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A hub of information technology

Zhejiang University: The Faculty of Information Technology

The Faculty of Information Technology (FIT) at Zhejiang University (ZJU) is a highly regarded institution, known for its excellence in teaching and research into optics, communication, control, electronic, biomedical, computer, software engineering and instrumentation science.

Information science and technology is an interdisciplinary field that encompasses the generation, collection, transmission, processing, computing, display and application of information. Work by FIT's six colleges covers the entire information life cycle.

Scientists in FIT research on both hardware and software, ranging from chips and devices to systems and communication networks. Their research integrates theories with technologies applied in sensing and detection, network and intelligent computing, biomedical information, human-machine engineering and intelligent security control.

With an annual research fund of over 450 million RMB, FIT's 410 faculty members have achieved a series of breakthroughs in areas such as optical imaging, automatic control, pico-satellites, bio-sensing, video coding and telecommunication, big-data analysis and virtual reality technologies. They have more than 700 papers published each year, most of which are featured in high-ranking Science Citation Index (SCI) journals and flagship conferences. Many results are translated into patents, and through partnerships with local enterprises, the faculty has contributed significantly to the regional economy.

Apart from conducting innovative research, FIT also takes significant responsibility for cultivating young people with technological excellence, an innovative mindset and global vision in information science and technology. It currently enrolls 2,313 undergraduates and 4,111 graduate students.

"Our students can be innovative researchers, as well as successful entrepreneurs," says Bao Hujun, dean of FIT. "Training such young talents is my greatest pride and delight," he adds.

In terms of research, education, and industrial application of information science, FIT plays a leading role in China. It has also formed partnerships with world-renowned research institutions, such as MIT, UIUC, UCLA and Philips Research to expand its global influence. To continue the 120-year pursuit of excellence at ZJU, FIT is making great strides towards becoming a globally prominent information science institution. ■

Six Colleges of FIT

1. College of Optical Science and Engineering
2. College of Information Science and Electronic Engineering
3. College of Control Science and Engineering
4. College of Biomedical Engineering and Instrument Science
5. College of Computer Science and Technology
6. College of Software Technology

浙江大學 ZHEJIANG UNIVERSITY

A snapshot of star programmes

Control Science & Engineering: Make it smart

The Chinese manufacturing industry is striving for better energy efficiency and environmental sustainability. To help the country accelerate this transition, ZJU's control science and engineering programme is devoted to providing the technology and talent needed for developing smart manufacturing in China and accomplishing its mission of serving societal demands.

The control science and engineering supports the deep integration of artificial intelligence, information science and manufacturing technology. The programme combines theory and practice to provide overall solutions for real-world challenges. With more than 60 years of development, it has established a solid framework that links fundamental research, technology, standards, equipment, systems, applications and commercialization related to control science and engineering. The programme is poised for significant breakthroughs by focusing on smart perception and analysis, intelligent control and optimization, decision-making and support, as well as smart control equipment and standards.

Optical Engineering: Vision changes everything

The optical engineering programme at ZJU plays an essential role in the development of the Chinese optoelectronics industry. As China's renowned training base for optical science, it has delivered a huge number of outstanding graduates to the industry and has made a wide range of technological breakthroughs in high-resolution imaging, special coating and ultra-precision testing.

The programme provides service and support to domestic industry. Partnering with a local company, Sunny Optical Technology, it has built an innovative team to support the research and development (R&D) of cell phone cameras and other camera modules. The resulting products have become stars of the global market and helped the company reach an annual output of more than 10 billion RMB, becoming China's largest optoelectronics manufacturing base.

Computer Science: Better living through CS

ZJU's computer science (CS) is geared towards technologies that improve human welfare. This science is a traditional strength of the university and the programme builds on 40 years' expertise. Its track records in artificial intelligence (AI), big data applications and computer graphics are particularly strong.

