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**MACHINE LEARNING BASED MAXIMUM POWER POINT  
TRACKING**

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree  
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## DECLARATION

I declare that this is my own work and this thesis / dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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Date: 27th April 2024

The above candidate has carried out research for the PhD/ MPhil/ Masters thesis/ dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. (Mrs.) Thushari Silva, PhD

Signature of the Supervisor:

Date: 27/04/2024

## DEDICATION

I dedicate this thesis to the most remarkable persons who have played key roles in shaping my academic journey. First and foremost, I would like to convey my heartfelt gratitude to my dear beloved wife and cherished family members whose unwavering support and encouragement have been my constant motivation. Their belief in me during the challenging times has been a beacon of strength.

I extend my deepest appreciation to my esteemed supervisor, Dr. (Mrs.) Thushari Silva, PhD, and the academic faculty for their invaluable guidance, expertise, and mentorship. Their trust in my abilities, constructive feedback, and insightful critiques have significantly contributed to the refinement of my work and my growth as a researcher. I am also indebted to my friends whose friendship and unwavering support have been instrumental in keeping me inspired and focused throughout this journey.

Additionally, I express my sincere gratitude to the Sri Lanka Navy for providing me with the opportunity to pursue this degree while serving my nation. Their support and guidance have been indispensable in the completion of this research.

This thesis stands as a testament to the collective efforts of those mentioned above. I am indeed deeply grateful for their presence in my life journey and for their instrumental role in helping and supporting me to achieve this significant milestone.

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## ABSTRACT

Origin of the solar cell dated back to 1883 when the first solar power generation was invented. A solar system converts sunlight into electrical energy through photovoltaic panels and known as solar power generation. At present solar power generation shows highest development of among all renewable resources. Maximum Power Point Tracking is a method of optimizing the solar panel in order to obtain maximum power output from the solar panel. Comprehensive literature review of MPPT systems, tracing their historical development and examining conventional and modern MPPT methods were carried out and observed existing MPPT methods often fail to capture the relationships between voltage, current, irradiance, and temperature parameters which directly affect the optimal operating point of a photovoltaic panel without disturbing the energy harvesting process, to deliver the maximum power output of the photovoltaic system. As a result, the overall efficiency and performance of the photovoltaic system may be compromised.

The proposed solution involves leveraging the capabilities of machine learning approaches to learn the complex relations between the voltage, current, irradiance and temperature parameters using random forest regression and the proposed approach aims to overcome the limitations of traditional MPPT to obtain optimized output power from photo-voltic system. Developed MPPT model is tested using real-world data collected from PV installations under diverse environmental conditions. The tests evaluate the model's accuracy, adaptability, and performance compared to conventional MPPT techniques. Results demonstrate the effectiveness of the machine learning-based approach in improving energy harvesting efficiency and overall system performance. The findings suggest that machine learning-based VCIT-MPPT offers a promising solution for optimizing PV system performance and maximizing energy yields. In conclusion, this thesis presents a novel approach to MPPT leveraging machine learning techniques named as VCIT-MPPT, showing significant improvement in efficiency of energy harvesting and MPPT system performance. The findings contribute to the advancement of renewable energy technologies and pave the way for more efficient utilization of solar power resources.

**Keywords:** Maximum Power Point Tracking (MPPT), Photovoltaic (PV), Machine Learning (ML), Random Forest Regression (RFR) (RFR), Renewable Energy.

# TABLE OF CONTENTS

	Page
DECLARATION.....	ii
DEDICATION .....	iii
ACKNOWLEDGEMENT .....	iv
ABSTRACT.....	v
TABLE OF CONTENTS .....	vi
LIST OF FIGURES .....	ix
LIST OF TABLES .....	xii
LIST OF ABBREVIATIONS .....	xiii
CHAPTER 1 .....	1
INTRODUCTION .....	1
1.1 Prolegomena.....	1
1.2 Objectives.....	2
1.3 Background and Motivation.....	2
1.4 Problem in Brief.....	3
1.5 Proposed Solution .....	3
1.6 Resource Requirement .....	4
1.7 Structure of the Thesis.....	4
1.8 Summary .....	4
CHAPTER 2 .....	5
EVOLUTION OF MAXIMUM POWER POINT TRACKING SYSTEMS .....	5
2.1 Introduction .....	5
2.2 Gestation of Maximum Power Point Tracking Systems .....	5
2.3 Major Developments .....	23
2.4 Future Directions of MPPT Systems.....	24
2.5 Summary of Challenges in MPPT Systems .....	25
2.6 Problem Definition.....	26
2.7 Summary .....	26
CHAPTER 3 .....	27
TECHNOLOGY ADOPTED.....	27

