Quantum computer architecture

John Scott, Oliver Thomas

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Abstract

This is for a demonstration of 12 or 16 *Classical qubits* to demonstrate the differences between a 4 bit digital microcomputer and state of the art quantum processors

1   Notes

- 16 qubits (4 by 4 grid) requires $2^{16} = 65536$ entries in the state vector. Each entry must be signed and could optionally be complex (to express the addition algorithm). If we used 4 bits of precision that means complex amplitudes require 16bits. Then the state vector can be stored in 131072 Bytes (approx. 131 KiB).

- Multiplication requires only 2 by 2 and 4 by 4 matrix multiplications. The unitary operations can be performed in block diagonal form. You probably need 2 or 3 external memory chips (one for the state vector and a few for working memory).

- States of qubits will be shown using RGB LEDs. We also need to figure out how to measure.

- The memory needs to be quite fast. We found one (AS6C4008-55PCN) that has 55ns read/write times (we think). The time it takes the micro-controller to do the matrix multiplication is also important. If the micro-controller has 70MHz instruction rate and a single matrix multiplication takes 200 clock cycles for a 4 by 4 matrix (guess) then the total processing will take about 40ms assuming that you need to do 2^{14} blocks. That seems quick enough.

- We could cycle between the non-zero amplitudes to show the superposition. If you did it fast enough in proportion to different amplitude sizes it would do the averaging for you.