Quantum Computational Advantage Enhanced with New Study

Voice of world

Edited by QI Liming

A research team has successfully designed a 66-qubit programmable superconducting quantum computing system named Zuchongzhi 2.1, significantly enhancing the quantum computational advantage.

The study is led by renowned Chinese quantum physicist Pan Jianwei of the University of Science and Technology of China, and was published online on 25 October in the journal *Physical Review Letters* and *Science Bulletin* respectively.

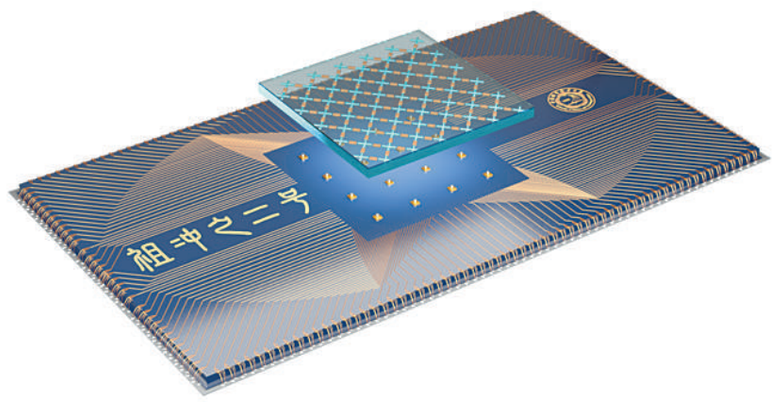
Chinese research teams have made marked progress in superconducting quantum computing (Zuchongzhi 2.1) and photonics quantum computing technology (Jiuzhang 2.0), making China the only country to achieve quantum computational advantage in two mainstream technical routes, analysts said on authoritative physics websites.

Jiuzhang 2.0 is faster than the world's fastest existing supercomputer

According to the essay released in *Physical Review Letters*, Jiuzhang 2.0, with 113 detected photons, has made a major breakthrough in quantum computational speedup.

In the study, Gaussian boson sampling (GBS) was used to provide a highly efficient way of demonstrating quantum computational speedup in solving some well-defined tasks.

With 113 detected photons, Jiuzhang 2.0 can implement large-scale GBS septillion times faster than the world's fastest existing supercomputer.



Superconducting quantum computing "Zuchongzhi 2.1". (PHOTO: the research team)

Zuchongzhi 2.1 performs large-scale random quantum circuits sampling

Zuchongzhi 2.1 is a 66-qubit programmable superconducting quantum computing system, which significantly enhances the quantum computational advantage.

With an improved average readout fidelity of 97.74 percent, Zuchongzhi 2.1 can perform large-scale random quantum circuits, sampling about 10 million times faster than the fastest existing supercomputer.

"This indicates that our research has entered its second stage to start realizing fault-tolerating quantum computing and near-term applications, such as quantum machine learning and quantum chemistry," said Zhu Xiaobo, a member of the research team.

Comments from the authoritative physics website

Physics World said that the computational goal is to work out the probability that a certain input configuration would lead to a certain output configuration. It turns out that this task is exceedingly difficult for a conventional computer if the quantum circuits have more than a few tens of inputs and outputs.

A quantum computer, however, can use quantum sampling techniques to calculate random instances of the probability distribution in much less time than a classical computer. As a result, sampling experiments are a way to demonstrate quantum advantage, and the idea that quantum computers are much better than their classical counterparts at solving certain problems.

In the first paper, Pan and his colleagues explain how they used a technique called Gaussian boson sampling to analyze the output of a 144-mode optical interferometer.

The team says that their system has 10^{43} possible outcomes and that their implementation can sample the output 10^{24} times faster than a classical supercomputer. This quantum speedup is a huge increase over the team's previous result of 10^{14} times, which they reported in December 2020. The result makes it extremely unlikely that a specialized classical algorithm can be devised to match this performance, thereby establishing quantum advantage.

In the second paper, another team led by Pan used a quantum computer that comprised 66 transmon superconducting qubits that are connected via 100 tuneable couplers. Their sampling experiment involved using 56 of the qubits, and the system was put through 20 quantum logic cycles.

Barry C. Sanders, director of the Institute for Quantum Science and Technology at the University of Calgary in Canada, released an article on American *Physical Society* website, saying that, "The two experimental quantum computers tackle the most complex problems yet, suggesting an end to the debate on whether quantum 'primacy' — the point at which a quantum computer outperforms the best possible classical computer—can be reached. "

American Physical Society commented that these two experiments represent the rapid advancement in experimental quantum sampling, establishing more firmly that we are in an age of quantum primacy for computing, thus further motivating efforts to put quantum sampling to practical use.

