2007

Human behavioural skills modelling and recognition

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Human Behavioural Skills Modelling and Recognition

by

Chao Sun

A dissertation submitted in fulfillment of the requirements for the degree of Master of Engineering (Research) (SECTE) in University of Wollongong 2007

Supervisor:

Professor Fazel Naghdy,
Doctor David Stirling,
Associate Professor Golshah Naghdy.
ABSTRACT

Human behaviour can be considered as the ensemble of various activities performed by an individual towards performing a particular task. There are many factors influencing human behaviour including culture, attitudes, emotions, values, ethics, and so on. In this work, the concept of “human behaviour” in the context of human psycho-motor behaviour is studied.

This work is primarily concerned with the development of a system to learn, distinguish and recognise various pre-defined human behavioural tasks. As an initial constraint, the challenging goal, subject to the limitation of hardware, is to model various human behaviours with only one integrated inertial sensor. The motions are captured with the sensor and recorded as streams of multi-dimensional sensory data, which are subsequently analysed into certain patterns. Since only one point on the human body can be measured with that sensor at a time, there are not sufficient motion data to enable the generation of new synthetic behaviours (which might be possible with multiple sensors). It is not really possible to develop a comprehensive model of complex behaviours under this condition. Thus, this work has focussed on building a system to model the behaviour of a specific part of the human body, and in turn to recognise and compare these behaviours.

The experimental rig consists of an inertial sensor mounted on the subject providing kinematics data in real-time. Through this sensor, the behavioural motions are transformed into continuous streams of signals including Euler angles.
and accelerations in three spatial dimensions. Unsupervised machine learning algorithms and other techniques are implemented to analyse and build models of human behaviours in this work. An intrinsic classification algorithm called MML (Minimum Message Length encoding), and a popular unsupervised fuzzy clustering algorithm FCM (Fuzzy c-Means) are used to segment the complex data streams respectively, formulating inherent models of the dynamic modes they represent. Subsequent representation and analysis including FSM (Finite State Machines), DTW (Dynamic Time Warping), Kullback-Leibler divergence and Smith-Waterman sequence alignment have proved quite effective in distinguishing between behavioural characteristics that persist across a variety of tasks and multiple candidates.

The hypothesis pursued in the thesis has been validated based on two machine learning algorithms for unsupervised learning namely MML and FCM. Each of these methods is capable of producing a range of primitives from the motion training data. However, the outcomes of regular expression and Dynamic Time Warping analysis results indicate that MML provides better results compared with the FCM algorithm in terms of identifying behaviours.
Dedicate to My Family
DECLARATION

I, Chao Sun, declare that this thesis, submitted in fulfilment of the requirement for the award of Master of Engineering, in the School of Electrical, Computer and Telecommunications Engineering, Faculty of Infomatics, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. No part of this document has been submitted for qualifications at any other academic institution.

(Signature)

Chao Sun

31/Oct/2007
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Last but not least, I thank my mother, my wife and the rest of my family members who have always been there for me when I needed them the most, and for supporting me through all these years.
PUBLICATIONS


# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>a</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>c</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>d</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>e</td>
</tr>
<tr>
<td>PUBLICATIONS</td>
<td>f</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>vi</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>1. Introduction</td>
<td></td>
</tr>
<tr>
<td>1.1 Psycho-motor Behaviour</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Human Motion Modelling</td>
<td>1</td>
</tr>
<tr>
<td>1.3 Skill Primitive</td>
<td>3</td>
</tr>
<tr>
<td>1.4 Core Concept in Behaviour Identification</td>
<td>5</td>
</tr>
<tr>
<td>1.5 Aim of This Work</td>
<td>7</td>
</tr>
<tr>
<td>1.6 Structure of This Thesis</td>
<td>8</td>
</tr>
<tr>
<td>2. Background</td>
<td></td>
</tr>
<tr>
<td>2.1 Challenges of Human Behaviour Modelling</td>
<td>9</td>
</tr>
<tr>
<td>2.2 Approaches to Human Behaviour Modelling</td>
<td>10</td>
</tr>
<tr>
<td>2.3 Motion Acquisition Methods</td>
<td></td>
</tr>
<tr>
<td>2.3.1 Optical Sensor</td>
<td>11</td>
</tr>
<tr>
<td>2.3.2 Inertial Sensors</td>
<td>13</td>
</tr>
<tr>
<td>2.3.3 Other Sensors</td>
<td>14</td>
</tr>
<tr>
<td>2.3.4 Sensor Fusion</td>
<td>15</td>
</tr>
<tr>
<td>2.4 Motion Modelling Methods</td>
<td></td>
</tr>
<tr>
<td>2.4.1 Taxonomy of Machine Learning</td>
<td>16</td>
</tr>
<tr>
<td>2.4.2 Machine Learning in Modelling of Human Behaviour</td>
<td>18</td>
</tr>
<tr>
<td>2.4.3 Motion Primitive Concept</td>
<td>21</td>
</tr>
<tr>
<td>2.5 Summary</td>
<td>23</td>
</tr>
<tr>
<td>3. Experimental Set Up</td>
<td></td>
</tr>
<tr>
<td>3.1 MTx Sensor</td>
<td></td>
</tr>
<tr>
<td>3.1.1 Hardware</td>
<td>24</td>
</tr>
<tr>
<td>3.1.2 MT software</td>
<td>26</td>
</tr>
<tr>
<td>3.2 Output Mode and Sensor Specifics</td>
<td></td>
</tr>
<tr>
<td>3.2.1 Calibration Data</td>
<td>28</td>
</tr>
<tr>
<td>3.2.2 Orientation Data</td>
<td>30</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>3.3 Experimental Environment</td>
<td>32</td>
</tr>
<tr>
<td>3.3.1 Behavioural Definition</td>
<td>32</td>
</tr>
<tr>
<td>3.3.2 Experimental Set Up</td>
<td>34</td>
</tr>
<tr>
<td>3.4 Motion Feature Selection</td>
<td>35</td>
</tr>
<tr>
<td>3.5 Summary</td>
<td>39</td>
</tr>
<tr>
<td>4. Experimental Design</td>
<td>40</td>
</tr>
<tr>
<td>4.1 Experimental Framework</td>
<td>41</td>
</tr>
<tr>
<td>4.2 Data Pre-Processing</td>
<td>44</td>
</tr>
<tr>
<td>4.2.1 Data Calibration</td>
<td>44</td>
</tr>
<tr>
<td>4.2.2 Data Scaling</td>
<td>46</td>
</tr>
<tr>
<td>4.3 Motion Data Modelling</td>
<td>50</td>
</tr>
<tr>
<td>4.3.1 FCM Modelling</td>
<td>52</td>
</tr>
<tr>
<td>4.3.2 MML Modelling</td>
<td>53</td>
</tr>
<tr>
<td>4.3.3 Golden Ratio Criterion</td>
<td>57</td>
</tr>
<tr>
<td>4.4 Motion Identification</td>
<td>59</td>
</tr>
<tr>
<td>4.5 Summary</td>
<td>60</td>
</tr>
<tr>
<td>5. Experimental Work and Results</td>
<td>61</td>
</tr>
<tr>
<td>5.1 Basic Experiment</td>
<td>61</td>
</tr>
<tr>
<td>5.1.1 Application of MML</td>
<td>62</td>
</tr>
<tr>
<td>5.1.2 Basic Experiment with FCM</td>
<td>67</td>
</tr>
<tr>
<td>5.1.3 Dynamic Time Warping (DTW) Analysis</td>
<td>70</td>
</tr>
<tr>
<td>5.2 Analysis and Improvement</td>
<td>72</td>
</tr>
<tr>
<td>5.2.1 Standard Motion Induction</td>
<td>72</td>
</tr>
<tr>
<td>5.2.2 Primitive Merging</td>
<td>73</td>
</tr>
<tr>
<td>5.2.3 Advanced Sequence Alignment</td>
<td>75</td>
</tr>
<tr>
<td>5.3 Advanced Experiment</td>
<td>80</td>
</tr>
<tr>
<td>5.3.1 MML Modelling</td>
<td>80</td>
</tr>
<tr>
<td>5.3.2 FSM Analysis</td>
<td>81</td>
</tr>
<tr>
<td>5.4 Summary</td>
<td>87</td>
</tr>
<tr>
<td>6. Real-time Behaviour Recognition</td>
<td>89</td>
</tr>
<tr>
<td>6.1 Introduction</td>
<td>89</td>
</tr>
<tr>
<td>6.2 Primitive Analysis</td>
<td>89</td>
</tr>
<tr>
