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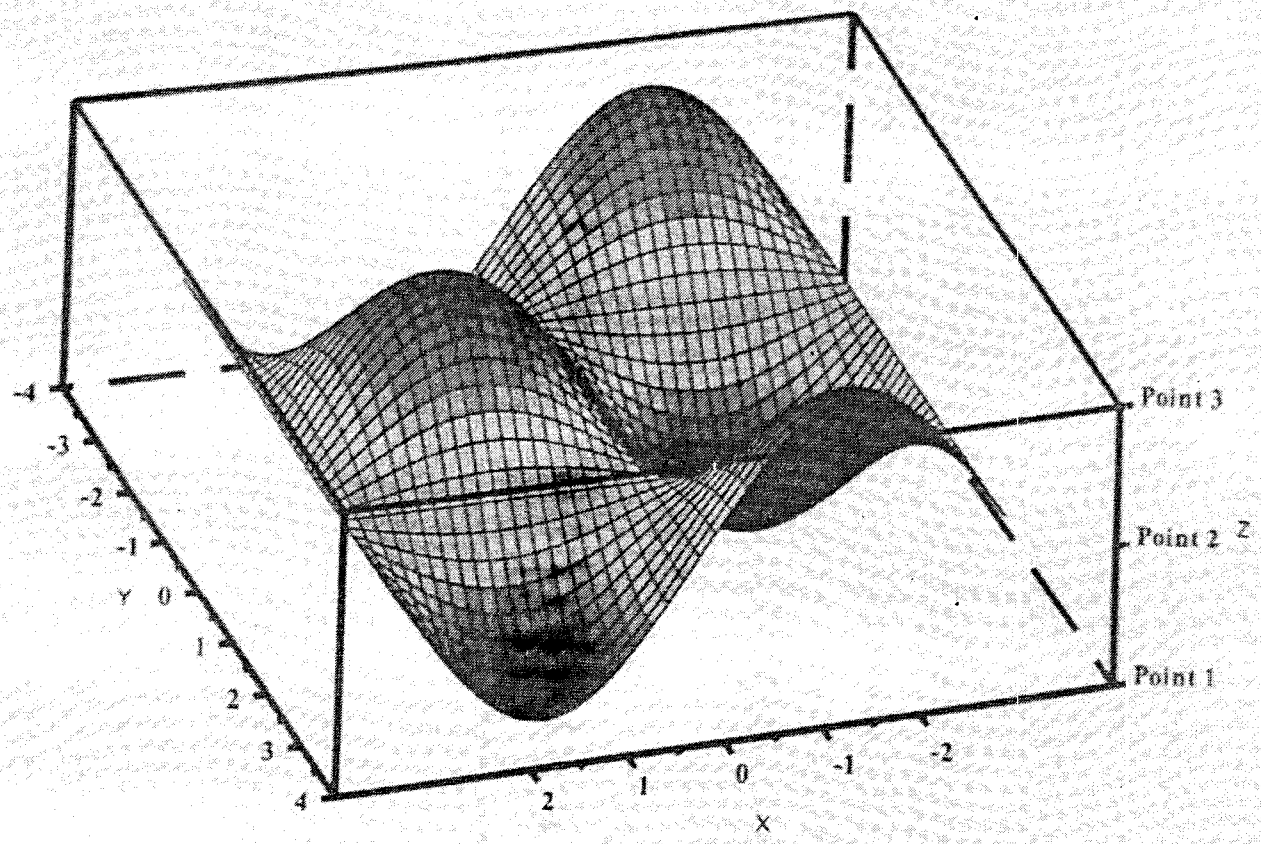

Rachna Verma

Arvind Kumar Verma

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This book provides a comprehensive, hands-on introduction to Scilab, a powerful, open-source scientific and technical computing environment. Starting with basic concepts, the book lucidly builds advanced Scilab concepts one needs for solving real-life industrial and academic research problems. The book contains a large number of illustrative examples and practice problems. The book is well suited as a textbook for learning Scilab for science and engineering students. It is sold under the express understanding that the information contained in this book is accurate to the best of authors' knowledge. However, the authors will not be held responsible for the consequences of any actions based on the content of the book for any purpose.

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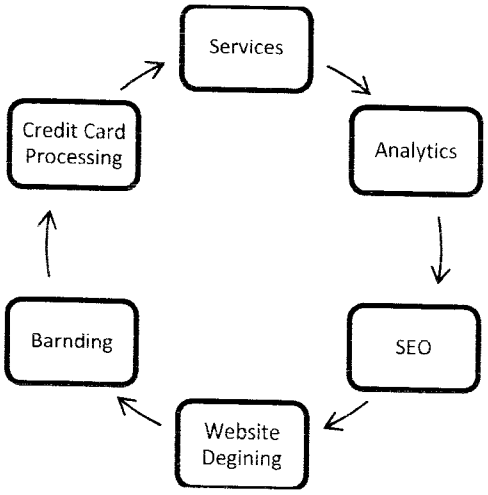