The Digital Economy at a Glance

By Safder Nazir

Digital technologies have transformed society on an unprecedented scale over the last two decades. They have changed the way we live, work, play, commute, and interact.

It is digital technology that now has the potential to usher in widespread social changes and economic advancement. Accordingly, to prosper in the digital age, it has become crucial for nations to understand and cater for the digitally-based economic construct also known as the digital economy.

Definition of the digital economy

The digital economy has been defined in different ways, primarily based on scope. According to the latest definition from the Organization for Economic Cooperation and Development, it encompasses all economic activities reliant on, or significantly enhanced by, the use of digital inputs, including digital technologies, digital infrastructure, digital services, and data.

This broader scope refers to all producers and consumers, including governments that use digital inputs in their economic activities.

The four key enablers of the digital economy

The global economy is well on its way to fulfilling its digital destiny. More than 65 percent of GDP is predicted to be digitalized as early as 2022.

Accelerated investment in digital transformation will further spur the creation of digitally-enabled products, services, and experiences across all industries, significantly impacting economic development, particularly as nations across the world move away from resource-based economic models.

To facilitate this transition, national authorities and policymakers should focus their efforts and investments on the critical enablers of the digital economy, which are foundational to its evolution, namely digital strategies and regulations, digital infrastructure, data-driven economy and digital skills.

Economic prosperity, wealth creation, and the improvement of citizens' lives are priorities for every nation. As digital technologies are steadily intertwined with the way products and services are created and consumed, the digital economy is becoming a critical component of national transformation.

National digital transformation

By 2023, digitally transformed enterprises will account for more than half of global GDP. Two overarching factors will drive this trend: the proliferation of digital devices and the rising prominence of the millennial and zoomer (Generation Z) user base.

These digital-savvy generations account for 75 percent of the population in the Middle East today. By 2025, the number of connected devices globally is predicted to reach 100 billion, more than 12 times the number of people in this world.

These shifts have significant implications for the evolution of Smart Cities towards Cognitive Cities and the future of national digital transformation.

Trends and concerns on digital economy

The emergence and evolution of the digital economy is characterized by key trends. The primary driver of these trends is technological innovation, namely the advent and widespread use of social media and smartphones, as well as advanced broadband networks and technologies such as the Internet of Things, Big Data Analytics, robotics, Artificial Intelligence and Machine Learning.

The digital economy is primarily a data-driven economy. However, fully exploiting data remains a significant challenge for organizations. It is estimated that less than three percent of existing data is analyzed with the aim of improving enterprise intelligence. National governments and policymakers that focus on developing the digital economy should strive to create an open data economy, where data is shared widely, creating value, albeit supported with strong data privacy and protection laws to counter potential threats.

The increasing role of digital technologies in the workplace requires a range of new digital skills. This falls into two categories: core Information and Communications Technology (ICT) skills, such as programming, applications, infrastructure, cybersecurity and data analytics, and generic ICT skills required by all employees to work in a digitalized environment.

However, as organizations often point out, it is tough to find core ICT skills. Moreover, with rapid technological evolution, the skills learned at educational institutions often fall short and quickly become outdated.

(Safder Nazir is the head of Huawei's Digital Industry Center of Excellence, prior to which he has held various leadership roles in global "blue chip" companies. The opinions in this article are the author's and do not represent S&T Daily.)

'Smart' Winter Olympic Uniform, a Winner

By Staff Reporters

Uniforms, shoes and accessories for staff, volunteers and technical officials were unveiled on October 27, the 100-day countdown to the Beijing 2022 Winter Olympic Games.

The range of high-tech items have their own characteristics to make the wearer comfortable, protected and fashionable.

A Chinese homemade multi-layer structural cotton filler with patented technology was chosen as the wadding, which will be tailored to meet the needs of the cold environment. Meanwhile, the waterproof film used for moon boots is 100 percent waterproof, windproof, breathable and recyclable. The sole was made of anti-skid material providing grip on wet and icy ground.

Moreover, the laminated composite fabric used in the uniform is combined with high-performance membrane material, which is light, elastic and fits well, along with having waterproof, air permeability and anti-condensation properties.

In terms of the outfit design, based on winter sports professional equipment and ergonomics theories, the design team used functional fabric and a 3D tailoring method. As a result, the outfits can meet the requirements of both indoor and outdoor daily activities.

To combat the cold, outer fabric has excellent windproof, waterproof, and leakproof velvet characteristics. Fleece fabric has undergone post-processing to be antistatic and improved the overall wear comfort. The functional outfit has also increased the night reflective safety design and is waterproof, nonslip, breathable in parts such as cuff, collar, and zipper.