<td>6.2.1 Raw Data Analysis</td>
<td>89</td>
</tr>
<tr>
<td>6.2.2 Primitive Statistic</td>
<td>92</td>
</tr>
<tr>
<td>6.2.3 Graphical Representation of Primitives</td>
<td>94</td>
</tr>
<tr>
<td>6.3 Real-time Recognition</td>
<td>96</td>
</tr>
<tr>
<td>6.3.1 Longest Common Primitive Sequence</td>
<td>96</td>
</tr>
<tr>
<td>6.3.2 Improved Regular Expression Form</td>
<td>97</td>
</tr>
<tr>
<td>6.3.3 Primitive Sub-sequences</td>
<td>101</td>
</tr>
<tr>
<td>6.4 Summary</td>
<td>103</td>
</tr>
<tr>
<td>7. Conclusion and Future Work</td>
<td>104</td>
</tr>
<tr>
<td>7.1 Introduction</td>
<td>104</td>
</tr>
<tr>
<td>7.2 Major Contributions of Work</td>
<td>104</td>
</tr>
<tr>
<td>7.3 Comparison of MML and FCM</td>
<td>105</td>
</tr>
<tr>
<td>7.4 Future Work</td>
<td>107</td>
</tr>
<tr>
<td>Bibliography</td>
<td>109</td>
</tr>
<tr>
<td>Appendices</td>
<td>113</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>An HMM Mimesis Model Based on Motion Primitives[27]</td>
</tr>
<tr>
<td>1.2</td>
<td>A block diagram of speech recognition[45]</td>
</tr>
<tr>
<td>1.3</td>
<td>An HMM model for speech recognition[45]</td>
</tr>
<tr>
<td>2.1</td>
<td>Flowchart of Sensor Fusion System with Knowledge Database [29].</td>
</tr>
<tr>
<td>2.2</td>
<td>A Primitive Based Multi-layer Motion Modelling Procedure [6].</td>
</tr>
<tr>
<td>3.1</td>
<td>The MTx Inertial Sensor [64].</td>
</tr>
<tr>
<td>3.2</td>
<td>Embedded Sensor Fusion of MTx Sensor [64].</td>
</tr>
<tr>
<td>3.3</td>
<td>The MT Software Interface.</td>
</tr>
<tr>
<td>3.4</td>
<td>Comparison on the Orientation Output after a Movement Stops</td>
</tr>
<tr>
<td>3.5</td>
<td>MTx with Sensor-fixed Co-ordinate System Overlaid [64].</td>
</tr>
<tr>
<td>3.6</td>
<td>Data Type of Calibration Output Mod [64].</td>
</tr>
<tr>
<td>3.7</td>
<td>Data Type of Rotation Matrix Output Mode [64].</td>
</tr>
<tr>
<td>3.8</td>
<td>Tracks of three Arm Behavioural Tasks.</td>
</tr>
<tr>
<td>3.9</td>
<td>The Actual Experimental Set Up.</td>
</tr>
<tr>
<td>3.10</td>
<td>Installation of the MTx Sensor.</td>
</tr>
<tr>
<td>3.11</td>
<td>Raw Motion Data from three Defined Tasks.</td>
</tr>
<tr>
<td>4.1</td>
<td>Diagram of Basic Approach Framework.</td>
</tr>
<tr>
<td>4.2</td>
<td>Data calibration for subtract direction information (Red for Yaw Feature).</td>
</tr>
<tr>
<td>4.3</td>
<td>Feature Comparison Between ‘Push’ and ‘Zigzag’.</td>
</tr>
<tr>
<td>4.4</td>
<td>Comparison of motion features among different candidates (‘Grab’ task).</td>
</tr>
<tr>
<td>4.5</td>
<td>Normalised Motion Feature Comparison between Task ‘Push’ and ‘Zigzag’</td>
</tr>
<tr>
<td>4.6</td>
<td>Normalised (2nd Method) motion features among different candidates (‘Grab’).</td>
</tr>
<tr>
<td>4.7</td>
<td>Performance Index for Different FCM Models.</td>
</tr>
<tr>
<td>4.8</td>
<td>The concept of Minimum Message Length.</td>
</tr>
<tr>
<td>4.9</td>
<td>The Enhanced Version of MML Modelling Application – ACPro.</td>
</tr>
<tr>
<td>4.10</td>
<td>Elbow Criterion [4].</td>
</tr>
<tr>
<td>4.11</td>
<td>Optimal Model Selection for MML Clustering.</td>
</tr>
<tr>
<td>5.1</td>
<td>Message Length Decreasing Trend with Different Normalisation Methods. (Blue: 1st Norm.; Red: 2nd Norm.; Green: 3rd Norm.-Method)</td>
</tr>
<tr>
<td>5.2</td>
<td>Performance Index for FCM clustering normalised training data.</td>
</tr>
<tr>
<td>5.3</td>
<td>FCM clustering patterns on training data with different normalisation methods.</td>
</tr>
<tr>
<td>5.4</td>
<td>DTW Distance Distribution among testing data sequences (with different motion models).</td>
</tr>
<tr>
<td>5.5</td>
<td>Standard Motion Generation.</td>
</tr>
<tr>
<td>5.6</td>
<td>Improved DTW Analysis.</td>
</tr>
<tr>
<td>5.7</td>
<td>Main GUI of the SW-Alignment application – Jaligner.</td>
</tr>
<tr>
<td>5.8</td>
<td>MML model with 20 Clusters.</td>
</tr>
<tr>
