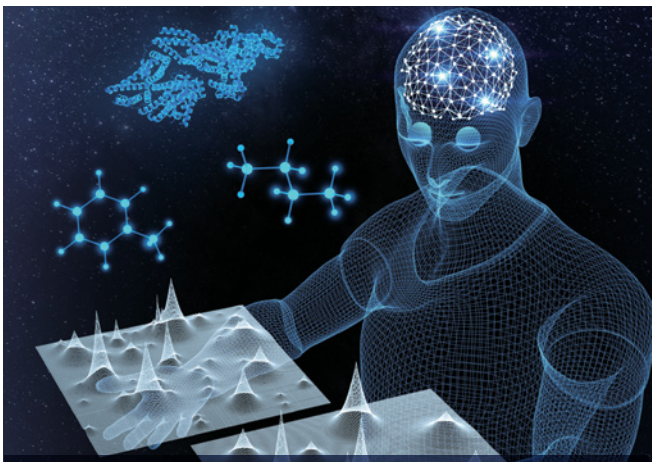
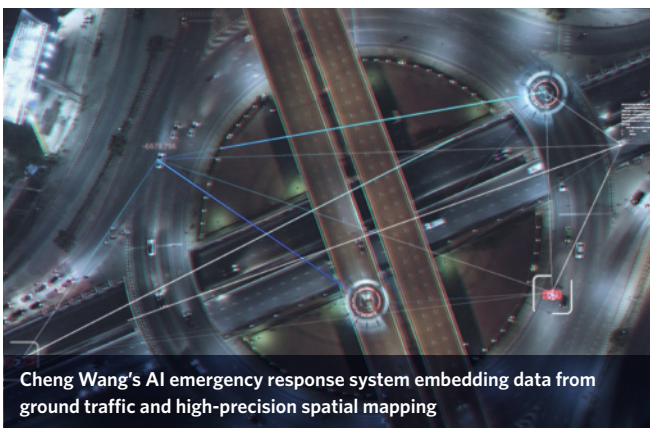
SUPER-CHARGED TECHNOLOGICAL INNOVATION

Optical and AI discoveries at XMU help advance big data.



Xiaobo Qu's convolutional neural network for NMR spectra reconstruction



Cheng Wang's AI emergency response system embedding data from ground traffic and high-precision spatial mapping

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With a strong background in semiconductors and radio physics, scientists at XMU's School of Electronic Science and Engineering (SESE) and School of Informatics (SI) are developing new technologies to advance optics and data sciences, which are also transformative for everyday applications.

Optical devices are vital for imaging, detection and sensing technologies. An SESE team led by Huanyang Chen applies conformal transformation optics, which provides a simple scheme for manipulating light rays, to their design of optical tools with special functions. By studying how light transmits in virtual and physical spaces, they have devised geodesic lenses, which provide perfect imaging between two points on a curved surface. In this work, Chen studied conformal lenses using inverse transformation optics, which exploits the topological advantage in virtual space to improve the flexibility of beam bending in geodesic lenses.

Chen's SESE colleague, Baoping Zhang, studies vertical-cavity surface-emitting lasers (VCSELs), which, due to their high optoelectronic performance, have wide applications in displays, high-speed optical communication systems, printers, and 3D imaging. Zhang's team focuses on using the third-generation semiconductor material, GaN, to create green VCSEL, which, with shorter wavelength than the traditional infrared or red VCSELs, is resistant to high temperature and radiation. Having developed several techniques and tools, Zhang's team became one of the first to produce green VCSELs with wavelengths of around 500nm and longer. Using the quantum-dot technique, they extended the wavelength and achieved room-temperature continuous-wave lasing. They have also made use of quantum wells to obtain the highest output power for green VCSELs.

SESE researchers are also using AI to accelerate nuclear magnetic resonance (NMR) spectroscopy, a powerful tool for analysing organic compounds. To shorten data acquisition time, modern NMR experiments often sample only a fraction of data, so a reliable spectra reconstruction method is needed to quickly restore the lost information. To solve this, Xiaobo Qu has developed a deep learning method using the exponential-inspired convolutional neural network, enabling high-quality, reliable, and fast NMR spectra reconstruction from limited experimental data. His system shows strong reconstruction performance, with a much shorter computation time.

AI technologies are also explored by SI researchers, and one application is real-time analytics of massive visual data. Focusing on improving efficiency, Rongrong Ji has developed a novel compact vision system, which reduces computation and storage redundancy by mining golden data and parameters, enabling broad applications that require timely processing of massive visual data.

To fully explore the potential of deep neural networks, Ji's team is a pioneer in weakly supervised methods that support highly efficient model training and inference. Their theories and tools on neural network compression and network architecture search have been widely used by academic colleagues and AI industries to solve real-world challenges, including cyberspace security.

Another example is the use of AI and big data to improve emergency responses to natural disasters. Cheng Wang's team was among the first to embed the technology of spatial crowd-sensing in an emergency response system.

Based on data collected from multiple sources, including ground vehicle trajectories, high-precision spatial mapping, and satellite imagery, they proposed methods to identify changes in the natural environment. Their work established multidimensional spatial-temporal modelling, enabling real-time, low-cost risk evaluation and monitoring of damage caused by natural disasters. The study is already being used by the municipal government to inform disaster prevention and control. ■