments. AGVs with robotic arms save time

MAV+ lab automation

by streamlining transport, pre-cleaning and sterilisation processes, reducing delays between surgeries. Personnel can focus on critical, patient-centered tasks, improving job satisfaction and reducing burnout. Material handling is optimised, minimising errors and waste. While initial investment costs are high, long-term savings in labour, operational efficiency, and error reduction make this solution cost-effective and highly beneficial for hospitals.

TECHNOLOGICAL DESCRIPTION

The proposed solution integrates NEURA MAV+ 1500, a multi-sensing autonomous vehicle, into the reprocessing workflow of surgical instruments in hospitals. The MAV+ 1500 is designed for heavy-duty tasks, capable of transporting payloads up to 1.5 tons with high precision (±5 mm) and operating autonomously for up to 10 hours. Equipped with advanced 360° laser scanners and dynamic obstacle avoidance, it ensures safe navigation in complex environments, such as hospital corridors.

In this application, the MAV+ 1500 is paired with a robotic arm to automate key steps in the Central Sterile Supply Department (CSSD). The process begins with the MAV+ collecting used surgical instruments from operating rooms. It then performs pre-cleaning and loads the instruments into cleaning and disinfection devices (RDGs).

After sterilisation, the MAV+ delivers the instruments to technicians for functional checks and maintenance. Then the AGVs place the instruments into sterilisation containers, load them sterilisers and transport the sterilised instruments to their designated locations.

The MAV+ 1500's integrated sensors and AI capabilities enable it to detect discrepancies in inventory, locate misplaced instruments and optimise workflows. Its modular design allows for future upgrades, such as AI-driven decision-making and integration with hospital-wide data systems. This solution reduces manual labour, enhances efficiency and ensures consistent, error-free instrument reprocessing.

NEURA ROBOTICS GmbH
Industriestraße 33 | 72585 Riederich | Germany
www.neura-robotics.com

TEDIRO – Service robotics for gait rehabilitation

Mobile robots from TEDIRO accompany patients during walking training, increase the frequency of therapy and relieve specialists by taking over routine tasks.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

TEDIRO's mobile therapy platform THERY is used in acute care and rehabilitation clinics. It supports patients in gait training with forearm crutches – for example, after hip or knee surgery.

The robot is based on a mobile platform (e.g. manufactured by MetraLabs). TEDIRO has developed specialised medical application software for this platform, while MetraLabs provides the robotics hardware.

QuickBird Medical was involved in the initial development of the therapy management system.

Before this robotic therapy approach, gait training was entirely manual. Therapists supervised patients during exercises — such as training with forearm crutches — and provided continuous feedback on performance. This form of supervised guidance was time-consuming, monotonous, and highly dependent on the availability of skilled staff.

For clinics the use of robots means that training can now also take place in the evenings, on weekends, or on public holidays – less dependent on staff availability.

For therapists, robots take over instruction and monitoring. This creates more scope for individualised, hands-on therapy, complemented by detailed documentation of training progress.

For patients, additional training opportunities arise, including real-time feedback – even when therapy resources are limited.

For society, there is the potential to relieve pressure on the healthcare system while at the same time improving the quality of care.

Currently in use in Germany (CE certified), TEDIRO is deployed in five different facilities—ranging from rehabilitation centers to acute care clinics (as of 09/2025). An expansion is planned to other European countries as well as Asia.

The background drivers include the ongoing shortage of skilled workers in the healthcare sector. Automating repetitive tasks reduces daily workload and increases efficiency.

Challenges remain, particularly in the form of regulatory requirements such as MDR compliance and data protection.TEDIRO is already working on further applications for the THERY platform, e.g. gait training independent of the use of aids, stair training, etc.

EFFICIENCY ADVANTAGES

The solution contributes to efficiency gains by enabling additional training sessions regardless of staff availability, thus increasing the frequency of therapy. Therapists are relieved of repetitive routine tasks and can use their time for more complex treatments. Clinics benefit from better resource utilisation and standardised documentation. Overall, time and costs are saved while patient mobility is promoted and the quality of care is maintained.

