

LIST OF FIGURES

2.1	Comparison of traditional network and SDN [1].	7
2.2	InSDN testbed [2].	8
2.3	The implementation IDS on SDN.	12
2.4	Example of the RGB image.	14
2.5	Example of the grayscale image.	14
2.6	Process of the convolutional layer.	15
2.7	Maxpooling process.	16
2.8	Fully connected layer.	16
2.9	Random forest illustration	17
3.1	Data processing model.	18
3.2	Main system model on the research.	19
3.3	Flowchart of simulation.	21
3.4	Data preprocessing model.	22
3.5	Data correlation.	24
3.6	Image result with red-blue colors.	26
3.7	Image result with grayscale.	27
3.8	Process of CNN	29
3.9	The example of confusion matrix	30
4.1	Time is taken to convert data to grayscale images.	32
4.2	Time is taken to convert data to red-blue images.	32
4.3	Information of grayscale image sample with 81 features.	33
4.4	Information of red-blue image sample with 81 features.	33
4.5	Information of grayscale image sample with 49 features.	34
4.6	Information of red-blue image sample with 49 features.	34
4.7	Confusion matrix CNN with grayscale images with 81 features.	35
4.8	Confusion matrix CNN with red and blue images with 81 features.	36
4.9	The effect of the dataset size on accuracy.	37
4.10	The effect of the dataset size on learning time.	37
4.11	Confusion matrix CNN with grayscale images with 49 features.	38
4.12	Confusion matrix CNN with red and blue images with 49 features.	39
4.13	Accuracy of CNN compared to machine learning.	40

4.14 VRAM usage on CNN.	40
4.15 Learning time in second.	41