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3.3.2 - Number of research papers per teachers in the Journals notified on UGC website during the year

Sr. No.	Documents	Page No.
1.	Number of Research Papers in the Journals-Computer Department	2-8
2.	Number of Research Papers in the Journals-IT Department	9-11
3.	Number of Research Papers in the Journals-E&TC Department	12-14
4.	Number of Research Papers in the Journals-Mechanical Department	15
5.	Number of Research Papers in the Journals-ASGE Department	16-17

ORIGINAL RESEARCH

Text Region Identification in Indian Street Scene Images Using Stroke Width Transform and Support Vector Machine

S. S. Shiravale[1] · S. S. Sannakki[2] · R. Jayadevan[3]

Abstract

Detecting the presence of text in street scene images is a very crucial task for many applications and its complexity may vary from script to script due to the unique characteristics of each script. A technique to detect and localize text written in Devanagari script from scene images is presented in this paper. Initially, candidate regions are localized using low-level features like edge and colour. Due to the complex nature of scene images, these regions may contain irrelevant information. Stroke Width Transform (SWT) and geometric features are then extracted from these localized regions for correctly identifying the text regions. An efficient technique is proposed in this paper for the extraction of stroke width from dark text (foreground) on a light background as well as from light text (foreground) on dark background. Methods based on heuristic rules are inefficient for text and non-text identification due to the nonlinearity of extracted features. It has been observed that Support Vector Machines are the most popular and efficient classifiers for text/non-text classification. Also, an attempt is made here to explore other computationally less expensive classifiers like Bayesian due to its simplicity and Decision Tree due to its pure class partitioning power. Hence SVM, Bayesian and Decision Tree classifiers are used for the classification of text and non-text regions and the results are compared. An image dataset containing 1250 scene images has been created for experimentation. It is clear from the experimental results that the technique proposed in this paper outperforms some of the existing techniques in terms of accuracy.

Keywords Natural scene images · Devanagari script · Text detection · Text extraction · Colour-based segmentation · SVM

Introduction

Image-based applications are gaining popularity due to the high availability of low priced, high-performance smartphones and other handheld imaging devices. The text information present in natural scene images will be of great use in such image/vision-based applications. A smartphone/imaging device-based application capable of detecting, localizing, extracting, recognizing and translating the text information (written in a local script) present in a scene image into a target language (script) will be very useful for foreign travellers and tourists in reading or interpreting the text information regarding route, directions, names of shops, instructions etc. Such a system shall also be used in automatic navigation systems, understanding environment for blind persons, content-based image search, object recognition, automatic indexing and scene understanding etc. Text detection and recognition are the main steps in such text-based applications.

Once the text is detected, the same must be located by drawing bounding boxes around the text as shown in Fig. 1. Thus, text localization gives an answer to the location of the text present in a scene image. The background information must be removed from the text regions or bounding boxes for better recognition. In text extraction, the foreground text is separated from its background. As the cameras attached to smartphones are of low resolution, enhancement of the text is also needed as the text region is of low resolution and is prone to noise. Also skew and slant corrections can be done at this stage to improve the recognition accuracy. Each word or text-line

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STUDIES ON MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

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Abstract:

AI-based techniques, such as machine learning, have already been established in the industry to achieve sustainable manufacturing as a result of intensive research efforts in the field. Thus, the purpose of this study was to conduct a systematic review of the scientific literature on artificial intelligence and machine learning (ML) in industry. Although artificial intelligence and

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COMPARATIVE STUDY OF MACHINE LEARNING AND DEEP LEARNING ALGORITHM FOR FACE RECOGNITION

Nikita Singhal[1], Vaishali Ganganwar[2], Menka Yadav[3], Asha Chauhan[4], Mahender Jakhar[5] and Kareena Sharma[6]

ABSTRACT

In the present world, biometric systems are used to analyze and verify a person's distinctive bodily or behavioral features for authentication or recognition. Till now, there are numerous authentication systems that use iris, fingerprint and face feature for identification and verification, where the face recognition-based systems are most widely preferred, as they do not require user help every time, are more automated and are easy to function. This review paper provides a comparative study between various face recognition techniques and their hybrid combinations. The most commonly used datasets in this domain are also analyzed and reviewed. We have also highlighted the future scope and challenges in this domain, as well as various Deep Learning (DL)-based algorithms for facial recognition.