The THERY therapy robot in action.

Images: Matthias Schmidt, Erfurt

TECHNOLOGICAL DESCRIPTION

TEDIRO equips mobile service robots with digital applications for therapy and diagnostics. Currently, a mobile service robot from MetraLabs serves as the basis, which meets the requirements for a medical device (EN 60601-1).

The medical application uses camera-based motion capture to record, classify and prioritise patient movements and provide feedback during training. The robot also motivates patients to train. In a study with a prototype, for example, patients who trained with the robot demonstrated higher walking speeds.

Therapists use the complementary, cloud-based therapy management system to manage patients, assign them (e.g. individual) training plans and, after training, view the training results and export them to the patient's file.

The robot thus operates independently of staff availability: after registering with the robot, patients receive detailed instructions. User studies have shown that both young people and seniors get along well with the robot.

The entire system is a medical device in accordance with MDR.

TEDIRO Healthcare Robotics GmbH
Ehrenbergstr. 11 | 98693 Ilmenau | Germany
Deutscher Platz 5a | 04103 Leipzig | Germany

Anke Mayfarth
Managing Director
anke.mayfarth@tediro.com

www.tediro.com

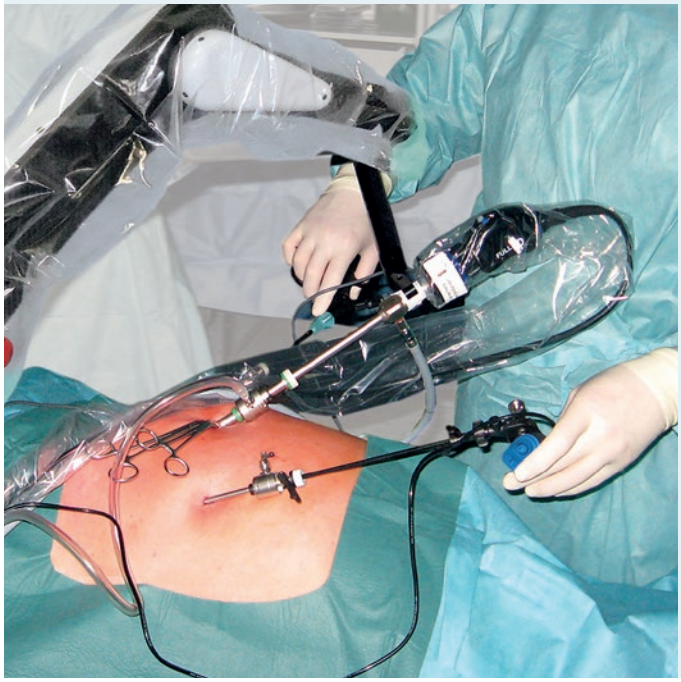
SOLOASSIST II – Robotic camera guidance in minimally invasive surgery

The SOLOASSIST II enables more concentrated, safer and more relaxed surgery thanks to its consistently stable image. The system can be controlled intuitively by the surgeon using a joystick, remote control, voice control or manually.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Minimally invasive surgery (MIS) has become the gold standard across many surgical disciplines. Smaller incisions, less trauma, faster recovery – the benefits for patients are well established. However, despite ongoing advancements in instruments, imaging systems and visualisation technologies, one critical aspect often remains a challenge: the stable and precise guidance of the endoscope.

In traditional MIS procedures, the endoscope is usually guided manually by an assistant. This approach, however, is prone to human error. Fatigue, limited line of sight, or miscommunication between the surgeon and assistant can negatively affect the efficiency and precision of the procedure.



Unstable or delayed camera guidance can lead to:

- Unnecessary movements and prolonged operation times
- Restricted visibility and spatial disorientation
- Increased stress for the surgical team and reduced focus for the lead surgeon

Stable endoscope guidance is essential in minimally invasive surgery – and this is where SOLOASSIST II sets new standards. Because precise surgery starts with a precise view.

The robotic endoscope holder SOLOASSIST II offers a smart, efficient solution to these challenges. It provides stable, precise and intuitively controlled camera positioning – fully under the control of the surgeon, without relying on an assistant.