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Introduction to Xcos

A Scilab Tool for Modeling Dynamical Systems

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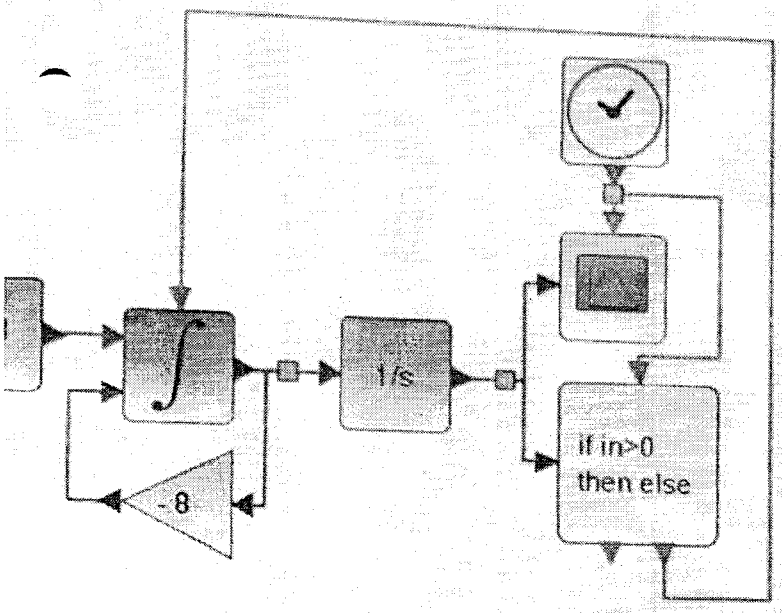

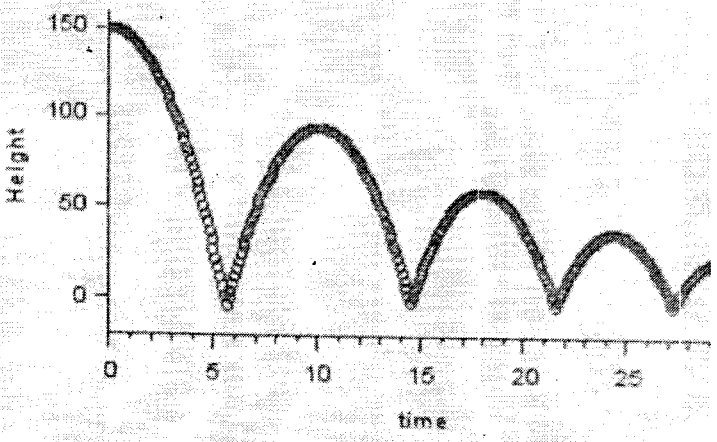

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Arvind Kumar Verma

Rachna Verma

Introduction to Xcos

A Scilab Tool for Modeling Dynamical Systems

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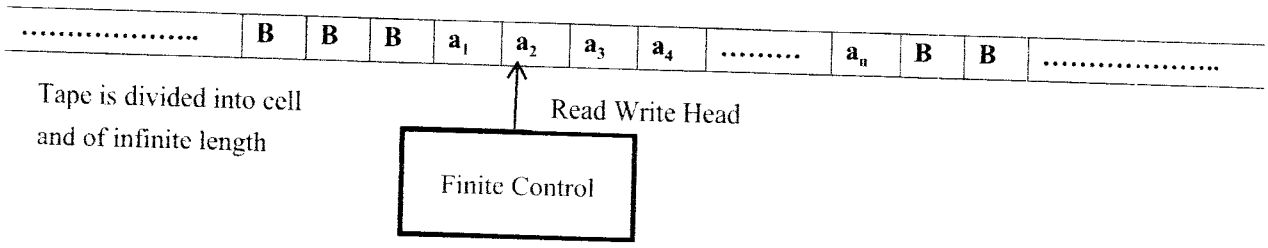
This book provides a comprehensive, hands-on introduction to Xcos, a powerful, open-source Scilab tool for modeling dynamical systems. Starting with basic concepts, the book lucidly builds advanced Xcos concepts one needs for modeling complex real-life systems. The book contains a large number of illustrative examples. The book is well suited as a textbook for learning Xcos for science and engineering students. It is sold under the express understanding that the information contained in this book is accurate to the best of authors' knowledge. However, the authors will not be held responsible for the consequences of any actions based on the content of the book for any purpose.