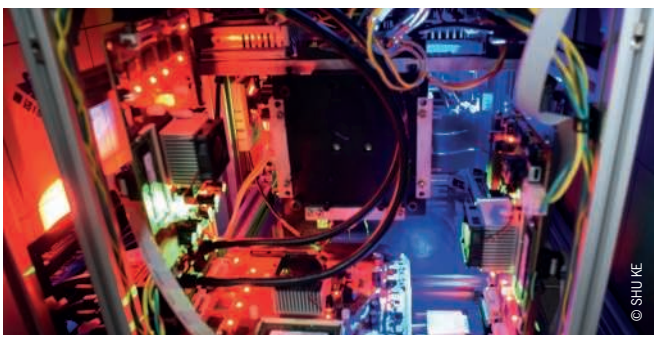
"We aim at better CS and a better life," says Zhuang Yueting, dean of CS college, who spoke of the daily impacts of ZJU CS programme. The China Academic Digital Associative Library (CADAL) led by ZJU is offering access to knowledge with its 2.6 million online books. New computer image rendering algorithms, along with advanced virtual reality technologies are improving wearable devices, powered exoskeletons and mobile terminal devices. Other technologies that have improved daily life include AI-based product innovation and design, information services for people with disabilities, and automated medical consultation.

Biomedical Engineering: Solutions from bench to bedside

With an increasingly ageing population, unequal distribution of healthcare resources and rising healthcare costs, China faces a great challenge in healthcare. The biomedical engineering programme at ZJU aims to address the biomedical issues by capitalizing on its interdisciplinary expertise.

The programme has strong R&D and technology transfer capabilities. By integrating a wide range of key technologies, such as biomedical sensors, biomedical imaging, biomedical semantics and big-data analysis in healthcare, ZJU researchers facilitate the development of wearable medical devices, tele-medical assistance services, chronic disease management systems, clinical decision support systems and healthcare knowledge bases.

These systems and devices provide medical solutions to national healthcare inequality and ultimately help improve welfare of the whole society.



Electronic Engineering: Training adaptable students

The primary goal of the ZJU electronic engineering programme is to translate advances in information science into real-world applications that benefit the society.

To build a working environment that nurtures research commercialization, the programme has plans to revolutionize student training. It has recently established a polytechnic institute in collaboration with leading engineering institutions abroad to provide an international platform for innovation and training in microelectronic engineering.

The institute emphasizes training in practical skills for graduate students and plans to offer hands-on courses. By promoting cooperation between industry and academia, it provides new opportunities to translate ZJU's many findings into real world applications.

The programme is also designed to provide undergraduates with integrative training in experimentation, innovative design, teamwork and engineering leadership skills.

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Collecting and sharing the best of human intelligence

Bao Hujun, the dean of ZJU's Faculty of Information Technology (FIT), outlines its strengths and reveals his plan for a world-class faculty of education, research, and further innovation of information science and technology.

What is your vision for the faculty?

Bao: With a mission of research, education, and societal services, our goal is to become a world-class faculty in scientific research, technological development and professional training in information science and technology and strive for academic excellence and technological innovation in our primary research areas. We also aim to contribute our expertise to national security and socioeconomic development, generating substantial societal impacts with global influence. To this end, we need world-class research, professional services, and an excellent environment for entrepreneurship to put our faculty at a top-tier level.

What are the measures taken to achieve this goal?

Bao: Advancing interdisciplinary research is at the centre of our strategy to promote academic excellence. We are still developing a wide spectrum of interdisciplinary research programmes, such as the Collaborative Innovation Centre on Industrial and Cyber-Physical-Social Systems (iCPS), the Micro-Nano Public Platform, and the integration of intelligent agriculture, quantum information, and smart oceans. Our various academic exchange programmes encourage and facilitate interactions between faculty members, students and external experts, in academia and industry, from home to abroad. We have built partnerships with leading research institutions worldwide, such as Caltech and Microsoft Research. We are also recruiting top-notch faculty and students to make us the home of world-leading research and training in information science and technology.

What are the research strengths of the faculty?

Bao: High-quality research is the foundation of our sustainable development. We are highly positioned nationally and internationally, particularly in optical engineering, automatic control and computer science. We are the first in China to establish an optical engineering programme, which provided key support to our country's defence capabilities in its early years. This programme has now earned an international reputation for excellence in leading-edge areas, such as nano-photonics and electromagnetic/optic camouflage. Our chemical engineering automation programme is nationally well known in the research and design of automation equipment and control systems. Our computer science programme, ranked among the top 100 globally, has established an international status specifically in cross-media intelligent information processing and computer graphics. We were also the first Chinese recipient of the prestigious VLDB Best Paper Award in 2014.

