

Contents

1	Introduction	1
	Introduction	1
1.1	Introduction	1
1.2	Motivation	3
1.3	Aim of the work	3
1.3.1	General objective	3
1.3.2	Specific objectives	3
1.3.3	Scope	3
1.4	Structure of the work	4
2	Methodology	5
2.1	Resources available for this Thesis	6
3	Background	7
3.1	Welding	7
3.1.1	Previous work	8
3.2	Machine Learning	9
3.3	Artificial Neural Networks	11
3.3.1	Activation functions	14
3.3.2	Training	14
3.3.3	Regularization	16
3.4	Convolutional Neural Networks	18
3.5	Segmentation models	22

3.5.1	Fully convolutional networks	22
3.5.2	Transposed convolution	24
3.5.3	Residual connections	25
4	Proposed approach using Fully Convolutional Networks	27
4.1	Segmentation architectures	27
4.2	Segmentation loss function	31
4.3	Validation	31
5	Dataset	33
5.1	Video files	33
5.2	Labeling	33
5.3	Data augmentation	36
6	Results and analysis	38
6.1	Grid search	38
6.2	Training	40
6.3	Testing	40
6.4	Post processing	47
6.4.1	Centroids, velocity and acceleration	47
6.4.2	Area and detachment rate	56
6.5	Surface tension	59
7	Concluding remarks and future work	65
7.1	Conclusions	65
7.2	Further work	66
Bibliography		67

A	Grid search results	71
B	Post processing	78
B.1	Calculation of properties	78
B.1.1	Geometry	78
B.1.2	Physical properties	79
B.2	Signal smoothing	80