MCA-302

Formal Language and Automata



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UNIT-10

Pushdown Automata

Structure of the Unit

10.0 Objective

After reading this chapter you will be able to:

- Understand Pushdown Automata
- Build PDA (Pushdown Automata) using context Free Grammar
- Understand the relation between CFG and PDA
- Understand the Parsing mechanism using PDA

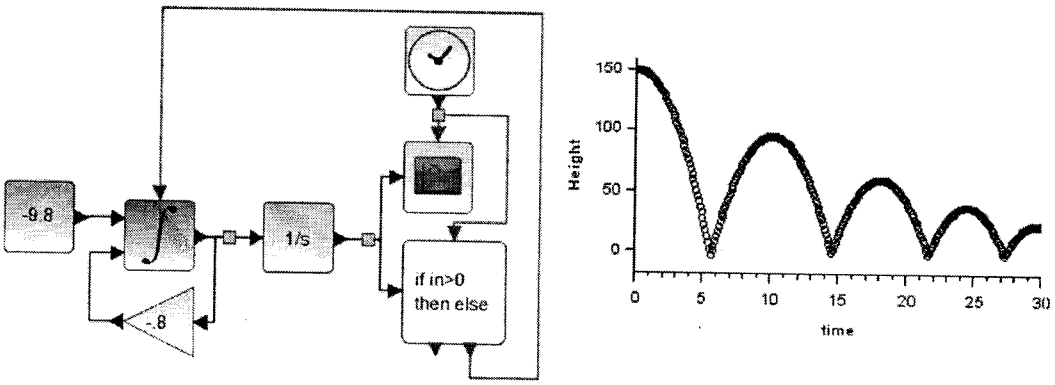
10.1 Introduction

In previous chapters, we have discussed the concept of FA and CFG with their acceptability. As FA accept regular languages like ab*, However Finite Automata

Introduction to Xcos

A Scilab Tool for Modeling Dynamical Systems

Bouncing Ball



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Arvind Kumar Verma
Rachna Verma

Rachna

Deep Learning Architectures, Methods, and Frameworks: A Review

Anjali Bohra and Nemi Chand Barwar

1 Introduction

Intelligence is an ability to use knowledge and skills efficiently. Making machines behave intelligently is Artificial Intelligence, which is a sub-area of computer science. One of the ways of creating intelligent machines is machine learning which use learning algorithms to extract information from the data while is deep learning which creates intelligent machines using specific algorithm called neural networks [ ]. The key difference between machine learning and deep learning is how the features are extracted from the input using algorithms [ ]. Machine learning use algorithms first to extract the features from the given input and then apply learning while deep learning automatically extract the features and represent them hierarchically in multiple levels [ ]. In today's scenario, the problems which is used to take large time in processing are now being solved with less time using deep learning concepts [ ]. It is applied in many fields like natural language processing, image processing, computer vision, sentiment analysis from text and videos, object identification, etc. Deep learning provide hierarchical representation of data and classify as well as predict the patterns through multiple layers of information processing modules in hierarchical architectures [ ].

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D. Goyal et al. (eds.). *Information Management and Machine Intelligence*, Algorithms for Intelligent Systems.

Data Management Techniques in Hadoop Framework for Handling Small Files: A Survey

Vijay Shankar Sharma and N. C. Barwar

1 Introduction

Big Data is a wider term that will cover all sorts of huge data, i.e. organized, unorganized, semi-organized, in the present era by the increasing popularity of the internet and social media sites, every day a large volume of data is produced. In the year 2012, 2.73 Lac Exabyte's of digital data were stored across the globe. This explosion of the data is increasing day by day and it has been estimated by the IDC (International Digital Corporation) that the volume of the digital data will reach up to 35 Lac Exabytes by 2020. Due to this changing scenario of the use of digital data, traditional techniques for storing, processing and managing the huge data are not sufficient and it will create a great demand for the distributed computing framework that can handle the massive data sets efficiently. The Apache foundation is providing a powerful distributed computing framework Hadoop, this framework is based on the Map Reduce parallel programming model and can easily handle the massive data processing in the distributed environment.

When dealing with millions of small files, it will create a lot of issues like there will be a requirement of more space for Name Node in RAM, network traffic will increases that result in the consumption of more time to store the data, Map Reduce will take longer times to process the requests, etc., therefore there is the requirement of the efficient data management techniques that can deal the small file problem of the Hadoop efficiently. A number of solutions are proposed to the small file problem of the Hadoop, i.e. Hadoop Archives (HAR), Sequential File, Combine File Input Format, etc. Theses proposed solutions are discussed in detail in Section-3 of the paper

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Algorithms for Intelligent Systems.

Chapter 56
A Collaborative Versioning Framework for Model-Based Version Control Systems

Jai Prakash Jyani and N. C. Barwar

1 Introduction

Software projects undergo constant evolution. Specifications undergo change, enhancements and customizations are made, bugs are fixed, and different software versions are created to suit different needs. Handling such changes for a large system is a significant and tedious task. Version control system (VCS) is an important tool in the area of software development which is mainly used for tracking and managing changes to the project file contents (mainly source code). They help developers to carry out parallel modifications in the software artifacts and facilitate them to share, collaborate and merge the changes [ ]. If version control systems are not used, the developers face problems in communicating their changes and are forced to merge the changes manually which makes the changes untraceable. Version control systems store the changes in the server and allow the developers to coordinate their changes in a well-structured and traceable manner. Conflicts are detected and resolved properly, thus reducing the possibility of errors. The basic idea of version control systems is to keep the working copies (files on which developers work) separated from the master copies (files which are stored in the repository). The developers check out the working copies from the repository to their local system, make changes in the working copy and finally check in (commit) their changes back into the repository. Every time a developer commits a file, and the version control system creates a new version in the repository. In this way, the repository stores all the versions of a file. The basic diagram of version control system is shown in Fig. .

