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# Flow Control of Agricultural Spraying Machines

A Thesis in partial fulfilment of the requirements for the Degree of

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## Abstract

New Zealand relies heavily on its agricultural industry. A large portion of this industry is pastoral farming, where livestock are raised to graze on pasture. This includes beef, sheep and dairy farming. An important aspect of this style of farming is maintaining pasture quality. In order to increase growth fertilisers are often applied to the pastures. This increases yields in both meat and milk production. However, the increased application of fertiliser is linked with diminishing water quality. While the effects of nitrogen leaching and the best ways to manage fertiliser use are still being investigated, it is clear that control over the application will become more and more important.

The Tow and Fert is a range of fertiliser machines designed and built in New Zealand by Metalform Dannevirke. The Tow and Fert range is capable of spraying a wide range of fertilisers including both soluble and non-soluble fertilisers. The Tow and Fert is unique in its ability to spray fertiliser slurries consisting of mixture ratios of up to three-parts fine particle fertiliser to one-part water. This is achieved by the use of a recirculating system. Currently there is next to no control on the flow rate of the machines and the application rate is determined by the speed the operator maintains.

The purpose of this thesis is to design and build a flow control system for the Tow and Fert product range and investigate the effect of the changing flow rate on the spray characteristics. The ability to spray such a wide range of fluids with drastically different properties presents many challenges.

Many flow meters were considered and a low cost ultrasonic sensor (TUF2000M) was installed and investigated. After limited success of the ultrasonic sensor, a simple turbine flowmeter was installed. A flow controller was developed and tuned. Based off a PID control loop, the controller was able to maintain flowrate well between 10 L/min and 25 L/min depending on the installed nozzle.

After flow control had been achieved, methods for assessing the impact of flow rate on spray characteristics and specifically spray distribution were investigated. Several prototypes were created and tested. A stationary patternator capable of continuous measurement was developed and tested. The patternator does not correctly measure the flowrates in low flow sections. Only half of the flow being applied to the platform is being measured. This causes highly nonlinear results in spray distribution measurement. The testing did show an increase of spray area with increasing flowrate. However, the true distribution can be improved when the low flow issues have been resolved.

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# Table of Contents

Abstract.....	i
Acknowledgements.....	ii
List of Figures .....	vi
List of Tables .....	viii
1 Introduction .....	1
1.1 Pastoral Farming and Soil Health.....	1
1.2 Precision Agriculture.....	1
1.3 Fertiliser Application Technology.....	2
1.4 Research Challenges and Objectives.....	3
2 Sprayers in Agriculture.....	4
2.1 Traditional Field Sprayer Setup.....	4
2.1.1 Booms and Boom Components .....	4
2.1.2 Nozzles .....	5
2.1.3 Control of Multi-Nozzle Boom Sprayers .....	7
2.2 C-Dax Sprayers .....	8
2.2.1 Trailed Units .....	8
2.2.2 Tractor Mounted Units .....	8
2.3 The Tow and Fert Range .....	10
2.4 The Tow and Fert 1000 .....	10
2.4.1 Tow and Fert System Overview .....	10
2.4.2 Motor and Pump.....	11
2.4.3 Tank Agitation and Premixer.....	12
2.4.4 Retractable Spray Booms.....	13
2.4.5 Detachable Spray Heads .....	14
2.4.6 Spray Control and Electronics .....	14
2.4.7 Load Cells and Weight Measurement.....	15
2.5 Tow and Fert Nozzles .....	15
3 Volumetric Flowrate Measurement.....	18
3.1 Types of Flowmeters.....	18
3.1.1 Differential Pressure Flow Metering.....	18
3.1.2 Turbine and Related Flow Meters.....	19
3.1.3 Positive Displacement Meters .....	20
3.1.4 Electromagnetic Flow Meters .....	21
3.1.5 Ultrasonic Flow Meters.....	22