How do you characterize information technology?

Bao: Information science is basically driven by applications. I always believe that scientific discovery and technological innovation help promote each other, but the latter may develop ahead of the former. Leveraging ZJU's strengths in basic and applied sciences, our faculty exploits the value of both.

While the majority of our researchers work independently in their own labs, we also encourage them to work collaboratively to address significant research issues, particularly, large-scale, interdisciplinary projects requiring our expertise across the broad areas of information science and technology.

> "WE HAVE BUILT PARTNERSHIPS WITH LEADING RESEARCH INSTITUTIONS WORLDWIDE, SUCH AS CALTECH AND MICROSOFT RESEARCH."

Education-wise, we also emphasize both scientific theories and engineering applications. Given the rapid development of information science and technologies, almost all of our academic programmes have incorporated experimental sciences into the syllabi to train students' hands-on and analytical skills.

How does the faculty's research benefit society?

Bao: Our research has already generated phenomenal societal impacts. In manufacturing, we have applied advanced computer technology in textile printing. This has led to the development of digital textile printing equipment, which has achieved high market share and brought a direct profit of nearly 700 million RMB. Our research in automatic control and optical imaging has also helped drive fast development in related industries.

Benefiting public welfare is also part of our mission. To support and promote public education, taking advantage of our computer science expertise, we have developed a large-scale public digital library with a user-friendly intelligent service system. The largest of its kind in the world, it provides global sharing of around 2.6 million digital books.

In healthcare industry, our biomedical engineering research has assisted the development of digital diagnosis facilities and intelligent information systems to better serve the handicapped.

Our research has also been extensively applied in national security projects and provides technical foundation for policy-making in relevant areas.

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CONTROL SCIENCE & ENGINEERING

Safeguarding industry nerve centres

From a large refinery plant to a small smart robot, control equipment and systems are essential for the safety and efficiency of modern industry. Yet for China, which did not start large equipment manufacturing until the 1950s, high-end automation equipment has been largely imported.

ZJU researchers' breakthrough in control and automation technology filled this industrial gap nationally. Their technologies are now widely applied in China's paper and pulp, oil refinery, energy, steel, chemical engineering and bio-pharmaceutical industries, contributing significantly to national economic growth.

Control equipment and systems are like the brain and nerve centre for industrial operations and drive advances in manufacturing processes, according to ZJU professor, Sun Youxian, member of the Chinese Academy of Engineering. "We have the manufacturing equipment, but still lack the knowledge to control its operation," said Sun. "We aim to change the situation by developing China's own high-quality automation systems."

One example is the application of automation in steel plants. Top-pressure recovery turbine (TRT) is an energy-recovery unit that employs the heat and pressure of blast furnace top gas to generate electricity. It is widely used in steel plants, because of its great profitability. A reliable control system is essential for ensuring fast and precise top gas pressure control and the safety of the unit. Applying intelligent control and optimization, ZJU researchers upgraded the control system for TRT units by improving the stability of blast furnace top pressure, the control of the turbine speed and the safety of TRT emergency stop control. Specifically, fluctuation of top pressure was controlled to within 1.5kPa, a fraction of the control systems imported from abroad. The set-up for such a high-end TRT control system only takes five days, a record for the industry. This technological advancement saves energy, reduces emissions and brings costs down for China's iron and steel industries.

Having established a model of innovation that links fundamental theories, key technologies, international standards and control equipment and systems with industrial application, the college has also provided technological support for many other large-scale projects, including the world's largest coal gasification programme and the largest soda ash factory. Their industrial partners include many renowned enterprises in China, such as Zhejiang Supcon, Hangzhou UWNTEK and Shanghai Electric Group. In 2011, of the four oil refinery projects with a capacity of over ten million tonnes undertaken by China Sinopec, three adopted control systems developed by ZJU researchers.

Recent research efforts by Sun Youxian and his colleagues range from smart sensing and detection and control system security to intelligent control equipment and robotics. The dream of achieving intelligent control of manufacturing is close to realization. ■

ZJU Control Science & Engineering achievements

- Various national honours, including a first-class National Science and Technology Progress Award and a National Technology Invention Award
- Numerous high-quality publications, including multiple highly cited papers in *Automatica*
- Development of China's first international standards for industrial automation: Ethernet for Plant Automation (EPA)
- More than 40,000 high-quality plants and systems applied in industry

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COMPUTER SCIENCE

Best in the 3D printing game: add intricate colours

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By applying 3D mapping technology and computational simulation, ZJU computer science researchers have designed software that brings precision to hydrographic printing, making full-colour printing of 3D objects more accurate and accessible.