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organized by Jodhpur Local Centre, The Institution of Engineers (India) in Hybrid Mode during 27-28 November 2021 and presented the paper titled

"Effective Cooling Strategy for Solar PV Panels for the Climatic Conditions of Jodhpur"

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Analysis of Hotspot Development in Power Transformer and Its Life Estimation

Intelligent Energy Management Technologies pp 319-334 | Cite as

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Conference paper
First Online: 02 December 2020

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Abstract

The opportunity for the research in thermal modeling of power transformer is to estimate their loss of life due to overloading by employing the winding hotspot temperature (HST) and by carrying out aging studies based on heat transfer theory. This is facilitated by developing computational thermal models and their simulation using appropriate software tools. These models are employed to evaluate the actual functional age of transformers by estimating enhanced equivalent life at the reference temperature that will be spent over the specified time period for the given temperature cycle due to acceleration of aging. This paper presents a MATLAB/Simulink-based model for this purpose. Life determines the aging acceleration factor, which has been used for estimation of the loss of life of the transformer. Further, the effect of cooling for reducing the loss of life has also been studied. The proposed model has been validated using real-time data gathered from a power transformer in the field operation.

Keywords

Acceleration of aging Hotspot temperature Loss of life Thermal modeling

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Deregulated Electricity Market

The Smart Grid Perspective

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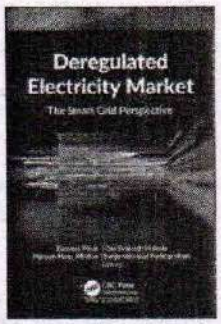

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Energy demand will increase by 70% by the year of 2030, and with the continual day-by-day depletion of traditional energy sources, there is a vast need to continue the development of dependable renewable energy sources that are locally available and that enhance energy generation efficiency. This important resource, **Deregulated Electricity Market: A Smart Grid Perspective**, presents the topical issues of the deregulated electricity market, focusing on the integration of renewable sources with engineering approaches.

The volume identifies and explores the deregulated electricity market s and looks at different renewable generation techniques and their operation and control issues. It considers the various power quality issues with renewable energy generation interfaced with smart grids and their solution techniques. It also addresses the various integration challenges of the energy storage systems and energy management of electric vehicles in the smart grid environment. Topics include methods for frequency, angle, and voltage monitoring in smart grids; load frequency and voltage control pricing; grid integration of wind energy generation systems; tracking and management techniques; performance analysis; and more.

This volume is an important resource for scientists, researchers, students, and academicians across the globe concerned with adopting and implementing novel research on smart power grids and renewable energy systems.

CONTENTS:

Simulation of Performance Characteristics of Different PV Materials

Intelligent Energy Management Technologies pp 199-208 | Cite as

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Conference paper
First Online: 02 December 2020

Part of the Algorithms for Intelligent Systems book series (AIS)

Abstract

The choice of the material for designing solar photovoltaic panels is very important both functionally and economically. This paper simulates models of PV modules designed from six different types of photovoltaic materials in MATLAB/Simulink and carries out their comparative study. These include commercially available materials like Monocrystalline Silicon (Si-mono), Polycrystalline Silicon (Si-poly), Amorphous Silicon (a-Si), and the experimentational materials like Copper Indium Selenide (CIS), Cadmium Telluride (CdTe), and Gallium Arsenide (GaAs.) In these models, the impact of major environmental and technological parameters, i.e., the temperature, insolation level, bandgap and ideality factor has been taken into account, in order to analyze the relative importance of each of these parameters on the performance of PV module. The reference data for the photovoltaic module are taken from the recent literature and manufacturers' datasheets. The comparison of simulation results reveals that the efficiency of Si-mono is the highest among all the materials at standard test conditions closely followed by Si-poly. It can also be seen that the materials having same ideality factor having same range of output current, voltage, and power like Si-poly/GaAs and CdTe/CIS.

Keywords

Materials for photovoltaic modules Mono-crystalline PV modules Poly crystalline PV modules Thin-film PV modules Modeling of photovoltaic modules Modeling using MATLAB/Simulink Simulation of PV modules

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21 | OriginalPaper | Chapter

27. MATLAB-Based Comparative Analysis of Alternative PV Models

Authors: Khamma Kanwar, Jayashri Vajpai

Publisher: Springer Singapore

Published in: Intelligent Energy Management Technologies

Abstract

The comparative simulation of different models of Photovoltaic (PV) array operating at maximum power point to transfer power to constant a load through boost converter has been done in this paper. The models have been developed by (i) mathematical equations that describe the nonlinear V–I characteristics of the PV array and (ii) using MATLAB/SIMULINK inbuilt PV block array model. The Perturb and Observe algorithm was implemented for the maximum power generation under particular environment condition. The peak point is tracked by using the boost converter to match the PV source side impedance with the load side impedance through change of Duty Cycle. The responses of inbuilt PV array block model and user-defined model have been compared with the model developed by using mathematical equations. The results indicate that the simulation of mathematical equations gives higher output and better dynamic performance with respect to the output characteristics of the system.

