Table of Contents

TABLE OF CONTENTS

	TITLE	PAGE NO.
	CERTIFICATE	
	DECLARATION	
	CERTIFICATE OF GENUINENESS OF THE PUBLICATION	
	CERTIFICATE OF PLAGIARISM CHECK	
	ACKNOWLEDGEMENT	
	ABSTRACT	
	TABLE OFCONTENTS	
	LIST OF TABLES	
	LIST OF FIGURES	
	LIST OF ABBREVIATIONS	
1	**INTRODUCTION**	1
	1.1 Background	1
	1.1.1 Agriculture in India	2
	1.1.2 Challenges in Agriculture	3
	1.1.3 Leaf: A Vital Organ of a Plant	4
	1.1.4 Plant Pathology and Pathogens	5
	1.1.5 Weather Conditions	7
	1.2 Various Types of Plant Leaf Diseases	7
	1.2.1 Factors Influencing Leaf Diseases	7
	1.2.2 Fungal Diseases	9
	1.2.3 Bacterial Diseases	12
	1.2.4 Viral Diseases	14

TITLE	PAGE NO.
1.3 Various Threads in Agriculture	15
1.3.1 Overview of Pests and Types of Pests	16
1.3.2 Causes of Pest Outbreak	17
1.3.3 Different Pest Management Strategies	19
1.3.5 Leaf Disease and Pest Detection in Agriculture	21
1.3.5 Effects of Environmental Factors on Leaf Disease	22
1.4 Introduction to Digital Image Processing	22
1.4.1 Different Steps in Digital Image Processing in Agriculture	25
1.4.1.1 Image Acquisition	26
1.4.1.2 Pre-Processing	27
1.4.1.3 Segmentation	28
1.4.1.4 Feature Extraction	29
1.4.1.5 Feature Selection	30
1.4.1.6 Detection	31
1.4.1.7 Ensemble Classifiers	31
1.4.1.8 Performance Validation	31
1.5 Leaf Disease Image Dataset	31
1.6 Role of Artificial Intelligence in Agriculture	33
1.6.1 Machine Learning Techniques	35
1.6.2 Deep Learning	36
1.6.3 Transfer Learning	37
1.6.4 Data Augmentation	38
1.6.5 Hyperparameters Optimization	39

	TITLE	PAGE NO.
	1.7 Motivation of the Research	40
	1.8 Problem Statement	40
	1.9 Objectives of the Research	41
	1.10 Research Contribution	41
	1.11 Organization of the Thesis	42
	1.12 Summary	43
2	**LITERATURE SURVEY**	44
	2.1 Preamble	44
	2.2 Literature on Machine Learning Models for Leaf Disease Detection	45
	2.3 Literature on Deep Learning Based Leaf Disease Detection	54
	2.4 Literature on Pest Detection Using Artificial Intelligence Techniques	66
	2.5 Literature on Recommendation Systems in Agriculture	81
	2.6 Research Gap	87
	2.7 Summary	87
3	**RESEARCH METHODOLOGY**	88
	3.1 Introduction	88
	3.2 Scope of the Research	88
	3.3 Block Diagram of Research Methodology	89
	3.3.1. Architecture of the Proposed Models	90
	3.3.1.1 A Positional-Aware Dual-Attention and Topology-Fusion with Generative Adversarial Network-Based High-Resolution Framework for Leaf Disease Image Classification	90

	TITLE	PAGE NO.
	3.3.1.2 A Positional-Aware Dual-Attention and Topology-Fusion With Evolutionary Generative Adversarial Network for High-Resolution Diseased Leaf Image Generation and Classification	91
	3.3.1.3 A Multi-Dimensional Feature Learning-Based DCNN MFL-DCNN for Leaf Disease and Pest Classification	91
	3.3.1.4 Hybrid Rough Set with Intuitionistic Fuzzy Approximation Space RSF-Based Decision Support System for Pesticide Recommendation	92
	3.4 Dataset Description	92
	3.5 Evaluation of Different Models	95
	3.5.1 Performance Evaluation Metrics	95
	3.5.2 Experimental Setup	97
	3.5.3 Hardware and Software Used	98
	3.6 Summary	98
4	**PROPOSED MODEL: A POSITIONAL-AWARE DUAL-ATTENTION AND TOPOLOGY-FUSION WITH GENERATIVE ADVERSARIAL NETWORK-BASED HIGH-RESOLUTION FRAMEWORK FOR LEAF DISEASE IMAGE CLASSIFICATION**	99
	4.1 Introduction	99
	4.2 Overview of Leaf Disease Image Classification	99
	4.3 High-Resolution Leaf Disease Image Generation Classification	101
	4.3.1 High-Resolution Leaf Disease Image Generation	101
	4.3.1.1 Data Augmentation	102
	4.3.1.2 Texture Synthesis	102

