Riverlane Looking to Unlock the Power of Quantum Computing with AMD

Company Building Innovative Operating System For Quantum Computers Leveraging Adaptive Computing Technology

PARTNER

river lane

INDUSTRY

Quantum Computing

CHALLENGES

Quantum computing requires precise control of subatomic particles (qubits) that are susceptible to errors caused by very slight environmental disturbances.

SOLUTION

The Zynq™ UltraScale+™ RFSoC from AMD creates high-accuracy, high-speed pulse sequences to control the qubits.

RESULTS

The Zynq devices integrate key subsystems for RF signal generation, providing exceptional spectral purity and latency, high I/O channel density and lower power consumption.

AMD TECHNOLOGY AT A GLANCE

Zynq™ UltraScale+™ RFSoC

In standard computing, each bit of data is stored as a zero or a one. In quantum computing, subatomic particles, known as quantum bits, or qubits, can be stored as both zeros and ones, simultaneously. This new way of manipulating data bits will transform the way computing is done, by enabling calculations of massive amounts of data to occur in ways that are simply not possible today.

Qubits are analogous to the transistors in the CPU of a classic computer, but they are vastly different in that they can perform calculations that no conventional computer can. It's completely revolutionary.

Quantum computing can have a transformative impact on many industries. "Even if we turn the entire planet into a supercomputer we could never simulate the way a new medicine would work in the human body or how a new catalyst could make an industrial process more efficient," said Leonie Mueck, chief product officer at Riverlane, based in Cambridge UK.

"With quantum computing, pharmaceutical companies, for example, may be able to design a new drug on the computer rather than having to discover it through laborious trial and error in the lab. It would be a complete game-changer," she added.

Mueck said quantum computing can benefit many other industries as well. "We work with companies making jet engines, new materials for storing clean energy, and many others. It's still a relatively small market right now, but it has huge potential."

However, there are still huge technical challenges that need to be overcome to make good on the promise on quantum computing. For example, the success of quantum computing is critically dependent on the ability to precisely control the behavior of millions of very fragile qubits. To help with this task, Riverlane has recently integrated the powerful Zynq UltraScale+ RFSoC adaptive computing platform from AMD with its qubit control product.

CHALLENGE

Traditional computing is based on bytes of data – each made up of a string of eight binary digits, known as bits. Each byte comprises any of 256 possible combinations of bits, but each bit can only be a zero or a one at any given point in time. Qubits also come in the one and zero state, but in contrast to regular bits, qubits have the ability to form combinations of ones and zeros and represent all states "in between." This gives rise to completely new algorithmic possibilities - there are around 400 algorithms we know of that deliver so-called "quantum speed-ups" over classical computing.

All of this power is critically dependent on being able to manipulate qubits in very special ways to hold them in a state of superposition or to perform calculations with them. Qubits interact readily with their environment and at slightest disturbance will lose their

quantum character, a process called decoherence. To counter this you need very precise control and rapid manipulation.

In many respects, quantum computing is a high-end industrial control system, responsible for orchestrating precision instruments using industrial control theory to provide a stable environment that maintains the state of qubits.

"Making qubits is an incredible technical feat'" said Mueck. "They can be made in different ways, for example using atoms, photons of light or superconducting resonators. In case of atoms, we need to manipulate the different states of the atom to be able to hold the qubit in a specific state or perform a calculation, which is mind-bogglingly difficult." For most qubit types, only 100 or so operations can be performed before the results are unusable. For the technology to be viable the industry needs to get the error rate down to less than one in 10 million. For comparison the error rate in classical computing is about one in a trillion.

"There is a long way to go to produce less error-prone qubits," said Mueck. "Quantum computer makers are investing heavily in finding different ways to build more and better qubits, but all of them require precise control, and that's where Riverlane comes in."

SOLUTION

Qubits are controlled by firing electromagnetic pulse sequences at them. Depending on the qubit types this is done using lasers or other microwave sources. Riverlane's customizable Deltaflow.Control™ software solution allows makers of quantum computers to configure these sequences, visualize and simulate them, and then apply them with high timing precision to the qubits. The software is built for scale so we can control thousands, or even millions of qubits, which is what will be required to move towards useful quantum computation.

"We rely on very fast, very precise technology from AMD to generate high-accuracy, high-speed pulse sequences to control the qubits," Mueck said. "The Zynq UltaScale+ RFSoC device acts as an interface between the control software and the lasers that are fired at the qubits."

Mueck added that the Zynq UltraScale+ family of devices "integrates key subsystems for RF signal generation, providing outstanding spectral purity and latency, high I/O channel density and lower power consumption – all of which impacts our ability to control qubits and will ultimately impact the performance of quantum computers."

Deltaflow.Control is a key element of Deltaflow.OS™, an operating system for quantum computers that creates error-free logical qubits from many unstable physical qubits, enabling large-scale applications to be built. As well as qubit control, Deltaflow.OS also includes decoders to detect errors that affect qubits as they occur, a runtime element that orchestrates the operation of the control system, and decoders and system tools for managing configuration and tuning performance.

RESULT

"Weird stuff happens at the quantum level in both nature and in physics. It's a bit complicated to understand how it all works, but the potential benefits of quantum computing are indisputably compelling," Mueck said.

"The industry hasn't reached a state of quantum advantage yet -- the point at which we can say that we have solved a problem not previously solvable with traditional computing, she added. "We don't know what that timing will be, but the industry is making progress."

WANT TO LEARN MORE?

About AMD's Zynq SoCs

About Riverlane

About Riverlane

Riverlane's mission is to make quantum computing useful far sooner than previously imaginable, starting an era of human progress as significant as the industrial and digital revolutions. We're comprehensively addressing the challenge of quantum error correction, the biggest barrier to large scale quantum computing. For more information visit www.riverlane.com or find us on Twitter, LinkedIn and YouTube.

About AMD

For more than 50 years AMD has driven innovation in high-performance computing, graphics, and visualization technologies. Billions of people, leading Fortune 500 businesses, and cutting-edge scientific research institutions around the world rely on AMD technology daily to improve how they live, work and play. AMD employees are focused on building leadership high-performance and adaptive products that push the boundaries of what is possible. For more information about how AMD is enabling today and inspiring tomorrow, visit the AMD (NASDAQ: AMD) website, blog, LinkedIn, and Twitter pages.