Springer Link

Restructuring of Transmission Network to Cater Load Demand in Northern Parts of Rajasthan Using Renewable Energy

Proceedings of International Conference on Computational Intelligence and Emerging Power System pp 193-212 | Cite as

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Conference paper
First Online: 14 December 2021

Part of the Algorithms for Intelligent Systems book series (AIS)

Abstract

This paper has considered restructuring of the existing transmission network in the Rajasthan State of India by creating new grid substation (GSS) of 400/220 kV and additional transmission lines of 400 kV and 220 kV voltage levels to meet the increased load demand in Northern Parts of the Rajasthan. The optimal restructuring is achieved by considering the different alternative schemes and analyzing the transmission elements' loading status. The study is performed on the transmission system of Rajasthan state of India considering the network of central transmission utility (CTU) in the Rajasthan State territory. Load flow studies and short circuit studies are performed to select the most feasible scheme out of the different available alternative options. Finally, an optimal set of Power Flow on the

Fusion-Based Feature Extraction Approach for Recognition of Handwritten Devanagari Numerals

Proceedings of International Conference on Data Science and Applications pp 159-172 | Cite as

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Conference paper
First Online: 23 November 2021

Part of the Lecture Notes in Networks and Systems book series (LNNS, volume 287)

Abstract

Exploring fresh methods for handwritten digit recognition receiving close attention from respective research communities due to its wide application fields ranging from bank and postal services automation to archaeological surveys. Handwritten digit recognition is a challenging task due to unconditional variation in shapes and sizes of handwritten digits written by different individuals. The task becomes more demanding for the scripts like Devanagari due to the richness of curvatures in digit structure. The proposed scheme implemented a transfer learning approach for feature extraction from handwritten digits. For this purpose, pre-trained deep convolutional models VGG-16 and VGG-19 were deployed due to their splendid capability of minute features extraction from the given pattern. The features collected from both the models were fused into a single feature map by reducing their dimensionality with the help of the effective principal component analysis (PCA) method. The model managed to attain a recognition accuracy of 97% with a fusion-based approach.

Keywords

Deep convolutional models Digit Fusion Handwritten PCA Pre-trained Transfer learning VGG-16 and VGG-19

References

Handwritten Devanagari Character Recognition Using CNN with Transfer Learning

Congress on Intelligent Systems

CIS 2020: Congress on Intelligent Systems pp 269-279 | Cite as

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Conference paper
First Online: 02 June 2021

Part of the Advances in Intelligent Systems and Computing book series (AISC, volume 1335)

Abstract

In this paper, we review the use of CNNs, along with the transfer learning for handwritten Devanagari character recognition. We compare the performance of VGG16 and DenseNet121 with transfer learning for recognition of handwritten Devanagari character dataset. The results of models trained in different conditions and compared with other methods are presented. Our study shows that DenseNet121 with deep fine-tuning method outperformed the other pre-trained models and other supplemental learning strategies. The learning accuracy further improved with some tweaking of hyperparameters like batch size, learning rate, etc.

Keywords

Convolutional neural networks Devanagari character recognition Transfer learning

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Modeling of Performance of a Solar PV Modules: (PV Power as a Function of Cell Temperature)

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Abstract: The cell temperature of a photovoltaic module is an important parameter that governs the performance of PV cell. The output power and therefore the efficiency is a function of the temperature. In tropical countries like India the cell temperature ranging from 50°C to 75°C. The performance of solar panels is negatively affected by high temperatures. This increase in temperature also causes the development of thermal stresses in the panel and affects its life span.

Therefore analyzing the effect of temperature on the performance of a solar PV module becomes very important for modeling and performance enhancement.

Keywords: operating temperature; photovoltaic conversion; energy conversion efficiency; mathematical modeling

Introduction: India has been making continuous progress in renewable power generation. From the year 2002 onwards, renewable energy capacity as a percentage of total capacity has increased by more than ten times. In April 2002, renewable energy based power generation installed capacity was 3497 MW, which was 3% of the total installed capacity in the country. As on 31.1.2021, it has reached 92,550.74 MW, which is about 24.5% of the total installed capacity of 3,77, 260.67 MW.