KEYWORDS

1. INTRODUCTION

With the evolution of humans in every field of technology, there is a need to control who can access the place, machinery or information; so, we require an authentication system. There are many human authentication systems, such as signature, password, pin and biometric systems that have been developed. Face authentication systems have become popular as they doesn't disturb the privacy of the individual and there is no requirement to get in physical contact with the system, which helps in controlling the spread of diseases like viruses. Face authentication is defined as giving access to the authorized person; i.e., face identification problem. It is a two-step process; firstly face detection, which is the detection of the human face in the frame of the image or video and highlighting it by making a square around the face discarding the surrounding and secondly Face Recognition (FR), which means the face detected in the above step has to be verified with those present in the database and if there exists a match, then the person is authorized by the system; if not, then the owner can take the necessary measures. There are many factors the affect the FR algorithm, including physical factors (e.g. illumination, occlusion) as well as facial features (e.g. twins, relatives, pose and aging factor). The methods addressing all these issues have been surveyed in [1] by Mortezaie et al. To achieve the best results for FR, we also require expertise in the subject of psychology, so that we can study the feature characteristics of the face. Lots of work has been done on the FR from the standard algorithms, like Principal Component Analysis (PCA), Local Binary Pattern (LBP) to the latest DL methods, like Convolutional Neural Networks (CNNs).

The organization of the paper is as follows. In Section 2, we provide the main steps involved in the process of FR. In Section 3, we summarize the various FR algorithms based on ML and DL. In Section 4, we provide open challenges and directions for future scope and in section 5, we conclude the work.

2. STEPS INVOLVED IN THE PROCESS OF FR

FR can be considered as a way of authentication and verification. In this sence, a new unknown face is matched with various other faces present in the database which all have known entities. After this

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Automated Subjective Answer Evaluation System

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ABSTRACT

In this paper, we have studied LSTM (Long Short- Term Memory) network and presented a siamese adaptation of it for labelled data composed of variable-length pattern and pairs. Our model first takes in right answer and then assesses semantic similarity between the right answer and the given answer. In order to accomplish these we use word embedding vectors which are supplemented with synonymic information to the LSTMs. These vectors encode the expressed underlying meaning of the sentence which is of fixed size. The wording and syntax are also taken care of. We limit subsequent operations that rely on the simple Manhattan metric. The model's learned sentence representations are compelled to a highly structured space. The geometry of this space represents complex semantic relationships. Our results show that LSTM's can be really powerful language models and are especially suited to tasks which require intricate understanding.

Index Terms—RNN, LSTM, NLP

I.   INTRODUCTION

Examining and evaluating answer sheets are time-consuming testing tools for assessing academic achievement, integration of ideas, and recall; however, manually generating questions and evaluating responses is costly, resource-intensive, and time-consuming. Manual evaluation of answer sheets takes up a notable number of instructors, a lot of valuable time and so it is a high-cost task. Also, different security concerns regarding paper leakage is one of the other challenges to conquer. The goal of this project is to create an automated examination system using machine learning, the natural language toolkit (NLTK), and the Python environment, Recurrent Neural Networks and web technologies to provide an inexpensive alternative to the

A Comparative Study of Software Development Waterfall, Spiral and Agile Methodology

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Abstract

Software development methodologies are used for developing the simple to complex project. It gives the idea of how systematically projects are developed. It plays important role in software development in academics to industries. It helps to reduce the chances of project failure. The major development technics like waterfall, spiral and agile methodologies, their processes and comparisons shows that, how efficient development occur. The article used to present the study of these three software development methodologies. The main contribution to this work in study and comparing the methodologies. This study helps the software development in academics and industries to understand and comparison to choose the method according to the application.

Index Terms— Waterfall, Spiral, Agile and Scrum.

