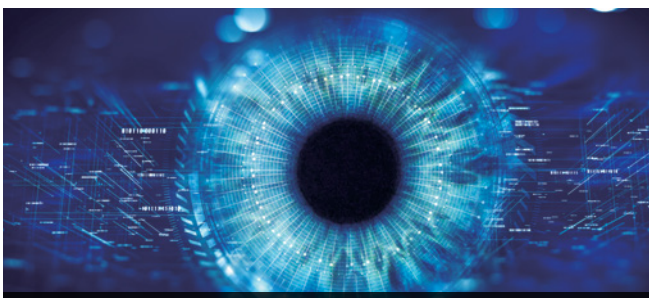
New reach for computer imaging

Tsinghua Shenzhen International Graduate School has been driving rapid progress in AI VISUALIZATION AND IMAGING, with diverse real-world applications.

VasNet is an unsupervised learning algorithm allowing multi-dimensional vascular features to be revealed.



New approaches reduce image processing errors in computer vision.

Founded by Tsinghua University and the Shenzhen Municipal Government

in March 2019, Tsinghua Shenzhen International Graduate School (SIGS) is an expansion of Tsinghua Graduate School in Shenzhen and the Tsinghua-Berkeley Shenzhen Institute.

Exemplifying this ambitious growth is its Data Science and Information Technology Research Center, where smart imaging studies, ranging from computational photography to brain science, are accelerating technological transfer for medical health.

"We have been working at the intersections of AI (artificial intelligence), BI (biological intelligence), and CI (computational imaging)," says Qionghai Dai, a member of the Chinese Academy of Engineering, and director of the School of Information Science and Technology.

Dai has developed a real-time, ultra large-scale, high-resolution (RUSH) imaging system with gigapixel videography, which is expected to advance the progress of brain science and studies on tumour metastasis, More recently, his team has turned to mapping the body's smallest blood vessels.

Simplified vascular mapping

Vascular abnormalities are symptoms for a range of potentially debilitating diseases, but their structural complexities need less invasive imaging. Dai gathered specialists from optics, biomedical engineering, computer vision to signal processing for a cross-disciplinary study to focus on close examination through AI.

Published in *Nature Machine Intelligence* in June 2020, their paper illustrates an unsupervised learning algorithm, 'VasNet', which works by augmenting the recognition of pathological symptoms, based on process fluorescence and digital subtraction angiography (DSA) images.

In tests on mice and humans, VasNet revealed multi-dimensional features from the brain to the abdomen, including vascular structure and blood flow. Other advanced functions include distinguishing between blood vessel dilation and potential tumours. These diverse applications reduce workload, diagnosis time, and strain on equipment for the treatment of vascular diseases.

A new metric for image processing

One of the main challenges of image processing is to deal with limited data and computation resources. A common practice to solve this problem is to transfer the knowledge from well-learned tasks to the new task with limited resources, known as transfer learning. While transfer learning has been widely applied, existing methods can neither effectively map between tasks, nor explain the performance gain from this reduced need for supervision.

Recent research led by Shao-Lun Huang, an associate professor of electrical engineering, has proposed a new metric, H-score. This measure has been experimentally proven to estimate task transferability effectively, and its efficient computation makes it applicable to various computer vision and image-based recognition tasks.

Future research directions

Having established a reliable evaluation function, the next step for Huang is to look into higher-order transferability and more scalable algorithms, along with better curriculum design for transfer learning.

Dai's vision for AI is three-pronged: introducing disruptive technologies to accommodate vast computing resources required for deep learning techniques, taking inspiration from brain science and cognitive neuroscience to improve current AI techniques, and building an 'AI body' to interact with the environment.

"The original Turing Test can no longer adapt to the present or future of AI," says Dai. "How to establish a new Turing Test is a central question for us." ■

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