3.1	Introduction .....	27
3.2	Machine Learning Based MPPT Technology .....	27
3.3	Python.....	28
3.4	Sklearn Library.....	28
3.5	Random Forest Regression (RFR) .....	30
3.6	Simulation & Data Capturing Software .....	31
3.6.1	MATLAB .....	31
3.6.2	Simulink.....	32
3.6	Summary .....	33
CHAPTER 4 .....		34
NOVEL APPROACH TO MAXIMUM POWER POINT TRACKING (VCIT-MPPT) .....		34
4.1	Introduction .....	34
4.2	Hypothesis.....	34
4.3	Input Process Output Model.....	34
4.4	Input .....	36
4.5	Output.....	36
4.6	Process.....	37
4.7	Features .....	38
4.8	Users.....	38
4.9	Summary .....	38
CHAPTER 5 .....		40
DESIGNING OF VCIT-MPPT .....		40
5.1	Introduction .....	40
5.2	Top Level Architecture of VCIT-MPPT System .....	40
5.3	Modules in the Design.....	42
5.3.1	Solar Panel Interface Module .....	42
5.3.2	MPPT Control Module .....	43
5.3.3	ML Engine.....	45
5.4	Selection of ML Model .....	46
5.5	Model Description.....	47
5.6	Summary .....	48
CHAPTER 6 .....		50

IMPLEMENTATION.....	50
6.1 Introduction .....	50
6.2 OS & Platforms .....	50
6.3 Installation of Required Software .....	51
6.3.1 Installation of Python 3.11.....	51
6.3.2 Installation of Jupyter Notebook 6.4.12 .....	52
6.3.3 Installation of MATLAB R2023b and Simulink 23.2.....	53
6.4 Data Acquisition.....	54
6.3 Generating Dataset .....	56
6.4 Model Training Process .....	59
6.5 Predicting the Voltage Reference.....	62
6.5 System Interfaces .....	63
6.6 Summary .....	64
CHAPTER 7 .....	65
EVALUATION OF VCIT-MPPT SYSTEM.....	65
7.1 Introduction .....	65
7.2 Selection of ML Model .....	65
7.3 Performance Evaluation .....	70
7.4 Dataset.....	72
7.5 Model Training.....	73
7.6 Testing of the Novel Design.....	74
7.7 Evaluation of the Novel Design .....	84
7.8 Results .....	87
7.9 Summary .....	87
CHAPTER 8 .....	89
CONCLUSION AND FURTHER WORK .....	89
REFERENCES .....	91

## LIST OF FIGURES

	Page
Figure 2.1: Annual power capacity expansion .....	6
Figure 2.2: V-I Characteristics of a Solar Panel .....	6
Figure 2.3: Typical MPPT Block Diagram .....	7
Figure 2.4: Basic Impedance Matching Circuit of MPPT .....	7
Figure 2.5 DC-DC converter for MPPT .....	8
Figure 2.6: Effects on MPP by Varying Temperature and Irradiance .....	8
Figure 2.7: Relationship between the OC voltage and temperature .....	9
Figure 2.8: Flow chart of hill climbing algorithm .....	10
Figure 2.9: PV curve for various irradiance levels .....	11
Figure 2.10: Flow chart of INC algorithm .....	12
Figure 2.11: Flow chart of OC voltage method .....	13
Figure 2.12: Flow chart of SC current method .....	14
Figure 2.13 : Two layer ANN in MPPT .....	15
Figure 2.14: ANN model for MPP voltage estimator.....	16
Figure 2.15: Learning & running stages of ML algorithms .....	19
Figure 4.1: IPO model of VCIT-MPPT system .....	35
Figure 4.2: Inputs & Outputs of VCIT-MPPT System .....	37
Figure 5.1: Top Level Architecture of VCIT-MPPT System .....	41
Figure 5.2: MALTAB Simulink solar panel interface module integrated to the PV panel ..	43
Figure 5.3: MPPT control module .....	44
Figure 5.4: ML Engine designed in MATLAB Simulink .....	46
Figure 6.1: Checking the Python version installed .....	51
Figure 6.2: Jupyter server .....	52
Figure 6.3: Jupyter notebook interface in a web browser .....	53
Figure 6.4: MATLAB R2023b .....	53
Figure 6.5: Simulink 23.2 installed on MATLAB R2023b .....	54
Figure 6.6: Conventional MPPT simulated in the MATLAB Simulink software simulator	55
Figure 6.7: MATLAB Simulink software simulator data logging mode .....	55
Figure 6.8: Conventional MPPT simulated in MATLAB Simulink software simulator	

