Chapter 1
Introduction

Motivation

Outline of thesis

Foundations

Chapter 2
Statistical Methods for Functional Data

Basis Expansions and Smoothing

Registration

FPCA

Functional Regression

Chapter 3
Introduction to the RISC Dataset

Data Collection & Extraction

Basis Representation

Landmark Registration

Novel Contributions

Chapter 4
Multivariate Functional Mixed Model

Development of a model for the average hip and knee angle functions from the RISC data

Quantify fixed effects of scalar covariates

Model dependence among bilateral observations from the same subject

Chapter 5
Multivariate Multilevel Longitudinal Functional Model

Extend the model from Chapter 4 to include the hip, knee and ankle angles from every stride in the RISC data

Development of novel multilevel longitudinal approach to capture serial correlation among adjacent strides

Chapter 6
An Understanding of Principal Differential Analysis

Re-examination of PDA as a generative statistical model

Development iterative bias-reduction algorithm to improve parameter estimates

Perspective of PDA as a time-varying linearised approximation to a non-linear ODE model

Demonstrations on a variety of simulated examples and kinematic data from the RISC dataset

Chapter 7
Conclusion

Summary of work

Future directions