

Introduction to Quantum and Nano Computing (Tutorial)

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We have been observing tremendous speedup in computing power, a quantum jump unmatched by progress in any other field. Moore's law has been relentlessly shrinking the size of transistors but this progress cannot go on forever and will knock at the doors of nanotechnology very soon. The quantum effects that come into play at this stage will be of tremendous potential for computing. Already quantum computers are being billed as the next generation of computing and their power will be comparable to nothing that we know of now. It will crack all cybersecurity based on RSA in a matter of seconds. Nanotechnology based quantum computers would revolutionize computing and increase their computing power tremendously. This tutorial describes concretely the large number of ideas and insights that go into quantum and nano computing.

Quantum computing is one of the fastest growing areas of research which synergizes two of the revolutions of the twentieth century - computer science and quantum mechanics, both gigantic fields in their own right [1]. It promises to affect our everyday lives in a much more profound effect than classical computers, with their inherent limitations have done. In spite the large amount of research and development, there are not many avenues for education in these frontier areas. This tutorial provides a smooth passage to our students from the classroom to the quantum and nanotech laboratories. It provides a gentle introduction to quantum and nano computing starting from the core of qubits and quantum gates and finally algorithms like Shor's and Grover's algorithms, applications, physical realizations and simulators. It discusses nanocomputing with its prospects and challenges, the underlying physics, reliability and most of all nanoscale quantum computing, optical and molecular computing [2].

Having a desktop quantum computer with quantum software is a challenge that might become a reality in the future. With that perspective, the tutorial presents Quantum Simulators as it enables learners to have practical experience of working with qubits and quantum gates. It also touches on Quantum Cellular Automata Designer software and provides an opportunity to start working on quantum and nano computing with nothing more than a desktop PC. It should make you sit down and start making your own quantum computer based on nanotechnology.

The tutorial concludes with discussion of a very interesting application of quantum teleportation—3D video conferencing as it might be used to transmit every bit of information about every particle at the transmission end to the receiver. Each receiver has to have its own bank of entangled bits shared with the transmitter which might become as simple as a SIM card someday [3].

References

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3. Satsangi P.S. and Sahni V., *A Systemic Experimental Study of Macrocosmic Consciousness*, Proc. of National Systems Conference 2007, Dec. 14-15, MIT, Manipal.