3.1.6	Summary of Flowmeters .....	24
3.2	TUF2000M Ultrasonic Flow Meters .....	24
3.2.1	About the TUF2000M.....	24
3.2.2	Installation of TUF2000M Flow Meters .....	25
3.2.3	Testing of the TUF2000M Flow Meters .....	28
3.2.4	Investigating TUF2000M Noise sources.....	31
3.2.5	Conclusions of TUF2000M .....	33
3.3	ZD1200 Impeller Flow Sensor .....	34
3.3.1	About the ZD1200 Flow Sensor.....	34
3.3.2	Installation of the ZD1200 Flow Meter onto the Tow and Fert.....	35
3.3.3	Measurement of Flow from ZD1200 Meter.....	35
3.3.4	Testing and Calibration of the ZD1200 .....	36
3.3.5	System Nozzle Flow Characteristics.....	37
3.3.6	Motor Speed / Pump Pressure:.....	37
3.3.7	Nozzle Flow Characteristics.....	38
3.3.8	Testing Diaphragm Valve Consistency .....	38
4	Hardware and Software Design of Flow Controller .....	40
4.1	Controller Design and Specifications: .....	40
4.1.1	Microcontroller selection (ATmega2560) .....	40
4.1.2	Additional Electronics and Modules .....	41
4.1.3	Controller PCB Design .....	42
4.2	Prototyping Code Development .....	44
4.2.1	TUF2000M Communication Library.....	44
4.2.2	Linear Actuator Class Development.....	46
4.3	Controller Tuning .....	48
4.3.1	Actuator Positioning Tuning.....	48
4.3.2	Flow Control Overview.....	48
4.3.3	Ultimate Gain Tuning .....	49
4.3.4	Testing Proportional Flow Control.....	52
5	Spray Area Distribution .....	53
5.1	Spray Area Measurement .....	55
5.1.1	Vision Based Measurement .....	55
5.1.2	Mechanical Patternators.....	55
5.1.3	Scanning Patternators.....	56
5.2	Scanning Load Cell Panel.....	56
5.2.1	Design and Construction.....	57

5.2.2	Electronics and Code Development .....	58
5.2.3	Calibration and Signal Conditioning .....	60
5.2.4	Testing and Results .....	62
5.2.5	Evaluation and Conclusion .....	66
5.3	Stationary Patternator .....	67
5.3.1	Design and Construction .....	67
5.3.2	Flow Measurement and Calibration .....	67
5.3.3	Spray Characterisation Testing and Results .....	72
6	Conclusions and Future Work .....	76
	References .....	78
	Appendices .....	81

# List of Figures

Figure 1 Precision Farming Cycle [5] .....	2
Figure 2 - Comparison of Dry and Wet Boom Types [8] .....	4
Figure 3 - Left: Teejet QJ200 Dry Boom Nozzle Body Right: Teejet Q17560A Wet Boom Nozzle Body [9] .....	5
Figure 4 - Left: TeeJet QJ360 Nozzle Body Right: TeeJet QJS-B3-AAA Stackable Nozzle Body [9].....	5
Figure 5 - Nozzle Geometry and Spray Pattern [11] .....	6
Figure 6 - Nozzle Configuration with 100% Overlap [11].....	6
Figure 7 – Example of Automatic Section Control [7].....	7
Figure 8 - C-Dax Goldline 1500L Trailed Sprayer [18] .....	8
Figure 9 - C-Dax GoldLine Hi-Spec [19] .....	9
Figure 10 - C-Dax Promotional Content Showing Goldline Options [19].....	9
Figure 11 - Tow and Fert Series [20] .....	10
Figure 12 - Tow and Fert System Overview .....	11
Figure 13 - Tow and Fert Front View .....	12
Figure 14 - Tow and Fert Boom Actuator.....	13
Figure 15 - Tow and Fert Manual Boom Operation .....	13
Figure 16 - Spray Head with Rubber Diaphragm Valve.....	14
Figure 17 - Existing Flow Control Overview .....	15
Figure 18 - Metalform TF40 Nozzle.....	16
Figure 19 - Importance of Nozzle Rotation for Spray Evenness .....	17
Figure 20 - Common Types of Differential Pressure Meters [25] .....	18
Figure 21 - Comparison of Axial and Radial Turbines [23].....	19
Figure 22 - Comparison of Singe and Multi Jet Radial Turbine Meters [26].....	20
Figure 23 - Left: Paddlewheel Meter Concept [28] Right: Example of Pelton Wheel Geometry [29] 20	20
Figure 24 - Left: Elliptical PD Meter Flow Process [31] Right: Round Gear PD Meter .....	21
Figure 25 - Left: Fundamental EM Meter Setup Left: ABB Brand EM Flowmeter [33] .....	22
Figure 26 - Left: Ultrasonic Transit Time Meter Principle Right: Sono-Trak Ultrasonic Flowmeter [34] .....	23
Figure 27 - Doppler Flowmeter Working Principal [27] .....	23
Figure 28 - TUF2000M Flow Meter [36].....	25
Figure 29 - TUF2000M Pipe Installation Requirements [36].....	26
Figure 30 - Ultrasonic Transducer Z Installation [36].....	27
Figure 31 - Ultrasonic Transducer V Installation [36] .....	27
Figure 32 - Ultrasonic Transducer W Installation [36] .....	27
Figure 33 - TUF2000M Raw Flow Data - Closed Loop Testing .....	29
Figure 34- TUF2000M Filtered, Offset Corrected Flow Data - Closed Loop Testing.....	30
Figure 35 - TUF2000M Calculated Nozzle Flowrate - Closed Loop .....	30
Figure 36 - Oscilloscope Trace of TUF2000M Operation .....	31
Figure 37 - Trace of TUF2000M Pulse and Response.....	32
Figure 38 - Trace of TUF2000M Pulse and Response with Transducer Disconnected.....	33
Figure 39 - ZD1200 Flow Sensor Calibration Plot.....	34
Figure 40 - ZD1200 Installed .....	35
Figure 41 - ZD1200 Calibration Data .....	37
Figure 42 - Effect of Pump Pressure on Nozzle Flow Characteristics.....	38
Figure 43 - Nozzle Flow Characteristics .....	39
Figure 44 - Diaphragm Valve Testing .....	39
Figure 45 - Arduino Mega Microcontroller Development Board [40] .....	41
Figure 46 - SP483 Pinout [41].....	41



