REPORT DUE DATE: July 04, 2016

McGILL UNIVERSITY
Graduate and Postdoctoral Studies

MASTER'S EXTERNAL REPORT

NAME OF STUDENT: Brendan Kyle THORN
DEGREE / UNIT: Master of Engineering / Department of Electrical & Computer Engr
THESIS TITLE: Decoding local field potential oculomotor signals during reach planning for neural prosthetic systems

Use the following scale:

EXCELLENT, VERY GOOD, GOOD, SATISFACTORY, or UNSATISFACTORY
(Choose one grade for each category)

Criteria	Excellent Top 10%	Very Good	Good	Satisfactory	Unsatisfactory
1. Evidence of originality and creativity	✓				
2. Resourcefulness, alertness to significance of findings	✓				
3. Diligence, care, technical skill in the research	✓				
4. Usefulness of the results to other workers in the field; value as a contribution to knowledge	✓				
5. Grasp of subject, powers of criticism and general adequacy in review of previous work	✓				
6. Quality of presentation (coherence, lucidity, grammar, style, freedom from typographical errors)	✓				

7. **OVERALL JUDGEMENT (circle one)** **PASSED** or **NOT PASSED**

8. If the overall judgement is '**PASSED**' please provide:
Comments explaining your evaluation of the thesis including recommendations for minor revisions to be included in the final thesis.

9. If the overall judgement is '**NOT PASSED**', at least one of the criteria above must be graded unsatisfactory.

Please provide:
   a. Comments explaining your evaluation of the thesis, including a detailed description of the shortcomings that have informed your decision that it does not meet the requirements of a passing thesis.
   b. An itemized list of the substantive issues that you expect the student to address for the written thesis to receive a passing grade upon re-examination. Please refer to appended instructions for examiners.

In order not to jeopardize the students anticipated graduation timeline (and potential associated costs), we must receive your report no later than **July 04, 2016**. Please return your report to: Thesis Office by fax 514-398-6283, email lucy.saunders@mcgill.ca or mail, Thesis Office, McGill University, James Administration Bldg, Room 400, 845 Sherbrooke St. W. Montreal, QC Canada H3A 2T5 Tel No. 514-3983990 Ext. 094220

DATE: July 12, 2016 SIGNED: _____
(Prof M. G. Rabbat)

Evaluation Report for the Masters Thesis of Brendan Thorn

"Decoding local field potential oculomotor signals during reach planning for neural prosthetic systems"

Evaluator: Michael Rabbat

Summary and judgement. This thesis explores the extent to which *local field potential* (LFP) signals from two regions of the brain (medial intra-parietal, or MIP, and dorsal pre-motor, or PMd) encode directional and temporal information during reach planning. The study is based on data from experimental trials involving primates that had sensors implanted in these two regions. The local field potentials were recorded while the primates performed trials, where eye trackers were also used to record saccades and pursuits related to motion planning. The main conclusions are that: 1) saccade and pursuit movement direction is indeed correlated with the spectral power in certain frequency bands of the LFPs from the regions considered; and 2) temporal information (about the saccade and pursuit onset) can also be predicted from the LFPs. The motivation for the study is to understand the extent to which these signals may be eventually useful for controlling prosthetics.

Overall this an extremely high-quality masters thesis. I was impressed by the depth of knowledge demonstrated, both in terms of the underlying neuroscience and biology, as well as in terms of the statistical, signal processing, and machine learning methods applied. There is clear evidence of originality in the selection of data and processing methods applied to answer the biological questions motivating the work. The thesis clearly highlights the significance of the various results presented while also being careful to discuss any limitations of the methods used. I really appreciated the attention paid to presenting background material. The review of related literature in Chapter 1 is well-written and accessible to a non-expert in neural prosthetic systems. The discussion of methods in Chapter 2 provides an excellent, succinct introduction to each method used, while also discussing the underlying assumptions and any potential limitations. The discussion in Chapter 4 clearly frames the thesis contributions in the context of other work in the literature. Throughout, the writing is lucid, and it is clear that significant effort went into revising and editing to make all arguments clear and well-justified, in addition to eliminating typos and grammatical mistakes.

The thesis meets all of the requirements and expectations for a masters thesis and there is no question that the overall judgement is PASSED. If there is an award or prize given for Masters theses then this one should seriously be considered.

Comments and questions. I particularly appreciated the care taken in applying statistical methods and signal processing methods. In each case, motivation was provided for why and how the method was applied to the data, and a thorough interpretation was always provided for the results. As the paragraphs above suggest, I think very highly of the thesis, and as such I only have a few additional (mostly minor) comments and questions that may be considered while preparing a final version of the document.

1. Although it is possible to follow the discussion at the bottom of page 19, regarding how PRR may encode hand position in eye-centered coordinates, directly from the text, a figure or diagram would have facilitated the discussion here.

2. The bottom of page 32 mentions that "obtaining a stationary signal over the duration of a trial is not possible". Instead of discussing the possibility of the event, you could say that it is not likely, and then go on to explain why it would anyways be undesirable.

3. The methodology discussed in Section 2.4.4 repeatedly applies an ANNOVA test to different time intervals and frequency bands. Should this be treated as a multiple hypothesis testing problem? You discuss choosing a threshold to achieve a certain level for the test, but this really only holds for a single application of the test, rather than across all applications.

4. Classification algorithms are applied in Fig. 10 to detect whether or not, in each time window, movement onset has occurred. This approach is memoryless, in the sense that the results of the SVM at one time instant does not depend in any way on the results it output at previous time instants. On the other hand, from the design of the experiment, you expect there to be one time when onset occurs and the test should continue to return positive from that time onwards (to the end of the period considered). Would there be any benefit to developing/applying a sequential testing procedure for onset detection?