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Reading a Single Qubit System Using Weak Measurement with Variable Strength

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Abstract

The information contents of an unknown qubit system is usually read using sharp measurement. Sharp measurement is an irreversible operation that will cause the superposition to collapse to one of the two possible states in a probabilistic way. This paper will propose a quantum algorithm to read the information contents of an unknown qubit without applying sharp measurement on that qubit. A quantum feedback control scheme will be introduced where sharp measurement will be applied iteratively on an auxiliary qubit weakly entangled with the unknown qubit. It will shown that the information contents can be read by counting the outcomes from the sharp measurement on the auxiliary qubit which will make the amplitudes of the superposition move in a random walk manner. The effect of this operation on the unknown qubit can be reversed to decrease the disturbance introduced to the system. The strength of the weak measurement can then be defined and can be controlled using an arbitrary number of dummy qubits (virtual qubits) μ to be added to the system. This can slowdown the measurement process to an arbitrary scale to reach the effect of the sharp measurement after $O(\mu^2)$ measurements on the auxiliary qubit.

Keywords: Quantum algorithm; Sharp measurement; Weak measurement; Random walk; Quantum feedback control.
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