with enabled data logging features .....	66
Figure 6.9: Output dataset displayed in MATLAB .....	57
Figure 6.10: Generating dataset table in MATLAB .....	57
Figure 6.11: MATLAB script to generate CSV dataset .....	58
Figure 6.12: CSV dataset for conventional MPPT using MATLAB .....	58
Figure 6.13: Importing of Python libraries features .....	59
Figure 6.14: Importing of dataset and converting to DataFrame .....	59
Figure 6.15: Checking for missing values and applying "ffill" to fill missing data .....	60
Figure 6.16: Splitting the MPPT dataset into training and testing .....	60
Figure 6.17: Training the VCIT-MPPT model using Random Forest Regression .....	61
Figure 6.18: Accuracy of the VCIT-MPPT model .....	61
Figure 6.19: Defining MPPT function in VCIT-MPPT .....	62
Figure 6.20: Designing of VCIT-MPPT system in MATLAB Simulink .....	63
Figure 6.21: Py_MPPT function block code .....	64
Figure 7.1: VCIT-MPPT dataset description using Jupyter Notebook .....	65
Figure 7.2: Visualization of VCIT-MPPT dataset using Seaborn pairplot() function .....	66
Figure 7.3: Correlation of VCIT-MPPT dataset using pandas corr() function .....	66
Figure 7.4: Visualization of VCIT-MPPT dataset using seaborn heatmap() function .....	67
Figure 7.5: Defining, training, evaluating and plotting various models .....	69
Figure 7.6: Selection of the machine learning (ML) model for the VCIT-MPPT system ..	69
Figure 7.7: Actual reference voltage values vs model predicted reference voltage values using Random Forest Regression .....	70
Figure 7.8: Variance and bias plot w.r.t. true line .....	71
Figure 7.9: Description of Dataset .....	72
Figure 7.10: Splitting the dataset into training and testing .....	73
Figure 7.11: Training the model using Random Forest Regression .....	74
Figure 7.12: Fluctuation of voltage reference in conventional MPPT at STC .....	75
Figure 7.13: Fluctuation of wattage in conventional MPPT at STC .....	75
Figure 7.14: Voltage reference in VCIT-MPPT at STC .....	76
Figure 7.15: Wattage in VCIT-MPPT at STC .....	76
Figure 7.16: Fluctuation of wattage in conventional MPPT at Temp. 10°C & Irr. Level	

1,020 W/m <sup>2</sup> .....	77
Figure 7.17: Wattage in VCIT-MPPT at Temp.10°C & Irr. Level 1,020 W/m <sup>2</sup> .....	77
Figure 7.18: Fluctuation of wattage in conventional MPPT at Temp. 15°C & Irr. Level 600 W/m <sup>2</sup> .....	78
Figure 7.19: Wattage in VCIT-MPPT at Temp. 15°C & Irr. Level 600 W/m <sup>2</sup> .....	78
Figure 7.20: Fluctuation of wattage in conventional MPPT at Temp. 20°C & Irr. Level 800 W/m <sup>2</sup> .....	79
Figure 7.21: Wattage in VCIT-MPPT at Temp. 20°C & Irr. Level 800 W/m <sup>2</sup> .....	79
Figure 7.22: Fluctuation of wattage in conventional MPPT at Temp. 22°C & Irr. Level 1,100 W/m <sup>2</sup> .....	80
Figure 7.23: Wattage in VCIT-MPPT at Temp. 22°C & Irr. Level 1,100 W/m <sup>2</sup> .....	80
Figure 7.24: Fluctuation of wattage in conventional MPPT at Temp. 25°C & Irr. Level 1,350 W/m <sup>2</sup> .....	81
Figure 7.25: Wattage in VCIT-MPPT at Temp. 25°C & Irr. Level 1,350 W/m <sup>2</sup> .....	81
Figure 7.26: Fluctuation of wattage in conventional MPPT at Temp. 30°C & Irr. Level 1,250 W/m <sup>2</sup> .....	82
Figure 7.27: Wattage in VCIT-MPPT at Temp. 30°C & Irr. Level 1,250 W/m <sup>2</sup> .....	82
Figure 7.28: Fluctuation of wattage in conventional MPPT at Temp. 35°C & Irr. Level 1,400 W/m <sup>2</sup> .....	83
Figure 7.29: Wattage in VCIT-MPPT at Temp. 35°C & Irr. Level 1,400 W/m <sup>2</sup> .....	83
Figure 7.30 PV array configuration and technical data .....	85
Figure 7.31: Accuracy of the VCIT-MPPT model .....	86
Figure 7.32: Cross Validation Scores of the VCIT-MPPT model .....	86

## LIST OF TABLES

	Page
Table 2.1: Fuzzy Logic Rule Table.....	18
Table 2.2: Comparison of various MPPT techniques .....	22
Table 7.1: Summary of conventional MPPT vs VCIT-MPPT test results .....	84

## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Description</b>
CUR	Current
FFILL	Forward Fill
INC	Incremental Conductance
IPO	Input Process Output
IRR	Irradiance
MAE	Mean Absolute Error
MSE	Mean Square Error
MPP	Maximum Power Point
MPPT	Maximum Power Point Tracking
PIP	Preferred Installer Program
PV	Photovoltaic
PWM	Pulse Width Modulator
P&O	Perturb and Observe
REF	Reference
RFR	Random Forest Regression
RMSE	Root Mean Square Error
STC	Standard Test Conditions
TEMP	Temperature
TVC	Temperature Voltage Converter
VOL	Voltage