Hydrographic printing is a widely-used technique that adds patterns to materials of various shapes by immersing them in a liquid.

The liquid is covered with a thin film of coloured inks, which wrap around and adhere to the object, transferring colour patterns to it.

The method was limited by its lack of precision. Objects with complex surface geometries stretch and deform the thin film, disturbing alignment.

ZJU computer scientists have been developing cutting-edge computer graphic technologies since the mid-1980s. The main limitation of the traditional hydrographic printing technique caught the interest of ZJU researcher, Zhou Kun, and his colleagues. They simulated the hydrographic printing process on computers and calculated the degree of deformation based on the different shapes of the object. Their computational model enables controlled immersion and object calibration based on data collected on the specific surface geometries. Multiple immersions with different object orientations are programmed to ensure that the combined colours form the desired print on the surface of the object.

Objects of any shape can now be immersed in the coloured ink and come out with an accurate print of the desired patterns. It broadens the horizon of 3D colour printing, making it more affordable to add customized colours and patterns to various objects. ■

Research, translation and impact

The ZJU College of Computer Science & Technology (formerly the Department of Computer Science) was founded in 1978. Ranked 60th in Essential Science Indicators (ESI) by highly cited papers in Computer Science, it is one of the oldest and best computer science programmes in China.

Focusing on cutting-edge theories, technologies and applications, the college has made remarkable progress in artificial intelligence,cross-media computing and computer graphics, providing substantial support to IT in China. Its researchers have proposed a novel framework for document summarization based on data reconstruction, winning AAAI Outstanding Paper Award in 2012.

Translating research output into real-world impact has always been at the centre of the college's mission. It has built a series of digital platforms for knowledge sharing and service, including one of the largest non-profit digital libraries in the world– CADAL, the China Knowledge Centre for Engineering Science and Technology (CKCEST) as well as the knowledge computation engine KS-studio. The college has also developed the information accessibility technologies and systems benefiting more than 80 million disabled people in China, enabling them to participate equally on the web. Their complex computing software is providing valuable services to users around the world, having created an added value of more than 3 billion RMB in the last four years.

Almost 80% of all CTOs and technology leaders in Hangzhou's software industry are alumni of ZJU's College of Computer Science. Enterprises led by ZJU graduates have emerged as key players in the IT industry in the region and beyond.

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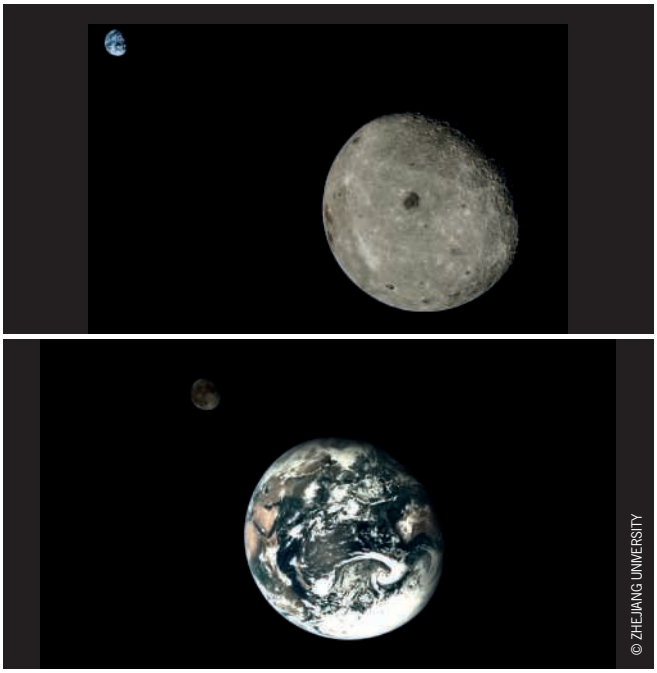
OPTICAL SCIENCE & ENGINEERING

Picture perfect technology

Beautiful images of the Earth and Moon system have been made possible thanks to a dual-resolution space optical camera developed by ZJU researchers.

