

## Abstract

Quantum computer has the potential to solve certain problems which are hard for a classical computer. It takes advantage of quantum mechanical phenomena such as superposition and entanglement to achieve computations at significantly higher speeds. Simulation of physical systems is one of the most important practical applications of computation. It plays a crucial role in advancing the scientific knowledge and developing technologies. But as far as simulation of a quantum system is concerned, the exponential increase of the Hilbert space with the system size forbids its efficient simulation on a classical computer. The exponentially large basis set is needed to describe the system and it becomes too complicated to solve the Schrodinger equation exactly. Quantum computer can make use of this exponential complexity of quantum systems to simulate the dynamics of other quantum system. An exponential speed up is achieved in simulation of a quantum system by a quantum computer. Here we present the digital quantum simulation of quantum tunneling in certain one dimensional potentials such as double well potential, Dirac comb potential, single potential barrier in path, two potential barriers in path, and three potential barriers in path. The algorithms are discussed for two qubit system as well as three qubit systems. For potential barriers in path, results clearly demonstrate the tunneling of wave function from one side of barrier to another. A similar behavior is observed for double well potential where it tunnels from one well to another in addition to the oscillations within the well. For the sake of comparison, we also simulated the evolution of free particle with zero potential using the same schemes. Other than the quantum simulation, we have discussed about quantum algorithms and NMR quantum computing. Three recently developed quantum algorithms are discussed in detail: algorithm for estimating numerical gradients of a function, algorithm to solve linear system of equations and algorithm to solve non-linear differential equations whose non-linear terms are polynomials. In NMR computing section, we have discussed about pseudo state preparation, quantum state tomography, and simulation of tunneling on an NMR quantum computer.