Key Advantages of SOLOASSIST II

- Rock-solid image stability – The SOLOASSIST II holds the endoscope absolutely steady, regardless of procedure length or external influences. This ensures consistently clear, high-quality imaging throughout the surgery.
- Intuitive control with joystick and voice commands – The SOLOASSIST II gives surgeons multiple options for controlling the camera — all designed for seamless integration into the surgical workflow.

Joystick Control

A standout feature of SOLOASSIST II is its user-friendly and ergonomic control. The joystick is mounted directly onto the surgical instrument held in the surgeon's non-dominant hand – exactly where it can be operated effortlessly without interrupting the workflow.

The attachment is made using a magnetic coupling system, allowing for secure, quick installation and removal. This design enables seamless, one-handed control of the endoscope position as a natural part of the surgical routine – with no need for verbal commands or manual repositioning by an assistant. Movements are smooth, precise, and fully under the surgeon's control – maintaining focus on the surgical field at all times.

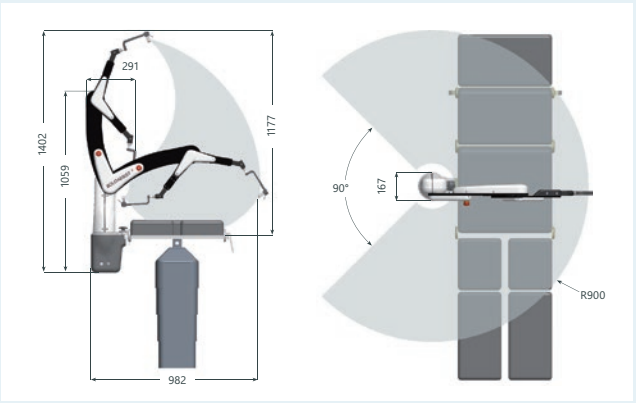
Voice Control (Optional)
Alternatively – or in combination – surgeons can use voice control to direct the endoscope. With clearly defined voice commands, SOLOASSIST II responds quickly and accurately to spoken instructions. This hands-free operation enhances comfort and flexibility, particularly in procedures where both hands are actively engaged or when joystick input is less practical.

EFFICIENCY ADVANTAGES
Whether using joystick, voice, or both, SOLOASSIST II adapts to the surgeon's preference and the demands of the procedure – providing complete control with maximum ergonomics.

In addition, there is another growing pressure: staff shortages in hospitals. Across many countries, hospitals are facing increasing staff shortages, particularly in surgical departments. Finding and retaining qualified personnel is becoming a serious challenge, placing additional strain on surgical teams and potentially affecting the quality and efficiency of care.

This is where SOLOASSIST II provides immediate and practical relief. By eliminating the need for an assistant to operate the endoscope, SOLOASSIST II frees up valuable personnel resources and ensures consistent, high-quality camera guidance – even in situations where staff are short or during emergencies at night and on weekends.

TECHNOLOGICAL DESCRIPTION
The SOLOASSIST II is technically a articulated arm robot, which mimics a human arm by size, specifically developed for endoscope guidance. The system features three motorised, computer-controlled axes, a mechanical joint that can be adjusted in 45-degree increments, and two free movable axes, providing a wide range of movement. The device is mounted to the operating table rail using a quick-release coupling mechanism, enabling fast installation and secure fixation. For sterile use, the entire arm is covered by a sterile drape.



During setup, the trocar position for the endoscope is registered within the system to define a fixed pivot point for controlled motion. All control electronics are fully integrated into the SOLOASSIST II – no external control units are required. To support flexible integration and expandability, all input devices like Joystick, Voice Control and Remote, but also third-party controls can be connected via a CAN bus. In addition, the SOLOASSIST can be unlocked at the touch of a button and repositioned by hand with virtually no resistance.

When not in use, the SOLOASSIST II is safely stored on a mobile trolley, providing protection and easy transport within the operating room environment.

