

DESIGN AND DEVELOPMENT OF AROID PLANT
DEFECT CLASSIFIER USING CONVOLUTIONAL
NEURAL NETWORK

Design Project

MARIEL G. BUSTAMANTE
JACOB D. MOJARES

College of Engineering and Information Technology
CAVITE STATE UNIVERSITY
Indang, Cavite

August 2022

DESIGN AND DEVELOPMENT OF AROID PLANT DEFECT CLASSIFIER USING CONVOLUTIONAL NEURAL NETWORK

Undergraduate Design Project
Submitted to the Faculty of the
College of Engineering and Information Technology
Cavite State University
Indang, Cavite

In partial fulfillment
of the requirements for the degree
Bachelor of Science in Electronics Engineering



00081854

*Design and development of aroid plant
defect classifier using convolutional
621.367 B96 2022
DP.753*

**MARIEL G. BUSTAMANTE
JACOB D. MOJARES**

August 2022

ABSTRACT

BUSTAMANTE, MARIEL G., and MOJARES, JACOB D. Design and Development of Aroid Plant Defect Classifier using Convolutional Neural Network. Undergraduate Design Project. Bachelor of Science in Electronics Engineering. Cavite State University, Indang, Cavite. August 2022. Adviser: Dr. Edwin R. Arboleda.

The general objective of the study was to design and develop an Aroid Plant Defect Classifier using Convolutional Neural Network. It was intended to be portable and rechargeable. It was targeted to be capable of classifying defects of a Black Velvet "*Alocasia reginula*" plant based on its leaves to avoid severe damage due to improper watering.

The design project was composed of Raspberry Pi 3B+ which handled all the processes the device had to execute. This microcomputer was used to interface other components of the device such as the Camera, Battery, and Touchscreen Display. The back-end system of this device was a trained Convolutional Neural Network Model with an Accuracy of 89.50% while the front-end system was a Graphical User Interface displayed on the Touchscreen display when it turned ON.

The project was tested by the researchers at a farm in Dasmariñas, Cavite, where the device had accuracy values of 90.48%, 87.62%, and 91.43%, and precision values of 87.88%, 78.75%, and 88.24% in classifying Normal, Underwatered, and Overwatered leaves, respectively, using a confusion matrix. The evaluation was conducted at the Engineering Science Building, Cavite State University, Indang, Cavite with the Electronics Engineer Professors.

Based on the results of the evaluation, the design project succeeded in achieving its objectives. The overall performance was considered satisfactory. The cost of the construction of the system amounted to P11,176.00.

TABLE OF CONTENTS

	Page
BIOGRAPHICAL DATA.....	ii
ACKNOWLEDGEMENT.....	v
ABSTRACT.....	x
LIST OF TABLES.....	xiii
LIST OF FIGURES.....	xiv
LIST OF APPENDICES.....	xv
INTRODUCTION.....	1
Statement of the Problem.....	3
Objectives of the Study.....	3
Significance of the Study.....	4
Time and Place of the Study.....	4
Scope and Limitations.....	5
Definition of Terms.....	5
REVIEW OF RELATED LITERATURE.....	7
METHODOLOGY.....	16
Conceptual Framework.....	16
Design Considerations.....	17
Selection of microcomputer unit.....	17
Selection of Camera Module.	17
Selection of Touchscreen Display.	17
Selection of Power Supply.....	17
Materials.....	17
Methods.....	18
Design and Construction of the Aroid Plant Defect Classifier Unit.....	18

Training and Deployment of CNN for AroidPlant Defect Detection... 21

Development of the CNN Model..... 23

Development of the System Software and Graphical User Interface. 24

Evaluation of the Performance of the System..... 26

Cost Computation..... 26

RESULTS AND DISCUSSION..... 27

Preparation of Plant Samples and Image Gathering..... 27

Assembly and Construction..... 27

Principles of Operation..... 29

CNN Model Development and Training..... 30

Graphical User Interface Development..... 32

Evaluation..... 34

Cost of the Aroid Plant Defect Classifier..... 38

SUMMARY, CONCLUSION, AND RECOMMENDATIONS..... 39

Summary..... 39

Conclusion..... 40

Recommendations..... 41

REFERENCES..... 42

APPENDICES..... 46

LIST OF TABLES

Table		Page
1	RGB and HSV characteristics of crops under different conditions.....	8
2	Leaf symptoms of Alocasia Reginula plant.....	10
3	Input-Process-Output (IPO) map.....	16
4	Sample images of the defects with their symptoms.....	22
5	Confusion matrix for Farmer's classification.....	36
6	Confusion matrix for prototype's predictions.....	36
7	Performance measurement TP, TN, FP, FN of Farmer's classification.....	37
8	Performance measurement TP, TN, FP, FN of Prototype's classification.....	37
9	Summary of accuracy and precision of the confusion matrices.....	38
10	Bill of materials for the device construction.....	38

LIST OF FIGURES

Figures	Page
1 Block diagram of the system.....	19
2 Schematic diagram of the system.....	19
3 Dimensions of the Aroid plant defect classifier unit in isometric view.....	20
4 Parts of the Aroid plant defect classifier unit in external view	20
5 Internal View of the Aroid plant defect classifier unit.....	21
6 General structure of a CNN model.....	23
7 The system flowchart.....	25
8 Projected output of the graphical user interface.....	26
9 Internal view of the device.....	28
10 External view of the device.....	29
11 Training and validation loss.....	31
12 Training and validation accuracy.....	32
13 The initial page of the GUI with the camera feed.....	33
14 Graphical user interface after image capture.....	33
15 System information page.....	34
16 Evaluation of prototype in the farm.....	35

LIST OF APPENDICES

Appendix		Page
1	Figures.....	47
2	Tables.....	54
3	Source Code.....	61
4	Computations.....	69
5	Forms.....	72

DESIGN AND DEVELOPMENT OF AROID PLANT DEFECT CLASSIFIER USING CONVOLUTIONAL NEURAL NETWORK

Mariel G. Bustamante
Jacob D. Mojares

An undergraduate design project submitted to the faculty of the Department of Computer and Electronics Engineering, College of Engineering and Information Technology, Cavite State University, Indang, Cavite in partial fulfillment of the requirements for the degree of Bachelor of Science in Electronics Engineering with Contribution No. 2021-2022
SUMMER - 11. Prepared under the supervision of Dr. Edwin R. Arboleda

INTRODUCTION

There has been a growing trend of collecting houseplants and ornamental plants in the past years. In 2020, the number of people collecting has increased due to the comfort they find in plants. The pandemic, Novel Coronavirus is also a cause of increased growth of plant collectors (Endale, 2020). Taking care of plants became a popular hobby for ages 18-34. The plants became the source of peace, and fulfillment, and can help in lessening the stress and enlightening the mood of the collector. Also, there is a growing community on social media platforms for plant collectors which provides a sense of belonging especially during times of pandemic (Davies, 2020).

Numerous common houseplants are from the family Araceae, commonly known as Aroids, a family of flowering plants that are commonly seen in tropical regions. Many indoor plants are from this family because of their colorful leaves (Encyclopedia.com, n.d.) Although they can survive with low light, aroid plants prefer dappled sunlight. Aroid plants are known to have the same preferences when it comes to nutrients, light exposure, and water quantity (The Sill, 2018).

In Cavite, ornamental, cut flowers, and houseplants are mostly grown in the municipalities of Silang, Trece Martires, and General Emilio Aguinaldo. A total of 10.30