Modelling the effects of domestication in Wheat through novel computer vision techniques

Author:	Nathan Hughes (nah26@aber.ac.uk)
Supervisor:	Dr. Wayne Aubrey (waa2@aber.ac.uk)
Degree Scheme	G401 (Computer Science)

Date:	April 5, 2018
Revision:	0.1
Status:	Draft

This report was submitted as partial fulfilment
of a BSc degree in Computer Science (G401)

Declaration of originality

I confirm that:

- This submission is my own work, except where clearly indicated.
- I understand that there are severe penalties for Unacceptable Academic Practice, which can lead to loss of marks or even the withholding of a degree.
- I have read the regulations on Unacceptable Academic Practice from the University's Academic Quality and Records Office (AQRO) and the relevant sections of the current Student Handbook of the Department of Computer Science.
- In submitting this work I understand and agree to abide by the University's regulations governing these issues.

Name ....

Date ....

Consent to share this work

By including my name below, I hereby agree to this dissertation being made available to other students and academic staff of the Aberystwyth Computer Science Department.

Name ....

Date ....

Contents

List of Tables

List of Figures

List of Listings

Chapter 1

Introduction, Analysis and Objectives

Background

Problem Analysis

Objectives

Chapter 2

Method Design

Improvements to 3D imaging software

New Watershed Algorithm

In order to solve the problem of misidentified and joint seeds, from the primitive collection, I implemented a *quasi-euclidean* distance transform into the analysis pipeline [1]. This provided much better results than the previous *chessboard* transform which had been successful on more uniform data.

Quasi-Euclidean algorithm

This algorithm measures the total euclidean distance along a set of horizontal, vertical and diagonal line segments [2].

$$|x_1 - x_2| + (\sqrt{2} - 1), |x_1 - x_2| > |y_1 - y_2| \, (\sqrt{2} - 1) \, |x_1 - x_2| \, , \text{otherwise} \tag{2.1}$$

In order to apply this to a 3D space Kleinberg's method is used [3]. This allows for nearest neighbour pixels to be sorted by k-dimensional trees and enabling fast distance transforms via Rosenfeld and Pfaltz's *quasi-euclidean* method stated in equation:2.1.

