

**DEVELOPING A PREDICTIVE MODEL FOR FACILITATING
DRONE LANDING**

**AKPABIO, INYENEOBONG EFFIONG
(14CH017843)**

B.Sc. Computer Science, Covenant University, Ota Ogun State

AUGUST, 2023

**DEVELOPING A PREDICTIVE MODEL FOR FACILITATING
DRONE LANDING**

BY

**AKPABIO, INYENEOBONG EFFIONG
(14CH017843)**

B.Sc. Computer Science, Covenant University, Ota Ogun State

**A DISSERTATION, SUBMITTED TO THE SCHOOL OF
POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE AWARD OF MASTERS
OF SCIENCE (M.Sc) DEGREEE IN COMPUTER SCIENCE,
DEPARTMENT OF COMPUTER AND INFORMATION
SCIENCES, COLLEGE OF SCIENCE AND TECHNOLOGY,
COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA**

AUGUST, 2023

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfillment of the requirements for the award of Master of Science in Computer Science in the Department of Computer Information Science, College of Science and Technology, Covenant University, Ota, Nigeria.

Miss Adefunke F. Oyinloye
(Secretary, School of Postgraduate Studies)

Signature and Date

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies)

Signature and Date

DECLARATION

I, **AKPABIO, INYENEOBONG EFFIONG (14CH017843)**, declare that this research was carried out by me under the supervision of Prof. Victor C. Osamor of the Department of Computer and Information Sciences, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria. I attest that the dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data and scholarly information used in this dissertation are duly acknowledged.

AKPABIO, INYENEOBONG EFFIONG

Signature and Date

CERTIFICATION

We hereby certify that this dissertation titled “**DEVELOPMENT OF A PREDICTIVE MODEL FOR FACILITATING DRONE LANDING**” is an original research work carried out by **AKPABIO INYENEOBONG EFFIONG (14CH017843)** in the Department of Computer Information Science, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria under the supervision of Prof Victor. C. Osamor. We have examined and found this work acceptable as part of the requirements for the award of Master of Science in Computer Science.

Prof. Victor C. Osamor
(Supervisor)

Signature and Date

Prof. Olufunke O. Oladipupo
(Head of Department)

Signature and Date

Prof. Adio T. Akinwale
(External Examiner)

Signature and Date

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies)

Signature and Date

DEDICATION

This project is dedicated to Almighty God for his grace, wisdom, provision, and protection all through this program. I also dedicate this project to my family for their support during the span of this program

ACKNOWLEDGEMENTS

My sincere appreciation goes to God Almighty for the life, strength and grace to complete this study. I would also like to thank the following individuals and institutions for their contribution to the successful completion of this research work. The Founder of Covenant University; Bishop David Oyedepo and the Management of the University for providing the opportunity to conduct this research. I thank my parents and my siblings for their unending love and support; financially and emotionally, enabling me to finish this study successfully. I also thank my supervisor; Prof. Victor C. Osamor for his guidance, exceptional academic insight and understanding throughout this study. Finally, my colleagues and members of staff who have been with me and guided me throughout my study, I am truly grateful.

TABLE OF CONTENTS

CONTENTS	PAGES
COVER PAGE	i
TITLE PAGE	ii
ACCEPTANCE	iii
DECLARATION	iv
CERTIFICATION	v
DEDICATION	vi
ACKNOWLEDGEMENTS	vii
TABLE OF CONTENTS	viii
LIST OF FIGURES	xi
LIST OF TABLES	xiii
ABSTRACT	xiv
CHAPTER ONE: INTRODUCTION	1
1.1 Background to the Study	1
1.2 Statement of the Problem	3
1.3 Significance of the Study	4
1.4 Aim and Objectives	4
1.5 Organization Of Study	5
CHAPTER TWO: LITERATURE REVIEW	6
2.1 Drones and UAVS	6
2.1.1 Brief history of Drones	7
2.1.2 UAV Control	8
2.1.3 UAV Communication Network	8
2.1.4 Components of a UAV	9
2.2 Autonomy	11
2.3 Machine Learning	12
2.3.1 Supervised Learning	13
2.3.2 Unsupervised Learning	14
2.3.3 Reinforcement Learning	14
2.3.4 Evaluation in Machine Learning	14
2.4 Deep Learning	16
2.5 Computer Vision	17
2.6 Artificial Neural Networks	18
2.7 Convolutional Neural Networks	20

2.7.1	Convolution Layer	22
2.7.2	Pooling Layer	23
2.7.3	Fully Connected Layers.	24
2.8	Overfitting	24
2.8.1	Increasing the Training Data	25
2.8.2	Fine tuning the Hyper parameters	26
2.8.3	Model Regularization	26
2.9	Transfer Learning	27
2.10	Scene Classification	28
2.10.1	Object Detection	28
2.10.2	Semantic Image Segmentation	31
2.11	Related Works	33
2.11.1	Landing of UAVs in Static Scenes	33
2.11.2	UAV Landing utilizing Cooperative Targets	34
2.11.3	Machine Learning-Based Solutions	37
2.11.4	Autonomous Drone Landing Dynamic scenes	40
2.11.5	Scene Matching Systems	40
2.12	Autonomous Landing of UAVs in Dynamic Scenes	41
CHAPTER THREE: METHODOLOGY		43
3.1	Preamble	43
3.2	Methodology	43
3.2.1	Image Acquisition	44
3.2.2	Dataset Breakdown	45
3.2.3	Data Augmentation	49
3.2.4	Data Pre-Processing	49
3.3	Training and Evaluation of the model	50
3.3.1	Non-Linearity	54
3.3.2	Pooling - Sub Sampling	55
3.3.3	Classification Layer	55
3.4	Design and Develop System	57
3.4.1	Functional Requirement	58
3.4.2	Non-Functional Requirements	58
3.5	Test The System	59