Meanwhile, the underwear uses a one-way moisture-transferring fabric to provide skin-friendly, quick-drying material in areas where the body sweats.

Advanced Kindling Lamp Keeps the Flame Burning

By Staff Reporters

In mid-October, the Olympic flame was successfully brought from Greece to Beijing, which marks that it is officially entering Winter Olympics time. In order to keep this procedure on track, a wide range of technology has been used.

Li Jianye, the Beijing Winter Olympics torch designer, said that the kindling lamp is the first piece of equipment used during the torch relay. Its function is to ensure the flame would not be extinguished whilst being transported.

"We did a lot of structural innovations on this lamp. For example, the glass of the lamp is a double-layer structure, which ensures not only the air intake flow of the lamp, but also the moderate height and full combustion of the flame without producing any smoke and peculiar smell, so as to keep the appearance of the fire lamp clean and bright," said Li.

Hong Wenming, a fire lamp design team member, explained the preconditions for designing the torch equipment. "For example, a diversion channel is designed between the inside and outside of the lampshade. Its purpose is to relieve pressure effectively when the wind produces positive and negative pressure. This reduces the influence of wind, which affects the lamp, and finally ensures the flame will not be extinguished when the Beaufort Wind Scale reached five or six," he said.

According to the designers, this is the first time a double-layer structure has been used in the kindling lamp. But there were still challenges for the design team. For example, exhaust gas may occur and rise at the start of the flame, and if the wind blows from top to bottom, carbon dioxide will be deposited in the chamber, causing the flame to be deprived of oxygen and be extinguished.

In order to solve these problems, team members utilized the double-layer structure and opened up space from top to bottom entirely so that when there is air pressure on the top of the lamp, the carbon dioxide exhaust in the chamber can be smoothly discharged from the sidewall space.

The kindling lamp of the Beijing 2022 Winter Olympics adopts the appearance of the Gilt Bronze Human-Shaped Lamp. (PHOTO: XINHUA)

China, ASEAN to Boost Digital Economy

From page 1

Last year was designated the China-ASEAN Year of Digital Economy Cooperation. With 125,000 new users coming onto the Internet every day, the ASEAN digital economy is expected to grow significantly, adding an estimated 1 trillion USD to regional GDP over the next ten years, according to the World Economic Forum.

In January 2021, the first ASEAN Digital Ministers'Meeting approved the ASEAN Digital Master Plan 2025, to support the region's recovery from COVID-19 through facilitating cross-border trade and building a digitally inclusive society.

Wang Ruijie, Singapore's Deputy Prime Minister and Minister of Economic Policy Coordination and Finance, said that looking ahead, with rapid growth of the digital economy, the closer economic coordination between ASEAN and China will "benefit both parties more."

Sino-German Auto Bond: From 1.0 to 3.0

From page 1

Five joint meetings on electric vehicles strategic partnership have been held, setting up a platform for coordination between the involved departments from both countries, strengthening the communication and cooperation in terms of the standards and regulations, encouraging policies, scientific research and application of electric vehicles .

In the past ten years, the in-depth cooperation in the electric vehicles industry between the two countries achieved fruitful results. Several German car companies have established joint ventures with their Chinese counterparts.

There has been cooperation among universities and research institutes as well. In 2010, Chinese Ministry of Science and Technology and German Federal Ministry of Education and Research jointly launched a joint R&D center on electric vehicles. Together with 19 enterprises, 15 top universities and research institutes from both countries like Tongji University and Technical University of Munich achieved good results from projects concerning new lightweight electric vehicles.

Era 3.0: Intelligent connected vehicles

Roads of more than 3,500 kilometers have been intelligently upgraded, and there have been more than five million cars carrying Internet connected terminals, according to Xiao Yaqing, minister of Information and Technology, at the 2021 World Intelligent Connected Vehicles Conference.

Actually, China and Germany already signed a joint declaration of intent on cooperation in the area of automated and connected driving in 2018, focusing on several aspects, including coordination and promotion of (on-going) international standardization processes with regard to automated and connected driving.

In response to the declaration, a road test area for intelligent connected vehicles (ICVs) was launched in Chengdu, capital of Sichuan province. This was also the first cooperation project in terms of ICVs between China and Germany.

A Sino-German center on ICVs promotion and application was also established in Shanghai in 2020 to promote deeper bilateral cooperation in this field.

The cooperation in application of ICVs went deeper when the Chinese Academy of Information and Communications Technology and German Association of the Automotive Industry jointly started a cooperation project on ICVs and smart cities on July 2.

Supported by both governments and the automobile industry, the bilateral cooperation yielded a win-win result. The continuous evolution of the automobile industry is going to bring more opportunities for cooperation between the two countries.