	TITLE	PAGE NO.
	4.3.1.3 Data Fusion	103
	4.3.1.4 Image-To-Image Translation Using GAN Variants	104
	4.3.2 Leaf Disease Image Classification Techniques	119
	4.3.2.1 Alexnet	120
	4.3.2.2 VGG16	120
	4.3.2.3 InceptionV3	121
	4.3.2.4 ResNet101	122
	4.3.2.5 ResNeXt50	122
	4.3.2.6 ShuffleNetV2	123
	4.3.2.7 DenseNet121	124
	4.3.2.8 MobileNetV2	126
	4.4 Building the Proposed Model	127
	4.4.1 Dataset Preparation	128
	4.4.2 High-Resolution Image Generation Using PDATFGAN	128
	4.4.3 Leaf Disease Classification Using Pre-Trained DCNN Model	129
	4.5 Results and Discussion	130
	4.6 Summary	136
5	**PROPOSED MODEL: A POSITIONAL-AWARE DUAL-ATTENTION AND TOPOLOGY-FUSION WITH EVOLUTIONARY GENERATIVE ADVERSARIAL NETWORK FOR HIGH-RESOLUTION DISEASED LEAF IMAGE GENERATION AND CLASSIFICATION**	137
	5.1 Introduction	137

	TITLE	PAGE NO.
	5.2 Challenges of PGANs	137
	5.3 Review on Methods of Non-Convergence Problems of PGAN	138
	5.3.1 Evolutionary Algorithms in GAN	138
	5.3.2 Evolutionary Algorithm with Positional-Aware GAN	140
	5.3.2.1 Mutation	141
	5.3.2.2 Estimation	143
	5.4 Building the Proposed Model	144
	5.4.1 High-Resolution Image Generation Using PDATFEGAN	145
	5.5 Results and Discussion	146
	5.6 Summary	152
6	**PROPOSED MODEL: A MULTI-DIMENSIONAL FEATURE LEARNING-BASED DCNN MFL-DCNN FOR LEAF DISEASE AND PEST CLASSIFICATION**	153
	6.1 Introduction	153
	6.2 Significance of Pest Classification in Leaf Disease Detection	153
	6.2.1 Agricultural Crop Pests	154
	6.2.2 Considerations for Soil, Weather and Pest Data in Leaf Disease and Pest Classification	163
	6.3 Overview of Multi-Dimensional Features Learning	163
	6.3.1 Benefits of Using Ensemble Learning	165
	6.3.1.1 Multi-Dimensional Feature Learning Ensemble Classifier	166
	6.4 Building the Proposed Model	167
	6.4.1 Training and Testing MFL-DCNN Model	168
	6.5 Results and Discussion	169

	TITLE	PAGE NO.
	6.6 Summary	171
7	**PROPOSED MODEL: HYBRID ROUGH SET WITH INTUITIONISTIC FUZZY APPROXIMATION SPACE RSF-BASED DECISION SUPPORT SYSTEM FOR PESTICIDE RECOMMENDATION**	172
	7.1 Introduction	172
	7.1.1 Techniques Used for Pesticide Recommendation	172
	7.1.2 Rule-Based Decision Support Systems for Pesticide Recommendation	173
	7.1.2.1 Simple Threshold-Based Systems	173
	7.1.2.2 Expert System-Based Systems	173
	7.1.2.3 Weather-Driven Systems	173
	7.1.2.4 Degree-Day Systems	174
	7.1.2.5 GIS-Integrated Systems	174
	7.1.2.6 Integrated Pest Management IPM Systems	174
	7.1.2.7 Dynamic Systems with Learning	174
	7.1.2.8 Sensor-Driven Systems	174
	7.1.2.9 Time-Series Analysis Systems	174
	7.1.2.10 Fuzzy Logic Systems	175
	7.2 Building the Proposed Model	182
	7.2.1 Pesticide Recommendation Using RSF-Based Decision Support System	183
	7.3 Results and Discussion	187
	7.4 Summary	189
8	**SUMMARY OF FINDINGS**	190

	TITLE	PAGE NO.
	8.1 Introduction	190
	8.2 Comparison of the Leaf Disease Detection	190
	8.3 Comparison of the Pest Detection and Pesticide Recommendation	193
	8.4 Summary	195
9	**CONCLUSION AND FUTURE WORK**	196
	9.1 Conclusion	196
	9.2 Future work	197
	REFERENCES	
	LIST OF PUBLICATIONS	