AKTORmed GmbH
Neugablonzer Straße 13 | 93073 Neutraubling
Germany

Bernhard Schmidt
Bernhard.schmidt@aktormed.com
www.aktormed.com

AuxQ: flexibly integrable robotics solutions in diagnostic laboratories

In today's laboratory world, which is increasingly affected by a shortage of skilled workers, our advanced robotics solutions offer the perfect support. With a high degree of flexibility and manufacturer independence with regard to the analytical devices to be connected, our systems can be easily integrated into existing infrastructures – without any structural modifications.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The integration of AuxQ IncomingInspection is the gateway to autonomous laboratory operation. It enables the continuous transfer of samples from public areas and ensures their processability right from the start. At the same time, it guarantees a clean and traceable transfer of liability.

The AuxQ Lab Solution automates routine processes in the laboratory by integrating various modules directly into existing laboratory structures. These include AuxQ MobileLabRobotic, which flexibly transports samples and operates the analysis devices. The focus here is on collaboration between staff and robotics. The integrated analysis devices remain available for use by staff, and back-up scenarios in the form of secondary devices can be fully implemented.

Pre- and post-analysis of the samples takes place in the AuxQ CobotProcessing. The station can be configured according to customer specifications. All processes from sample verification, including level determination, centrifugation, decapping and sorting, to archiving can be integrated.

This reduces the workload on specialist staff and increases efficiency in laboratory operations. Depending on the service level selected, our trained team provides prompt support and ensures smooth operation.

The supply landscape in the field of laboratory diagnostics is characterised by a large number of small and medium-sized laboratories with low sample volumes. However, due to their connection to hospitals (e.g. with emergency rooms, stroke units, etc.), 24/7 availability of analytics is often essential. Full automation in the sense of a large laboratory or switching to a POCT laboratory is often not the preferred option in terms of cost and analysis. In view of the shortage of skilled workers, there is a growing need for solutions to reduce the manual workload in the low-throughput segment in the laboratory, as well as a need for solutions for self-sufficient laboratory operation.

AuxQ handles both the pre-analytical preparation of samples and the transport of laboratory samples and sample racks to the analysers within the laboratory. There, the AuxQ MR independently feeds the samples into the analysers and retrieves them again after processing is complete.

The system was developed to actively relieve the workload on staff, for example by processing samples autonomously at night without manual intervention. All interfaces to the hospital or sender are automated. Samples can be transferred to the system via pneumatic tube and pass-through. As an option, the AuxQ II can be placed outside the laboratory and thus accept samples around the clock. This component checks all relevant sample parameters before they are transferred to the AuxQ CP within the laboratory. This ensures the transfer of liability for the samples and increases the autonomy of the entire system.

As a result, there is more time for MTAs to perform more demanding tasks, and laboratories can work efficiently despite staff shortages – without any loss of quality. At the same time, an attractive working environment is created.

The system is used in hospital laboratories with varying sample volumes. Depending on the area of application, the focus is on support during daytime operations, autonomous night-time operations and automatic sample archiving.

The solution is currently in routine use in EMEA.

Driving forces include the shortage of skilled workers, the cost structure of laboratories, laboratory reliability, and digitalization. Fundamentally, close cooperation and staff acceptance are essential.

EFFICIENCY ADVANTAGES

The system is continuously adapted to customer requirements in the field of analytics. In addition, the field of immunohematology is the focus of overall development. Furthermore, areas of application are also being defined in larger laboratories and discussed with customers. Through its supportive role in day-to-day operations, the AuxQ MR enables employees to concentrate on more important tasks, saving valuable working time. It also helps to relieve the team during autonomous night-time operations. The aim is not to replace employees, but to fill gaps and effectively overcome challenges caused by staff shortages.

TECHNOLOGICAL DESCRIPTION

The AuxQ Lab Solution is a modular automation solution for diagnostic laboratories. The mobile robot moves through the laboratory without any structural modifications and takes on transport and handling tasks.

The various components of the AuxQ Lab Solution record sample parameters and perform pre- and post-analytical processes such as decapping or archiving.

The broad portfolio of manufacturer-independent analysers, which can be integrated specifically for each laboratory, gives laboratories the opportunity to diversify their analysis methods and adapt flexibly to changing requirements. Interfaces to the LIS make the robots an integral part of the laboratory workflow. This enables real-time communication between the various analytical components, increasing efficiency and minimising sources of error.