I. INTRODUCTION

The software development methodologies play a very important role in developing the project. Any small to complex software development require systematic flow from requirement to maintenance. It helps the group to develop the project in collaboration. There are many development methodologies, every method having pros and cons. some are traditional development and rest are evolutionary type. Every development technique is useful, but choosing the best technique is important considering the application. The selection is very important in terms of systematic development. If the application is very small and to be developed in weeks then the proper methodology is required, otherwise it will make a negative impact on development process, time and deadline skip. The unplanned or without the use of standard methodologies will make major chances of project failure. It can be observed in terms of satisfaction of customers. The chances that, customer may argue at the time of delivery of project about the quality and scope deviation. To avoid this, choosing of right methodologies will increase the chances of customer satisfaction.

Sensor based vehicle detection and classification – a systematic review

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Abstract: Traffic management has become a major problem in every country due to day by day increase of vehicles on road. With this enhancement, sometimes it becomes difficult to keep track of vehicles for the purpose of traffic monitoring and law enforcement. We need an intelligent transportation system (ITS) which will help in traffic management. In this study, we presented a review of the smart transportation system that focuses on vehicle detection and classification (VDC) that is generally used in applications like congestion prediction, future road infrastructure requirement prediction, automated parking, and security enforcement. We have reviewed more than 130 papers that are published between 2010 and 2021 and found that various sensor technologies, machine learning, computer vision and deep learning techniques have been applied for the detection and classification of vehicles by many researchers. This study will provide useful directions to the researchers in selecting appropriate technologies for VDC.

Keywords: vehicle detection; vehicle classification; intelligent transportation system; sensor; machine learning; deep learning.

Biographical notes: Nikita Singhal is an Assistant Professor in the Department of Computer Engineering, Army Institute of Technology, Pune. She is pursuing her PhD in CSE from SAGE University, Indore and received her MTech in Computer Science and Engineering from Defence Institute of Technology (DU), Pune. She has more than ten years of academic and research experience. Her research interests include deep learning, image processing and computer networks security.

Lalji Prasad is a Professor of Computer Science and Engineering at SAGE University, Indore. He received his PhD in Computer Science and Engineering from the Rajiv Gandhi Proudyogiki Vishwavidyalaya in Bhopal, India, and ME in Software Engineering from IET DAVV. He has more than 20 years of academic and R&D experience. He is a reviewer in various reputed journals. His research interests are in the areas of computer vision, deep learning and, software engineering.

1 Introduction

As day by day number of vehicle increases on-road, posed a serious problem of traffic congestion and management. Many a time people face traffic jams and due to this congestion, people do not follow traffic rules and regulations due to which personal injury, death, and damage to one's vehicle or other property takes place. ITS plays an important role in handling common traffic issues such as accidents, congestion of traffic, vehicle robberies, traffic rule violation, automatic toll collection and so on. That's why ITS attracted lots of researchers in the last decade and became an important area of study. Vehicle detection (VD) and classification is the heart of ITS which is widely used in effective traffic operation and transportation planning.

Various VDC systems have been developed on the basis of innovative sensor-based technologies, machine learning (ML), image processing, deep learning (DL), and wireless communication technologies. In this study, we present a review of smart traffic systems that focuses on the performance of VDC to provide insight and guidance on the choice of the right technology. The contributions to this study are as follows:

- This study focuses on the discussion of various research issues related to models and methods for sensor based VDC systems.

- This study provides the extensive application of ML and DL models in VDC system.

Blockchain Driven Secure and Efficient Logging
for Cloud Forensics

Sagar Rane[1], Sanjeev Wagh[1, 2] and Arati Dixit[1, 3]

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Abstract: Cloud computing is one of the most holistically used technology nowadays. To do the forensics in the cloud, it is essential to accumulate as well as safeguard the justifiable facts of different events to find out the culprit. However, logging the events that take place in the cloud and securing them while preserving the privacy of cloud consumers is a big challenge. Currently, cloud consumers are relying on cloud service providers to get the logs of events that take place on their data despite multi-stakeholder collusion. Thus, there is a strong requirement of publicly verifiable secure logging which will play a vital role in criminal investigations without depending on a third party. In this paper, we developed a Blockchain-driven Secure Logging-as-a-Service (BlockSLaaS) scheme that supports, privacy-preserving secure logging and eclectic verification. To make a serene forensic investigation, the proposed scheme guarantees the trustworthiness and reclamation of logs in case of tampering. The scheme proposes integrating the Interplanetary File System (IPFS), a decentralized off-chain data storage platform with blockchain for efficient logging and its visualization. The extensive experiments on the number of transactions, storage requirement, uploading, reading, and downloading of log files for varying node count and file size are performed. The proposed method is compared with nine existing methods based on 9 security and performance features. The response, proof insertion, and proof-verification times of the proposed BlockSLaaS are 38.3, 29.7, and 26.3 milliseconds respectively which outperform the existing methods.