In 2011 solar power installed capacity was only 503.9 MW and as per recently published data by Ministry of New and Renewable Energy (MNRE) it has reached 38794.07.64 MW which highest among the all other renewable energy based power generation installed capacity such as such as wind power, small hydro power, Biomass Power, Urban & Industrial Waste Power. [1,2]

Solar panels that supply bulk energy to power grids are set up in large arrays therefore it is important to monitor, estimate and predict he amount of power being provided to the power grid, for effective energy management. It is also essential to study the performance characteristics and the factors affecting its performance. [3]

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CHAPTER 2

RECENT TRENDS IN SOLAR PHOTOVOLTAIC TECHNOLOGY

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Solar energy received in the form of radiation, can be converted directly or indirectly into electricity. The direct means of solar energy utilization include thermal while the indirect means include photovoltaic conversion. Currently solar photovoltaic systems have emerged as the most effective means of converting solar energy to electrical energy. Research in the various aspects for deployment of solar photovoltaic systems has hence become necessary. In this chapter we will study about solar photovoltaic technologies from physics of solar cells to manufacturing aspect, solar PV system design and their applications, current scenario, policy and update in research, prospects and challenges and current policies adopted by Government for technology dissemination.

1. INTRODUCTION

Electrical Energy is one of the major inputs for the economic development of any country. The conventional sources of electrical energy are thermal power plants that are based on fossil fuels are depleting at a rapid rate, harder to retrieve, harmful for the environment and their prices are rising sharply. Thus sustainable and renewable energy sources, such as solar energy, wind energy, hydroelectricity, wave power, geothermal energy, bio-energy and tidal power are the need of the modern world.

A renewable energy source, specifically solar power, is a practical alternative to damaging carbon-intensive fuels. It is a very large, inexhaustible source of

Design of Solar Cell Temperature Based Single Parameter Model of PV Modules

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Abstract:

Single parameter models are very useful for the focused study of the impact of a particular parameter on a complex phenomenon while holding all other influencing parameters at some standardized constant values. Such models form the basis of many studies that require performance estimation and prediction with due parametric analysis. This paper aims to develop a single parameter model of a solar photovoltaic module. The output power and the efficiency of PV cells are primarily governed by cell temperature. In India, the range of highest cell temperature generally lies between 50°C to 75°C in different seasons and impacts their performance negatively. The increase in temperature also causes the development of thermal stresses in the panel and affects its life span. In this paper, we have proposed a methodology for designing a single parameter model of a PV module with respect to cell temperature. The proposed methodology has been validated by developing models for three different modules widely used by researchers. The model accuracy has been found to be better than 98% in all cases. This methodology will be useful for modeling and accurate prediction of the power output of PV modules for different operating cell temperatures.

Keywords

Operating Temperature, Photovoltaic Conversion, Energy Conversion Efficiency, Mathematical Modeling

1. Introduction

Temperature affects photovoltaic conversion and hence, is a major factor affecting module output power and efficiency. Increased temperature of solar cells is one of the main factors leading to decreased output power and efficiency. Hence, it needs to be considered for selecting the optimal operating conditions. Therefore analyzing the effect of temperature on the performance of a solar PV module becomes very important for modeling and performance enhancement.

India has been making continuous progress in renewable energy and its contribution to power generation has increased by more than eight times, from 3497 MW (3% of the total installed capacity in April 2002) to 95012.59 MW (24.8% of the total installed capacity of 382730.02 MW in May 2021). Similarly, the solar installed capacity was only 503.9 MW in 2011 and as per recent data of 31.05.2021, released by the Ministry of New and Renewable Energy, it has reached 41087.63 MW which is the highest among the all other renewable energy-based power generation installed capacity, including wind and small hydropower [1, 2].

Solar arrays now supply bulk energy to power grids. Therefore monitoring, estimation, and prediction of the power supply to the power grid are necessary for effective energy management. It is also essential to study the performance characteristics and the factors affecting them. The most important among these factors [3] are discussed in the paper and temperature has been selected for the design of a single parameter model.

The introduction section provides an overview and status of solar photovoltaic systems. This section also covers the basic idea of the performance of solar PV modules. State of art presents the literature survey of research work carried out by different scientists on temperature modeling of solar photovoltaic systems, showing the overall trend of the research and development in temperature-based modeling of these systems. The performance characteristics, factors affecting them, particularly the effect of temperature are covered in sections III, IV, and V respectively. Section VI represents the various correlations between the electrical output power of a PV panel and its temperature that have been proposed in the literature and identifies the various research gaps.

In section VII we have proposed a methodology for the development of a single parameter model of the solar PV module based on cell temperature. Finally, the developed model has been validated by applied to three different modules and the performance of the proposed model has been comparable to the proposed model to the referred models available in the literature and its accuracy has been found to be better than 98%. The last section concludes the paper by presenting the major inferences drawn from research.