AEM August Elektrotechnik GmbH
Seerasen 4 | 36284 Hohenroda | Germany
info@auxq.de
Phone +49 (6676) 9216-730
www.auxq.de

GUEST CONTRIBUTION

Magnetic micro- and nanorobots for targeted drug delivery

Many drugs not only act at the site of the disease, but also affect the entire body. In future, tiny, magnetically controlled micro- and nanorobots will be used to deliver active substances directly to the site of the disease.

PROF. DR. ANNA C. BAKENECKER

Bakenecker is a professor of Medical Engineering in the Department of Electrical Engineering and Information Technology (etit) at the Technical University of Darmstadt. She is a physicist, specialised in medical physics and medical engineering and is developing highly innovative research ideas fornano- and microrobots for drug transport for which she got granted a LOEWE start professorship, a funding programme of the State of Hesse.

anna.bakenecker@tu-darmstadt.de
www.etit.tu-darmstadt.de/nanomedtec

MICRO- AND NANOROBOTS FOR MORE TARGETED AND GENTLER TREATMENT

In cases of blockages and narrowing of blood vessels (thrombosis and stenosis), it is no longer possible to deliver drugs to the site of action via the bloodstream due to reduced or completely absent blood flow. Aneurysms in the brain, which can potentially rupture and lead to life-threatening bleeding, are also difficult to reach with current techniques. Furthermore, the treatment and surgery of tumours located in hard-to-reach areas of the body are problematic. Chemotherapy has a significant impact on the entire body.

The treatment of thromboses, aneurysms and tumours are examples where micro- and nanorobots can offer more targeted treatment tailored to the individual patient. They could be guided through the blood vessels to their target location, where they would then release a specific active ingredient. This would allow treatment in hard-to-reach areas while protecting the entire body, as medication could be administered locally. Depending on where they are used, the microrobots may only be a few millimetres, micrometres or nanometres in size.

MAGNETIC AND SIMULTANEOUSLY BIOCOMPATIBLE AND DEGRADABLE MATERIALS

Due to the size of the microrobots, a drive comparable to large robots, i.e. electric or fuel-powered, is not possible. We therefore use magnetic fields for control. These have the advantage that they penetrate deep into the body and are completely harmless. In addition, the microrobots themselves do not need to carry a drive or energy supply. However, they must have magnetic properties. We are therefore developing magnetic materials that are also biocompatible and degradable, and are working with various manufacturing techniques in the micro- and nanometre range. We are researching control, tomographic visualisation and effectiveness for various application scenarios.