<td>5.9</td>
<td>FSM flow charts for three standard tasks.</td>
</tr>
<tr>
<td>5.10</td>
<td>FSM flow charts for all the testing motion data.</td>
</tr>
<tr>
<td>5.11</td>
<td>Primitive paths from different candidates (Blue: C, Red: J, Green: T).</td>
</tr>
<tr>
<td>5.12</td>
<td>Average Similarity Scores between 90 test and 3 standard motions.</td>
</tr>
<tr>
<td>5.13</td>
<td>Differentiated Average Similarity Scores Between Test and Standard Motions.</td>
</tr>
<tr>
<td>6.1</td>
<td>Raw Motion Data (Training Set) from Three Candidates.</td>
</tr>
<tr>
<td>6.2</td>
<td>Normalised Training Data Set.</td>
</tr>
<tr>
<td>6.3</td>
<td>Abundance of Primitives in Different Motion Tasks.</td>
</tr>
<tr>
<td>6.4</td>
<td>Raw motion data representation of 20 primitives.</td>
</tr>
</tbody>
</table>
6.5 Thresholds $T_1, T_2$ Determination Matrixes. .......................... 100
7.1 2-Cluster Models on the “Push” and “Zigzag” behaviour ...................... 107
A.1 An example of FCM clustering. ............................................. 116
A.2 Performance Indices for Different FCM Models. ............................... 118
A.3 The concept of Minimum Message Length. ................................... 120
A.4 Elbow Criterion [4]. ......................................................... 121
A.5 Outstanding Characteristics of the Golden Ratio[33]. ......................... 122
A.6 Parsing the Word “nice” with FSM Sequence Detector [22]. ................. 123
A.7 Dynamic Time Warping between two time series [50]. ....................... 124
A.8 A cost matrix with the minimum-distance warp path traced through it [50] .... 125
A.9 Illustration of global and local alignments [61]. ............................. 126
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Performance Specifics of the MTx Calibration Output [64].</td>
<td>29</td>
</tr>
<tr>
<td>3.2</td>
<td>Performance Specifics of the MTx Orientation Output [64].</td>
<td>32</td>
</tr>
<tr>
<td>5.1</td>
<td>Content of the ‘.nam’ file for different normalisation methods.</td>
<td>63</td>
</tr>
<tr>
<td>5.2</td>
<td>Primitives relabelling according to their abundance.</td>
<td>65</td>
</tr>
<tr>
<td>5.3</td>
<td>MML estimation results with different normalisation methods.</td>
<td>66</td>
</tr>
<tr>
<td>5.4</td>
<td>FCM estimation results with different normalisation methods.</td>
<td>69</td>
</tr>
<tr>
<td>5.5</td>
<td>Kullback-Leibler Distance between Primitives.</td>
<td>75</td>
</tr>
<tr>
<td>5.6</td>
<td>Example Scoring Matrix for MML Model.</td>
<td>79</td>
</tr>
<tr>
<td>5.7</td>
<td>Scoring Matrix for SW alignment.</td>
<td>84</td>
</tr>
<tr>
<td>6.1</td>
<td>Statistical analysis on the 20 primitive set.</td>
<td>92</td>
</tr>
<tr>
<td>6.2</td>
<td>Acceptable Ranges of the Thresholds.</td>
<td>100</td>
</tr>
<tr>
<td>6.3</td>
<td>Common Primitive Sub-sequences for Different Behavioural Tasks.</td>
<td>102</td>
</tr>
</tbody>
</table>
LIST OF APPENDICES

Appendix

A. Algorithms .................................................. 114
   A.1 Data Clustering ........................................ 114
       A.1.1 Fuzzy C-means (FCM) ............................ 114
       A.1.2 Minimum Message Length Principle ............ 118
   A.2 Cluster Number Determination ......................... 119
       A.2.1 Elbow Criterion .................................. 120
       A.2.2 Golden Ratio ................................... 121
   A.3 Sequence Studying Algorithms ......................... 123
       A.3.1 Finite States Machine .......................... 123
       A.3.2 Dynamic Time Warping .......................... 124
       A.3.3 Smith Waterman Sequence Alignment ............ 126
   A.4 Kullback-Leibler Distance ........................... 128

B. Source Codes ............................................. 129