Researchers devise a way to make a simple quantum computer using holograms

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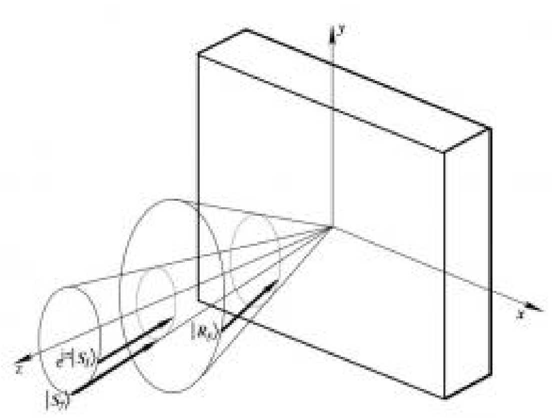

Volume holographic design of the fth of eight independent recordings used to generate the QT unitary transformation, U^QT , in PTR glass. For more information, please see the arxiv article.

(PhysOrg.com) -- Wouldn't it be nice if we could just jump from using computers based on circuits to machines based on quantum bits (qubits)? Things would run ever so much faster. Alas, the problem is, scientists have to first figure out how to make it all work, and thus far, little real progress has been made.

One of the main problems is that in using light as the medium, there needs to be a way to have the photons interact in a measurable way, to see if the qubit is representing an on or off state. Thus far, researchers have used something called interferometers to do the job, which unfortunately because of their high sensitivity, tend to come out of alignment easily and often; not something that leads to good computing.

Things are looking up however, as new research being done at the Air Force Research Laboratory in Rome, New York by a team of computer scientists, suggests that interferometers could be embedded in a hologram, as they describe in their paper published on the preprint server *arXiv*; in effect, freezing them in place and preventing them from going out of alignment.

That's the good news. The bad news is that using holograms to freeze the interferometers in place would mean that they couldn't reprogrammed; thus the resulting computing device would be but a one trick pony. There's also the problem of scalability, because the use of interferometers means using the output of one as input to the next and because holograms by their nature take up a certain amount of space, it would mean stacking millions or even billions of them, which just wouldn't be practical.

Currently the team is looking at an off the shelf product called the OptiGate to build their holographic interferometers, which would be easy and convenient, which is good because even if the final product can't be used as a true computer, it does seem possible that they could be used as a dedicated component on a larger system for such tasks as error-correction computations or in memory busses. There's also the optimism factor at stake here. Building a computer that used quantum components would surely breed more enthusiasm for added research into finding a way to build a truly quantum computer, the holy grail of computer technology.

More information: Quantum computing in a piece of glass, arXiv:1112.3489v1 [quant-ph] arxiv.org/abs/1112.3489

Abstract
Quantum gates and simple quantum algorithms can be designed utilizing the diffraction phenomena of a photon within a multiplexed holographic element. The quantum eigenstates we use are the photon's linear momentum (LM) as measured by the number of waves of tilt across the aperture. Two properties of quantum computing within the circuit model make this approach attractive. First, any conditional measurement can be commuted in time with any unitary quantum gate - the timeless nature of quantum computing. Second, photon entanglement can be encoded as a superposition state of a single photon in a higher-dimensional state space afforded by LM. Our theoretical and numerical results indicate that OptiGrate's photo-thermal refractive (PTR) glass is an enabling technology. We will review our previous design of a quantum projection operator and give credence to this approach on a representative quantum gate grounded on coupled-mode theory and numerical simulations, all with parameters consistent with PTR glass. We discuss the strengths (high efficiencies, robustness to environment) and limitations (scalability, crosstalk) of this technology. While not scalable, the utility and robustness of such optical elements for broader quantum information processing applications can be substantial.

via ArXiv Blog

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