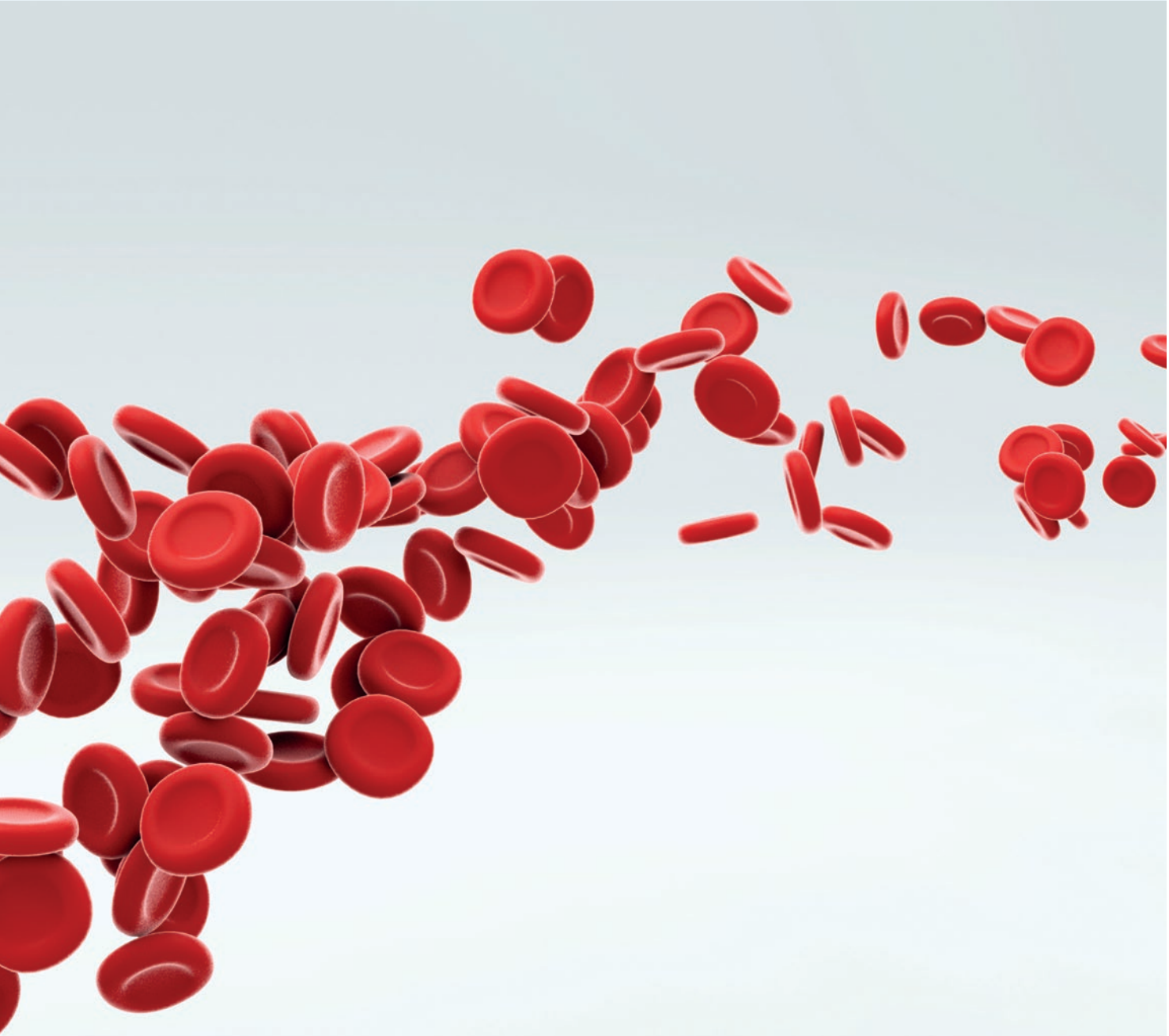
CONTROL VIA MAGNETIC FIELDS

The control of microrobots by external magnetic fields is essentially based on two mechanisms: Firstly, a magnetic force can be generated by a gradient field in which an object is pulled towards higher field strengths. Secondly, a magnetic torque can be generated. This means that a magnetic object aligns itself along the direction of the magnetic field. If a magnetic field is generated whose direction continuously rotates or oscillates, a magnetic object follows this field movement. In this case, microrobots with a helical shape are used to generate a helical forward movement, or flexible robots that move similarly

to a flagellum. Magnetic nanoparticles, which consist of biocompatible, biodegradable and well-tolerated iron oxide, are often used as materials. These can be loaded with drugs and controlled as swarms of thousands of particles. Alternatively, they can be embedded in hard or flexible biopolymers, which are given special controllable shapes using 3D printing processes.

THE RANGE OF POSSIBLE APPLICATIONS IS WIDE

The use of microrobots would initially benefit patients whose thrombosis, aneurysm or tumour cannot be reached using conventional treatment methods. Microrobots offer a new chance of recovery for these often life-threatening diseases. In the long term, a broader use of microrobots is also conceivable, as the targeted administration of active substances can reduce side effects and the strain on the body caused by strong medications. Other areas of application besides those mentioned above are also conceivable, such as the eye, the inner ear, the gastrointestinal tract or joints, so there is a wide range of potential applications.



Symbolic image: Blood cells flowing through a blood vessel

ABOUT US

Messe Düsseldorf / MEDICA and COMPAMED

Top platforms for the MedTech community to stay current on global business and emerging trends.