CHAPTER FOUR: RESULTS AND DISCUSSION	60
4.1 Preamble	60
4.2 The Implementation tools used	60
4.2.1 Model	60
4.2.2 The Web Prototype Application	63
4.3 System Requirements	64
4.3.1 Hardware Requirements	64
4.3.2 Software Requirement	65
4.4 The Application Interface	66
4.5 Model Evaluation	70
4.5.1 Accuracy Evaluation	73
4.5.2 Performance Evaluation	81
CHAPTER FIVE: CONCLUSION AND RECOMMENDATION	83
5.1 Summary	83
5.2 Contribution to Knowledge	83
5.3 Recommendation	83
5.4 Limitation	84
5.5 Conclusion	84
REFERENCES	86

LIST OF FIGURES

FIGURES	TITLE OF FIGURES	PAGES
2.1	Structure of neurons in a neural network	20
2.2	Showing the numeric representation of images in a computer	21
2.3	Detailing the process of the convolution steps	22
2.4	Shows the visual representation of the convolution operation	23
2.5	Optimal Fitting and Over-fitting	25
2.6	Showing standard network and thinned network	27
2.7	Showing the difference between image classification object detection	29
2.8	An example of different vision tasks.	31
2.9	Types of markers or Cooperative targets.	34
3.1	Methodology Overview	43
3.2	E58 Drone Quadcopter equipped with a 4KHD Camera.	44
3.3	Example building image	46
3.4	Example Grass Image	46
3.5	Example crowd image	47
3.6	Example sand image	47
3.7	Example aerial view of trees	48
3.8	Example aerial view of Vehicle	48
3.9	Overview of the transfer learning process and output	51
3.10	Showing an example result of CNN training	54
3.11	The CNN input and output	55
3.12	Image showing non-landing locations	57
4.1	PyCharm IDE	61
4.2	Google Colab utilizing the jupyter notebook	61
4.3	Showing a screenshot of Visual Studio Code IDE	64
4.4	A full interface of the app displaying a vehicle prediction	67
4.5	A full interface of the app displaying a tree prediction	68
4.6	A full interface of the app displaying a grass prediction	68
4.7	A full interface of the app displaying people on grass prediction	69
4.8	A full interface of the app displaying building prediction	69

4.9	Airport terminal	71
4.10	Amusement Park	71
4.11	Apartment Building	72
4.12	Lawn	72
4.13	Showing Accuracy and Loss chart for the model trained from scratch	73
4.14	Showing Accuracy and Loss chart for the model trained from scratch	74
4.15	Showing Accuracy chart for the resnet model	74
4.16	Showing loss chart for the ResNet model	75
4.17	Showing accuracy chart for the InceptionResNet model	75
4.18	Showing loss chart for the InceptionResNet model	76
4.19	Showing accuracy chart for the VGG-16 model	76
4.20	Showing loss chart for the VGG-16 model	77
4.21	Showing loss chart for the Mobinet model	77
4.22	Showing loss chart for the Mobinet model	78
4.23	Showing accuracy chart for the MobinetV2 model	79
4.24	Showing loss chart for the MobinetV2 model	79
4.25	Plot of test accuracy values of the best models after training	80
4.26	Results of the model evaluation for the mobinet model	81

LIST OF TABLES

TABLES	TITLE OF TABLES	PAGES
2.1	Confusion Matrix sample	16
3.1	Breakdown of images	45
3.2	Neural Network structure	56
4.1	Hardware Requirements (Model Development)	65
4.2	Software Requirements (Web App)	65
4.3	Software Requirement (Model development)	66
4.4	Example model result	67
4.5	Results obtained From Various Architectures	80
4.6	Performance Results of all models trained	82

ABSTRACT

Drones are one of the leading technological improvements of the 21st century and have a wide range of use in different fields of human endeavor: Military, Retail, and Medicine amongst other fields. The increasing use of drone in day to day like unfortunately comes with dangers as the number of damages and injuries increase with the increase in use of drones especially with respect to safely landing of the drones in cases of emergency. In Particular the use of autonomous drones has also seen increase number of usage in recent times. These unmanned aerial vehicles can perform majority of drone activities such as navigation, acceleration, landing, surveillance e.t.c with little to no human intervention. Landing is one such activity that yields dangers such as injury or loss of property. To mitigate this problem, this study aims to develop a model to analyze images and determine if the image represents a landmark that is safe for emergency landing of the drones. Across Literature several approaches exist to achieve autonomous drone landing, it can be broken down broadly into visual and non-visual approaches. Our study focuses on the visual approach, utilizing landmark images captured by the drone live camera. The image will then be processed by the deep learning model that utilizes convolutional neural network that will predict if the image is a safe landmark for landing. The other visual approach involves using a marker or co-operative target to mark where is safe for the drone to land with the obvious drawback of needing to pre-install the marker. Our solution also mitigates the need to have a marker installed before autonomous drone landing can be accomplished.

Keywords: Drones, Drone Landing, Image Classification, CNN, Deep Learning, Machine Learning, Transfer Learning.