Figure 47 - VNH2SP30 pinout and chip as implemented on Pololu MD01B [42] .....	42
Figure 48 - HC05 Module (front and back) [43] .....	42
Figure 49 - Flow Controller PCB Layout .....	43
Figure 50 - Flow Controller and TUF2000M Meters .....	43
Figure 51 - Basic TUF2000M Query.....	45
Figure 52 - findLimits() Function Flow .....	47
Figure 53 - Control System Overview .....	49
Figure 54 - Flowrate Control – Rough Ultimate Gain Tuning.....	50
Figure 55 - Flowrate Control - Rough Gain Tuning .....	50
Figure 56 - Flowcontrol Tuning - Refinement .....	51
Figure 57 – Flowrate Control Tuning – Refinement.....	51
Figure 58 - Flowrate Proportional Control Testing - Simulated Speed Variation .....	52
Figure 59 - Ideal Spray Application .....	53
Figure 60 - Areas of no spray caused by reduced spray width .....	54
Figure 61 - Areas of excessive spray caused by increased spray width .....	54
Figure 62 - Example of Horizontal Spray Patternator [44].....	55
Figure 63 - Scanning Patternator [47].....	56
Figure 64 - Scanning Platform Experimental Setup .....	57
Figure 65 - Scanning Element.....	58
Figure 66 - Scanning Element Spacers .....	58
Figure 67 - TAL201 Load Cells .....	58
Figure 68 - Load Cell Scanner Electronics Overview .....	59
Figure 69 - Load Cell Scanner Electronics Schematic.....	59
Figure 70 - Load Cell Scanner Electronics PCB Layout .....	60
Figure 71 – Load Cell Calibration Raw Data .....	61
Figure 72 - Load Cell Calibration Filtered Offset-Corrected Data .....	61
Figure 73 - Effect of Filtering on Impulse Response .....	62
Figure 74 - Scan Platform Test Path.....	63
Figure 75 - Initial Scanning Patternator Testing.....	63
Figure 76 - Scanning Element Water Accumulation .....	64
Figure 77 - Scanning Patternator - Typical Pattern One .....	65
Figure 78 - Scanning Patternator - Typical Pattern Two .....	65
Figure 79 - Visual Indication of Spray Pattern.....	66
Figure 80 - Segmentation of Spray Pattern by Scanning Element .....	66
Figure 81 - YF-S401 Flow Sensor .....	67
Figure 82 - Stationary Patternator Flow Sensor Installation.....	68
Figure 83 - Patternator Flow Calibration Variance .....	69
Figure 84 - Patternator Discharge Characteristics .....	71
Figure 85 - Totalised Patternator Platform Flow .....	72
Figure 86 - Flowrate of first six spray sections.....	73
Figure 87 - Flowrate of central spray sections.....	73
Figure 88 - Reported Spray Distributions – TF20 Nozzle at 10, 12, 14, 16 and 18 Litres per minute ...	75

## List of Tables

Table 1 - Tow and Fert 1000 Specifications .....	11
Table 2 - Metalform Nozzle Spray Rate and Spray Area .....	16
Table 3 - ZD1200 Calibration Data .....	34
Table 4 - ZD1200 CalibrationTest Data .....	36
Table 5 - Modbus Protocol Example Transaction .....	44
Table 6 - TUF2000M Relevant Registers .....	45
Table 7 - Patternator Flow Calibration Variance.....	69
Table 8 - Sensor Calibration Factors .....	70
Table 9 - Tow and Fert Nozzle Spray Density.....	71
Table 10 -Proportion of Flow Measured.....	74