Chang'e 5, scheduled for launch in 2017, will be China's first Moon sample return mission. In late 2014, Chang'e 5-T1, an experimental spacecraft predominantly designed to carry out re-entry tests for Chang'e 5, sent back a rare image. It displays the rarely seen 'back side' of the Moon, together with a much smaller Earth on the far corner.

Another amazing picture captured the Earth and the Moon in the same frame 920,000 kilometres away from the Moon. This was the first joint shot of the Earth and Moon system at that angle.



The high-resolution images were taken by a dual-resolution camera designed by ZJU College of Optical Science & Engineering professor, Xu Zhihai, and his colleagues.

Using fast super-resolution, the camera designed by Xu's team can capture two images with different resolutions in one shot, and then reconstruct them into one high-resolution image with wide field of view (FOV). This heat-free, shock-resistant camera system is also able to operate under extreme temperatures and radioactive environment. Dual-resolution has created a new optical imaging paradigm, achieving high spatial resolution and a wide FOV simultaneously.

Almost a year earlier, Xu's team also designed a landing camera for the Chang'e 3 unmanned lunar mission, which captured the amazing landing process of Chang'e 3, the first successful soft landing outside the Earth in China's space history. It also provided valuable images of Moon surface for the Moon rover. ■

Smoothing the edges in microscopy

ZJU professor Liu Xu and his team have opened a new door into the microscopic world with super-resolution imaging using a conventional optical microscope.

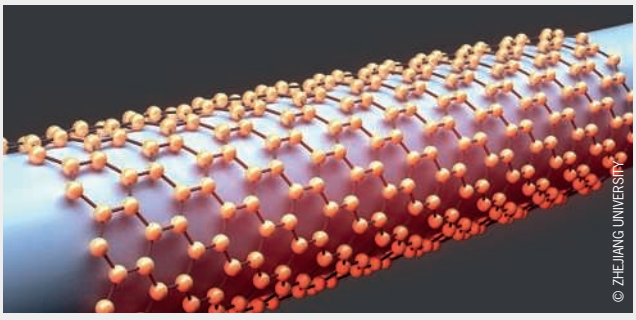
The resolution of conventional optical imaging systems is usually limited by the diffraction barrier, as light waves bend around the corners of the aperture and form a shadow, blurring the edges of images. Liu and his colleagues have worked on super-resolution microscopy technology for many years. In a recent attempt to overcome the diffraction limit, they introduced micro-fibre illumination to a conventional wide-field optical microscope. The micro-fibre has a diameter close to the wavelength of the guided light and works as a near-field source that illuminates the sample object, obtaining super-resolution images at far-field in a single snapshot.

The breakthrough enables direct and non-invasive observation of both metallic and non-metallic objects with a resolution of tens-of-nanometres within the visible spectrum. With potential applications in surface defect detection, biological imaging and optical lithography, it will have a significant impact on nanoengineering, bioengineering, clinical medicine and material science.

ZJU nano-optics researchers have also achieved significant breakthroughs in micro/nanofibers and nanowire photonic devices, metamaterials and electromagnetic shielding, and hybrid silicon photonic devices and technologies.

Their results were published in high-profile journals, such as *Nature* and *Nature Communications*, and were featured in these journals' special reports.

ZJU researchers have also been invited to give plenary speeches at top international conferences in the field. Their highly-rated research is making a significant global academic impact.