Effective Cooling Strategy for Solar PV Panels for the Climatic Conditions of Jodhpur

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Abstract - Jodhpur is a promising location for generation of electricity by solar photovoltaic (PV) cells because of the abundance of sunny days with high solar insolation. However, high summer temperature raises the maximum operating temperature of PV panels to as high as 60°-70°C. This rise in temperature severely affects its efficiency and hence its power output, also causing the development of thermal stresses that may reduce their life span. Hence, the cooling of the PV panels to decrease their operating temperature is essential. This paper presents a brief study of cooling methods of PV panels. The use of phase change material (PCM) has been reported to be the most effective among the various cooling techniques employed, because the phase-change process (melting) imparts a high heat storage capacity to PCM. A detailed discussion on the selection of PCM has been presented by considering the ambient temperature conditions of Jodhpur in the summers.

Keywords - Solar energy; Photovoltaic (PV) cells; Active and passive cooling; Phase change materials (PCM).

INTRODUCTION

The conventional electric power generation is associated with high carbon dioxide emissions with high global warming threat and this emphasises the need for greater use of solar PV systems. Jodhpur, located in the thar desert of Rajasthan, is popularly known as the Suncity of India because it is blessed with abundance of sunny days with high solar insolation. Hence, it is making rapid progress in the use of solar PV generation systems. The installed capacity of solar PV plants in Jodhpur has increased significantly in last decade, from 71 MW in 2011-12 to 3831.55 MW in 2021-22 (till 31.8.21) [1].

The data of mean daily maximum and minimum temperatures along with the peak maximum and minimum temperatures over the century for Jodhpur is given in Table I [2]. The temperature in the summer months can be seen to be quite high. Since, the solar plants are directly exposed to the sun radiation, their temperatures are prone to be much larger than the ambient temperatures.

The output power and efficiency of PV panels are significantly governed by the operating temperature of the cell. The increase in cell temperature leads to thermal stresses in the panels and reduces their life span. Hence, the cooling of panels to check the impact of the rise of cell temperature on the perfomance of solar PV panels is essential for their performance enhancement. In the last decade, many investigations have been carried out to control the PV cell temperature using passive and active techniques of cooling.

TABLE I

MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES ALONG WITH THE PEAK MAXIMUM AND MINIMUM RECORDED TEMPERATURES OF JODHPUR FOR THE PERIOD OF 1901 TO 2010 [2].

Month	Mean daily min. temp. (°C)	Mean daily max. temp. (°C)	Highest max. ever recorded		Lowest min. ever recorded	
			Temp. (°C)	Date	Temp. (°C)	Date
January	8.9	25.4	35.0	28, 91	-2.2	31, 05
February	11.4	28.1	38.3	28,53	-0.7	07,74
March	17.1	33.8	42.5	30,84	4.7	09,79
April	22.7	38.9	48.0	25,58	9.4	07,18
May	26.6	41.5	48.9	25,32	17.0	07,82
June	28.0	40.2	48.0	04,91	18.8	03,97
July	26.7	36.1	45.6	04, 01	16.2	28,83
August	25.4	34.2	42.9	05, 57	19.4	15, 37
September	24.2	35.5	42.8	11, 15	15.4	11, 15
October	19.8	36.4	42.3	02, 68	10.0	31, 49
November	14.5	31.8	38.4	01, 86	4.8	25, 93
December	10.3	26.9	34.8	04, 68	0.6	23, 45

The objective of this paper is to present a brief note on the effect of cell temperature on the performance of PV panels, followed by the study of cooling methods to identify the most effective among them. Finally, a detailed discussion on the selection of PCM has been presented by considering the ambient temperature conditions of Jodhpur in summers.

EFFECT OF RISE OF CELL TEMPERATURE ON PERFORMANCE

Among the numerous influencing factors, temperature has a major impact on the output power and efficiency of a PV cell. Photovoltaic panels convert a part of the incident solar energy into electricity and dissipate the rest as heat. The absorbed radiation leads to increase of operating temperature of the cells. Hence, power output and efficiency reduce due to increased internal carrier concentration and recombination rates.

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organized by Jodhpur Local Centre, The Institution of Engineers (India) in Hybrid Mode during 27-28 November 2021 and presented the paper titled

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This is to certify that Dr.Jayashri Vajpai of M.B.M. Engineering College, Jodhpur, India has Presented a paper titled Modeling of Performance of a Solar PV Modules in the Two Day's International Conference on "Recent Development in Engineering and Technology" held from 26-02-2021 to 27-02-2021 at Anand International College of Engineering, Jaipur.