Testing of Software

Chapter 3

Software Design, Testing and Implementation

Software Development Methodology

Data Pipeline

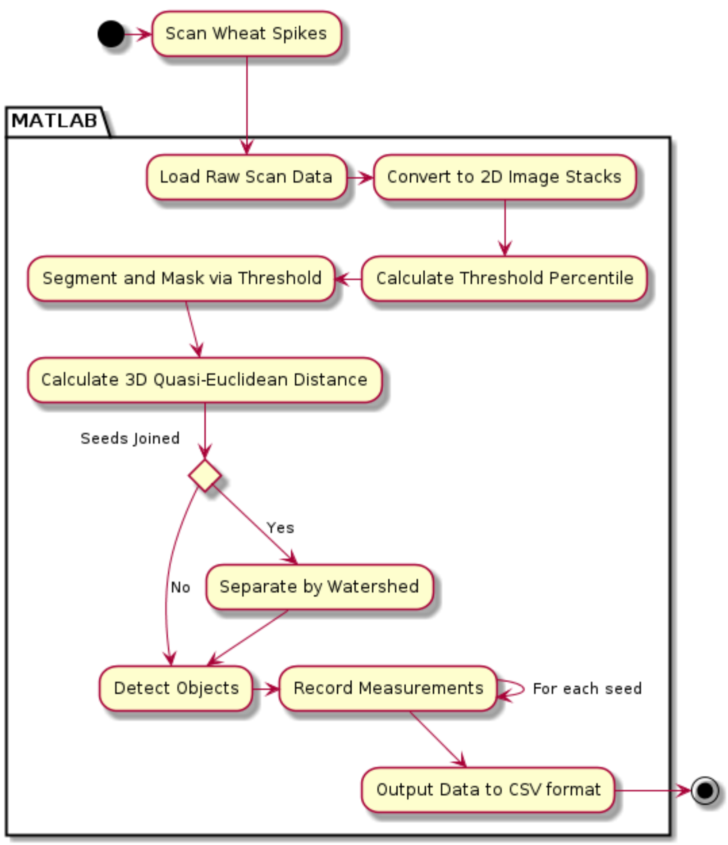

Figure 3.1: Image Processing Pipeline

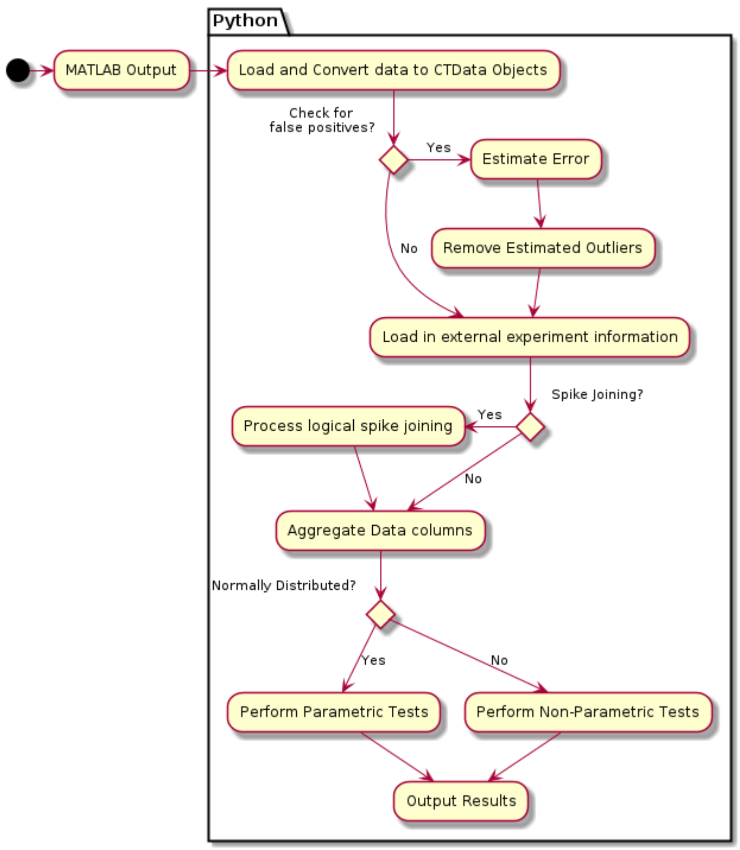

Figure 3.2: Data Pipeline and Information Flow

Chapter 4

Results

Improved accuracy of imaging software

Effect of enhanced watershedding algorithm

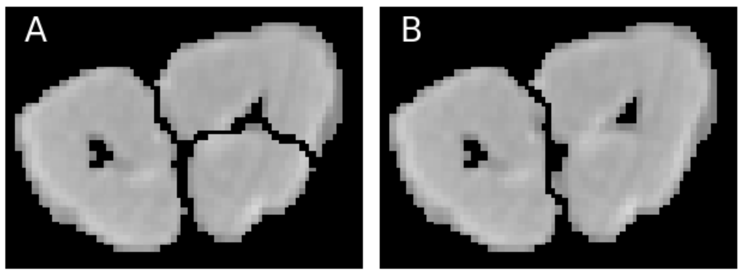

Figure 4.1: *A* showing the chessboard method, *B* improved quasi-euclidean method

Chapter 5

Discussion

Chapter 6

Critical Evaluation

Organisational Methods

Relevance to Degree

Time Management

Collaborative Work

Other Issues

Chapter 7

Code Segments and Examples

MATLAB Watershedding

```
function [W] = watershedSplit3D(A)
  % Takes image stack A and splits it into stack W
  % Convert to BW
  bw = logical(A);
  % Create variable for opening and closing
  se = strel('disk', 5);
  % Minimise object missshapen-ness
  bw = imerode(bw, se);
  bw = imdilate(bw, se);
  % Fill in any left over holes
  bw = imfill(bw,4,'holes');
  % Use chessboard for distance calculation for more refined splitting
  chessboard = -bwdist(~bw, 'quasi-euclidean');
  % Modify the intensity of our bwdist to produce chessboard2
  mask = imextendedmin(chessboard, 2);
  chessboard2 = imimposemin(chessboard, mask);
  % Calculate watershed based on the modified chessboard
  Ld2 = watershed(chessboard2);
  % Take original image and add on the lines calculated for splitting
  W = A;
  W(Ld2 == 0) = 0;
end
```

Listing 1: MATLAB Watershedding function

References

[1] N. Hughes, K. Askew, C. P. Scotson, K. Williams, C. Sauze, F. Corke, J. H. Doonan, and C. Nibau, "Non-destructive, high-content analysis of wheat grain traits using X-ray micro computed tomography," *Plant Methods*, vol. 13, 2017.

[2] J. L. Pfaltz, "Sequential Operations in Digital Picture Processing," *Journal of the ACM*, vol. 13, no. 4, pp. 471–494, oct 1966. [Online]. Available: http://portal.acm.org/citation.cfm?doid=321356.321357

[3] J. M. Kleinberg, "Two algorithms for nearest-neighbor search in high dimensions," in *Proceedings of the twenty-ninth annual ACM symposium on Theory of computing - STOC '97*. New York, New York, USA: ACM Press, 1997, pp. 599–608. [Online]. Available: http://dl.acm.org/citation.cfm?id=258533.258653