"Meet Health. Future. People." – the campaign slogan clearly defines what MEDICA in Düsseldorf stands for and what sets it apart. With several thousand exhibitors from over 70 countries attending regularly, it is the top platform for the global medtech community. For more than 50 years, renowned personalities and specialist audiences from all areas of the healthcare industry have been coming together here to make valuable contacts from all over the world. A comprehensive programme offers them information and discussions on the industry's hot topics. The entire spectrum of innovations for future-oriented medical care can be experienced live in one place – including technically sophisticated supplier products.

This uniqueness results from the interaction between MEDICA and the parallel COMPAMED. It has developed into the world's leading platform for the medical technology industry's supplier sector and, with its exhibition and stage programme, impressively showcases supplier expertise in key technologies: from a wide variety of high-tech components and material innovations for medical products to special packaging solutions and the entire spectrum of contract manufacturing.

medicalliance@messe-duesseldorf.com
www.medica.de
www.compamed.de

The programme highlights at MEDICA include the MEDICA INNOVATION FORUM on the latest digital health applications, the MEDICA LABMED FORUM for trending topics in laboratory medicine, the German Hospital Day as the leading communication platform for hospital management in German-speaking countries, and the MEDICA MEDICINE + SPORTS CONFERENCE for the international sports medicine community.

As a global platform for health tech innovations, MEDICA has also established itself as the world's number one meeting place for start-ups looking to enter the healthcare sector. Hundreds of young companies showcase smart wearables, AI diagnostics and micro-medical robotics in Düsseldorf – accompanied by formats such as the MEDICA START-UP PARK and the final pitch competitions of the MEDICA START-UP COMPETITION and the HEALTHCARE INNOVATION WORLD CUP.

The dates for MEDICA 2025 and COMPAMED 2025 at the Messe Düsseldorf exhibition centre are 17 to 20 November.

In line with the event concept, numerous services and up-to-date reporting on both trade fairs will be available online in advance and in parallel to the trade fair and conference events on site via the industry portals
https://www.medica-tradefair.com
https://www.compamed-tradefair.com

ABOUT US

German Industry Association SPECTARIS

SPECTARIS is the German industry association for optics, photonics, analytical and medical technologies

SPECTARIS is the German industry association with 400 members in the innovative sectors of optics, photonics, analytical and medical technology. Our goal is to strengthen the competitiveness and innovative power of our member companies. We are involved in shaping policy to promote our members' interests. We are pooling the expertise of our members and taking a joint stance on relevant issues.

Well-known representatives include B.Braun / Aesculap, Bruker, Dräger, Eppendorf, Jenoptik, Karl Storz, Leica, Richard Wolf, Rodenstock, Sartorius, Schott, Karl Storz, ThermoFisher or ZEISS. However, the majority of our member companies are medium-sized manufacturers that operate as "hidden champions" in their segments on the global market. Their products are used in many sectors of the economy and provide people with a high quality of life. It is no coincidence that the German government has declared some of these industries to be key technologies for securing Germany's position as a business location.

The medium-sized structure, enormous innovation potential, and strong export orientation form the common framework for these companies. In 2024, the SPECTARIS sectors generated total sales of €91 billion and employed around 360,000 people, making them an important cornerstone of German industry.

Consumer Optics | Photonics | Photonics, Medical Technologies | Analytical and Laboratory Technologies

MEDICA Meet Health. Future. People. Düsseldorf, Germany 17—20 Nov. 2025 **Hall 10 F42**

MEDICA TECH FORUM Hall 9 D10

SPECTARIS – German Industry Association for Optics, Photonics, Analytical and Medical Technologies e.V.
Werderscher Markt 15 | 10117 Berlin (from 01/12/2025: Robert-Koch-Platz 4, 10115 Berlin)
Germany
Phone: +49 (0)30 41 40 21-10
info@spectaris.de | www.spectaris.de
Linkedin: https://de.linkedin.com/company/spectaris

SPECTARIS
German Industry Association for Optics, Photonics, Analytical and Medical Technologies

SPECTARIS: a strong network of decision makers