ELECTRONIC ENGINEERING

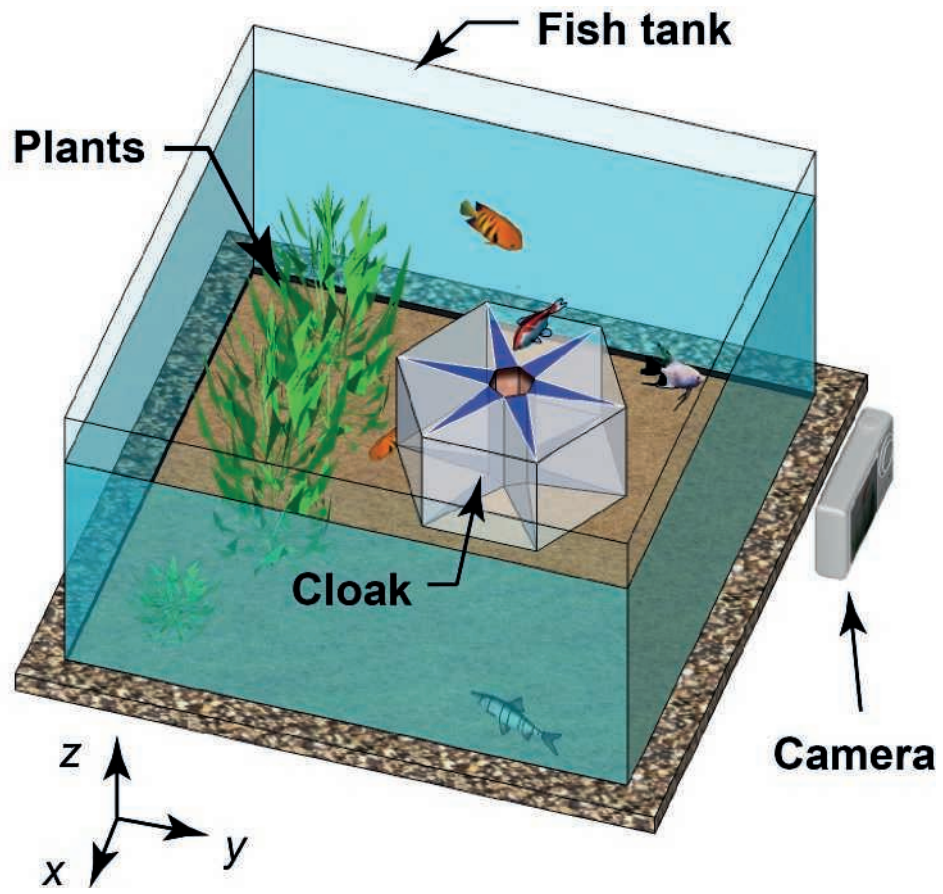
Invisible breakthroughs prove hard to hide

An invisibility cloak sounds like a technology only for the realm of sci-fi or Harry Potter movies. But, research by ZJU has brought such a cloak closer to reality.

In the past decade, invisibility cloaking technology, based on transformation optics principles, has seen great progress. However, making a large-scale living creature invisible to the human eye has not been possible, as metamaterials that can create 'perfect' cloaking are very hard to make at the wavelengths of visible light.

But, with some compromises of the ideal transformation optics theory, ZJU researchers and their international collaborators have designed a hexagonal-shaped cloaking device and made a cat and a fish disappear from plain sight.

According to Chen Hongsheng and his colleagues, human eyes cannot sense the phase and polarization of natural light. Without the need to preserve the phase of wave, Chen and co-workers managed to construct a polarization-insensitive cloak that makes living objects vanish from sight both on land and under water, when viewed from certain directions. The device is an enclosure made of widely-available, high-quality optical glass prisms. When set in a special arrangement, the prisms guided light around the objects. As a result, fish swimming into the enclosure disappeared and a cat entering it vanished, while the scene behind the cloaking device remained visible.



While Chen's "box of invisibility" may still sound like a magic show, extensive research by Chen and his colleague, Ma Yungui and other ZJU researchers on the theories and applications of cloaking devices has led to significant impacts. Applying the technology of electromagnetic invisibility cloaking, ZJU researchers have further developed innovative cloaking devices, such as three-dimensional magnetic cloak, full-polarization three-dimensional metasurface cloak, ultra-broadband surface wave cloak, large-scale cloaking device in the far-infrared spectrum, and even multifunctional cloaking device. Many of these exciting findings were published in leading journals in the optics and physics field, such as *Nature Communications*, *Proceedings of the National Academy of Sciences of the United States of America*, *Advanced Materials* and *Physical Review Letters*. These works have paved the way for future progress in designing and manufacturing of practical invisibility cloaking devices.

The current technology of invisibility cloaking is still facing bottlenecks in achieving an omnidirectional visible-light cloak, despite tremendous development in the past few years. However, with the help of researchers like Chen and Ma, and their co-workers, invisibility cloak research is seeing expedited progress. ■

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