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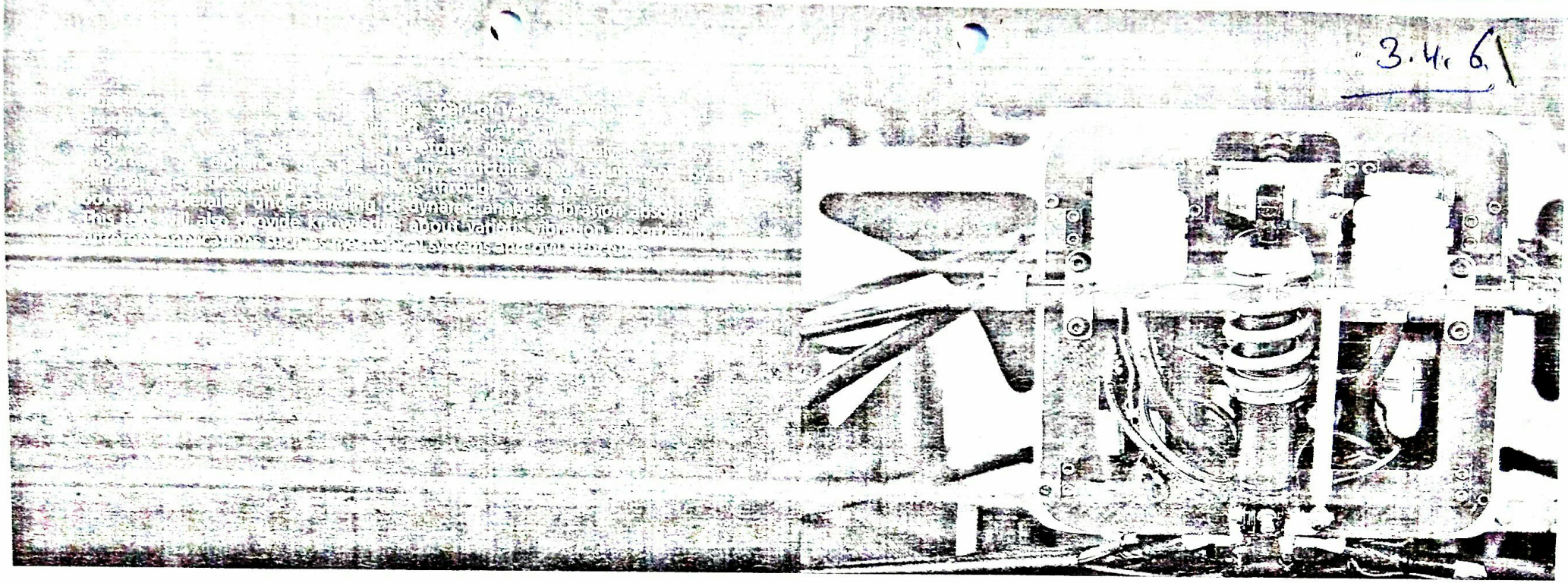

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Dynamic Analysis Of Vibration Absorber using MATLAB

Analysis of vibration absorber

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A Review on Dynamic Balancing and Link Shape Synthesis of Planar Mechanisms

Sajjan Singh Bajiya, Kailash Chaudhary, and Himanshu Chaudhary

Abstract This paper reviews the various methods developed for balancing of the planar mechanisms and synthesizing the link shapes. The methods discussed in this paper are used for complete force balance, complete force and moment balance, partial force and moment balance as well as for the link shape synthesis of different planar mechanisms. The concepts, applications, and limitations of various methods are discussed and reviewed from the available literature in the area of mechanism balancing. The better understanding of available methods will definitely help the researchers working in this area in analyzing the current practices and in developing the new methods.

Keywords Shaking force and moment · Driving torque · Mass redistribution · Counterweight · Topology · Optimization

1 Introduction

Several review papers throw light on the quantum of work carried out on the balancing of the mechanisms especially dynamic balancing [1–7]. Shaking moment and driving torque get increases due to balancing of shaking force alone. Review of the literature regarding the complete balancing, i.e., shaking force and the shaking moment states that there will be no clear-cut method for static and dynamic balancing.

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Chapter 5
Application of 3D Scanning for Reverse Manufacturing and Inspection of Mechanical Components

Kailash Chaudhary and Aditya Govil

Abstract Reverse manufacturing creates another object similar to the existing object. The point cloud data developed with the help of 3D scanning is used for manufacturing of the complex objects. The cost and time of the reverse manufacturing is less than that of the conventional methods. 3D scanner is an important part of 3D printing ecosystem which is playing most important role in latest research in mechanical engineering. The advantage of 3D scanner consists of ease of use, which derives from the shorter scanning duration and the less demanding skill requirement of the operator. Another advantage of the 3D scanning consists in the higher number of acquired surface points which statistically leads to more accurate description of complex parts. For example, mechanical parts like naval vessels, submarines, weapon systems, engines and hulls do not have 3D CAD files and they can be repaired with the help of 3D scanner in a very efficient and easy manner. 3D scanned data is directly used to make changes in programming of artificial intelligent based welding and machining processes. A lot of time and in turn money can be saved using this advanced technique because traditional measurement methods like callipers, rulers etc. consume time and skill. In this research work, reverse manufacturing is applied to propellers of a local aero model manufacturer. It was found that use of 3D scanners in combination with Coordinate Measuring Machine (CMM) helps in measurement of the features with good quality and accuracy in a very short span of time. Results based on comparison of reverse manufacturing with traditional method related to dimensional accuracy and mechanical properties will be presented in full paper.

Keywords Reverse manufacturing · 3D scanning · 3D printing · CMM · Dimensional accuracy · Mechanical properties

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