CONTENTS

APPROVAL PAGE

SELF DECLARATION AGAINST PLAGIARISM

ABSTRACT **i**

PREFACE **ii**

CONTENTS **iii**

LIST OF FIGURES **v**

LIST OF TABLES **vii**

LIST OF ABBREVIATION **viii**

I INTRODUCTION **1**

1.1 Background 1
1.2 Problem Identification and Objective 2
1.3 Related Research 3
1.4 Scope of Work 4
1.5 Research Methodology 4
1.6 Research Timeline 5
1.7 Structure of The Thesis 5

II BASIC CONCEPTS AND PROPOSED CNN MODEL **7**

2.1 Software Defined Networking (SDN) 7
2.2 Intrusion Detection System (IDS) 10
2.3 Synthetic Minority Over-sampling Technique (SMOTE) 12
2.4 Pearson Correlation 13
2.5 Data-to-Image Conversion Method 13
2.6 Convolutional Neural Network (CNN) 14
2.6.1 Convolutional layer 15
2.6.2 Max-pooling layer 15
2.6.3 Fully connected layer 16

2.7 Random Forest (RF) 16

III SYSTEM MODEL AND RESEARCH DESIGN 18

3.1 System Model 18
3.2 Simulation Scenario 19
3.3 Simulation Scenario 21
3.3.1 Data Pre-processing 22
3.3.2 Data-to-Image Conversion 25
3.3.3 CNN Learning Process 29
3.3.4 Simulation Output 30

IV PERFORMANCE EVALUATIONS 32

4.1 Analysis Data-to-Image Conversion 32
4.2 Analysis of CNN with 81 Features 34
4.3 Analysis of CNN with 49 Features 37
4.4 Comparison with Other Learning Methods 40

V CONCLUSIONS AND FUTURE WORKS 42

5.1 Conclusions 42
5.2 Future Works 42

REFERENCES 44

Appendices