Thesis title: Ultra-High Fidelity Spin Qubit Initialisation Using Digital Feedback

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A. **Problem statement**

The problem this thesis is framed to solve is to incorporate digital feedback with
current spin-qubit devices to alleviate the time cost of gathering and refining data.
This is to be accomplished by minimising the impact of load errors through
electron spin steering. Spin steering is to be performed using a software solution
running in real-time.

B. **Objective**

To improve total experiment fidelity by enhancing the intialisation fidelity. The
ultimate purpose of this is to increase the efficacy of qubit operations which
is required for various quantum computer architectures.

C. **My solution**

Incorporate digital feedback with current spin-qubit devices to minimise the impact
of load errors through electron spin steering. Spin steering is to be performed using a
software solution running in real-time. The solution utilises existing technology and
software which is operated from a MATLAB environment.

D. **Contributions** (at most one per line, most important first)

Applied qubit initialisation with quantum steering via digital feedback
Demonstrated high fidelity quantum operations
Enabled tuning insensitive measurements to be made
High-fidelity Rabi oscillations are easily attainable
Proposed a hardware-based solution, to mitigate software latency issues

E. **Suggestions for future work**

To improve further on initialisation, this software-defined feedback loop should be
shifted into an integrated solution, such as a purpose-built solution
with a microcontroller or FPGA.

While I may have benefited from discussion with other people, I certify that this thesis is entirely my own work, except where appropriately documented acknowledgements are included.

Signature:  Date: 2/6/2016

Thesis Pointers

14	Problem Statement
14	Objective

Theory (up to 5 most relevant ideas)

8	Quantum Information
13	Nuclear and Electron Spin Control
14	Load and Read Errors
14	Quantum Steering of an Electron Spin
18	Electron Spin Initialisation

Method of solution (up to 5 most relevant points)

21	Device Description
22	Gate voltage stimulus
24	NMR control of Rabi Oscillation

Contributions (most important first)

25	Applied qubit initialisation with quantum steering via digital feedback
25-27	Demonstrated high fidelity quantum operations
28	Enabled tuning insensitive measurements to be made
27	High-fidelity Rabi oscillations are easily attainable
33	Proposed a hardware-based solution

My work

14,21	System block diagrams/algorithms/equations solved
25-29	Description of assessment criteria used
22-24	Description of procedure (e.g. for experiments)

Results

25	Succinct presentation of results
25-29	Analysis
25-29	Significance of results

Conclusion

35	Statement of whether the outcomes met the objectives
33-35	Suggestions for future research

Literature: (up to 5 most important references)

A. Morello	Single-shot readout of an electron spin in Si
J. J. Pla	A single-atom electron spin qubit in Si
R. Kalra	The building blocks of a quantum computer...
C. H. Bennett	Quantum information and computation…
C. Bonato	Optimized quantum sensing with a single electron spin using real-time adaptive meas…