Keywords: Blockchain, Cloud Computing, Cloud Forensics, Secure and Efficent Logging, Forensic Investigation.

1. INTRODUCTION

Today, cloud computing services are widely used in various industries due to a tremendous efficiency of cost over conventional storage services [1] [2]. Currently, the market of cloud-based data storage is on the upsurge due to the successful espousal of cloud facilities in almost all companies. In India, cloud computing market will be valued at seven billion dollars by 2022 and expected to cross 1 trillion dollars by 2025 globally as per the NASSCOM report [3] [4]. However, the shift from onsite storage techniques to cloud storage services is a big challenge due to the rise in the issues of data security [5-11]. Certain malevolent cloud consumers can utilize the cloud storage to stock illegitimate information including but not limited to stolen Intellectual Property Rights (IPR) documents, pornographic content, and contraband documents or can target other cloud consumers by hosting the malware injection attacks, denial of service attacks, wrapping attacks, structured query language injection attacks, abuse and hijacking of services on cloud computing environment [12]. Once the attackers accomplish the unethical goal, they can smoothly wipe out the hints, traces, and remain unidentified [13] [14]. Therefore, there is a strong requirement of procedures and scientific methods to ensure trustworthiness and confidentiality of data in cloud computing environment for effective forensic investigations [2] [15]. Consequently, a new branch of forensics came into existence i. e. Cloud Forensics. Federal Bureau of Investigation (FBI) report of 2017 on internet crime statistics depicted that, over 3 lakh online misconduct complaints have been registered which amounted to around fifteen thousand-million-dollar loss in the year of 2017 itself [12]. The count of digital forensic belongings is on the upsurge [16]. The existing forensic methods and techniques cannot be applied to the cloud directly due to the nature of the cloud. Also, they require to be modernized to be competent and suitable for the cloud environment [6] [15]. In cloud computing, virtual

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Enhancement of cloud performance metrics using dynamic degree memory balanced allocation algorithm

Aparna Shashikant Joshi, Shayamala Devi Munisamy

Abstract

In cloud computing, load balancing among the resources is required to schedule a task, which is a key challenge. This paper proposes a dynamic degree memory balanced allocation (D2MBA) algorithm which allocate virtual machine (VM) to a best suitable host, based on availability of random-access memory (RAM) and microprocessor without interlocked pipelined stages (MIPS) of host and allocate task to a best suitable VM by considering balanced condition of VM. The proposed D2MBA algorithm has been simulated using a simulation tool CloudSim by varying number of tasks and keeping number of VMs constant and vice versa. The D2MBA algorithm is compared with the other load balancing algorithms viz. Round Robin (RR) and dynamic degree balance with central processing unit (CPU) based (D2B_CPU based) with respect to performance parameters such as execution cost, degree of imbalance and makespan time. It is found that the D2MBA algorithm has a large reduction in the performance parameters such as execution cost, degree of imbalance and makespan time as compared with RR and D2B CPU based algorithms

Keywords

cloud computing; CloudSim; degree of imbalance; load balancing; task scheduling;

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Sarcasm detection of tweets without #sarcasm: data science approach

Rupali Amit Bagate, R. Suguna

Abstract

Identifying sarcasm present in the text could be a challenging work. In sarcasm, a negative word can flip the polarity of a positive sentence. Sentences can be classified as sarcastic or non-sarcastic. It is easier to identify sarcasm using facial expression or tonal weight rather detecting from plain text. Thus, sarcasm detection using natural language processing is major challenge without giving away any specific context or clue such as #sarcasm present in a tweet. