Automatic Classification of Movement Variability in Human-Humanoid Interaction

Miguel P. Xochicale
Doctoral Researcher
map479@bham.ac.uk

Chris Baber
Lead Supervisor
c.baber@bham.ac.uk

Martin J. Russell
Co-supervisor
m.j.russell@bham.ac.uk

School of Electronic, Electrical and Systems Engineering
University of Birmingham, UK

ABSTRACT

This Thirty-three month report sumarises the contributions, workplan, final publication plans, thesis structure and viva preparation for my PhD project.

1 CONTRIBUTIONS

For the moment, my scientific outcomes are still far from either being scientifically impactful or creating original contributions. Nonetheless, I would like to note that I have presented some results in conferences after which I have refined my main research question as follows:

- *How can movement variability be used as an automatic index of users' performance over the course of practice in Human-Humanoid Interactions?*

With this in mind, I conducted three experiments whose results were reported in three conferences that had an acceptance rate of less than 50% [1, 2, 3]. From the reviewers' comments of the submitted work, I have have drawn the following considerations which should help the work to create original contributions to science and to make significant value of knowledge:

(i) Perform further data collection from a wider range of individuals (different gender, age and state of health); from additional inertial sensors attached to different parts of the body and from different levels of movement complexity.

(ii) Give an intrinsic explanation of the state space reconstruction in which is described why the time-delay embedding is an appropriate technique to analyse human movement variability and why it is important to compare different methodologies for dimensiality reduction.

(iii) Provide quantifiable evidence on how the postprocessing techniques (e.g. low-pass filtering, smoothing data, and interpolation) for the inertial sensors are affecting the metrics of movement variability.

(iv) Provide further understanding of human movement variablity in scenarios of one-human to one-humanoid interaction, two-humans to one-humanoid interaction and three-humans to one-humanoid interaction. For each of these, not only the arm movement variability will be taken into account but also the head pose estimation which can lead me to a better understanding and more reliable metrics of movement variability.

Thirty-three Month Report, 20 May 2017, Birmingham, UK

2 WORKPLAN

A detailed workplan for the third and four year of the PhD project is presented in Fig 1 where a list of submissions for reports, conferences, journals and thesis requirements are given with their respective submission date.

The initialism and acronyms in Fig 1(a) have the following meaning: HRI2017 is the 12th anual conference in Human-Robot Interaction 2017; IMMX2017 is the second forum of Innovation for Talented Mexicans 2017; MXSymposiumUK2017 is the 15th Annual Symposium of Mexican Students in the UK 2017; HRI2018 is the 13th annual conference in Human-Robot Interaction 2018; and HAI2017 which is the 5th annual conference in Human-Agent Interaction 2017. For Fig 1(b), J. of Social Robotics is the International Journal of Social Robotics, HRI2018 is the 13th annual conference in Human-Robot Interaction 2018, and MXSymposiumUK2018 is the 16th Annual Symposium of Mexican Students in the UK 2018.

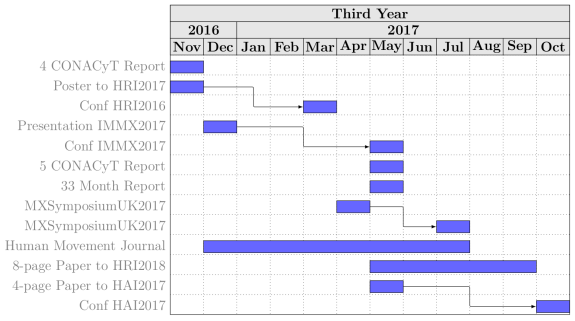
3 FINAL PUBLICATION PLANS

I am planning to submit two conference papers and two manuscripts which are described below:

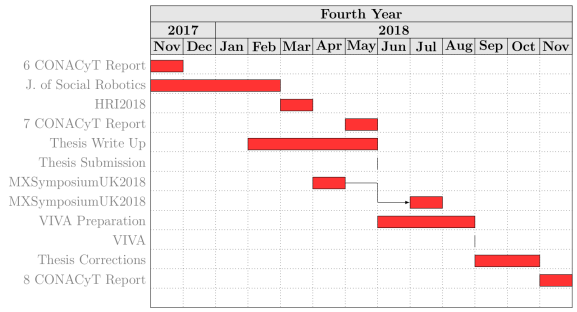
- Submission of a four-page paper to the 5th conference in Human-Agent Interaction which has an acceptance rate of 40% to 50 % (deadline: 2 June 2017)
- Submission of an eight-page paper to the 13th anual conference in Human-Robot Interaction 2018 which has a rate of acceptance of 24%. (deadline: 8 October 2017)
- Manuscript submission to the Human Movement Journal whose Impact Factor is 1.606 in 2015. (deadline: 31 July 2017)
- Manuscript submission to the International Journal of Social Robotics whose Impact Factor is 1.407 in 2015. (deadline: 28 February 2018)

4 THESIS STRUCTURE

The completion of the thesis is estimated to be at 40% to this month (May 2017). The possible thesis structure including a list of chapters with an estimated percentage of completion and sections is described below:



(a) Third year plan



(b) Fourth year plan

Figure 1: Workplan

Chapter 1: Introduction ..... (25%)
Structure of the Introduction: Opening hook. Context. Gap in the literature. Reserach questions. Argument. Outline of logic.

Chapter 2: Literature Review ..... (60%)
2.1 Sources of Variability in Human Movement. 2.1.1. Sensors 2.1.2. Variability within person and across persons 2.1.3. Variability for simple and complex activities 2.2 Techniques to measure human movement variability.

Chapter 3: Methodology ..... (60%)
3.1 Time-domain. 3.2 Frequency-domain. 3.3 Nonlinear dynamics domain.

Chapter 4: Experiments ..... (75%)
4.1 Dance. 4.2 Simple Movements. 4.3 Human-Humanoid Imitation. 4.4 Group Activity in Human-Humanoid Imitation.

Chapter 5: Automatic Classification ..... (10%)
5.1 Convolutional Neural Networks 5.2 Convolutional Neural Networks Using time-series from Inertial Sensors.

Chapter 6: Conclusions ..... (0%)

5 VIVA PREPARATION

As shown in Fig 1(b), the VIVA preparations are planning to be done between June 2018 to August 2018 so as to present the VIVA in the first week of September 2018.

6 ACKNOWLEDGMENTS

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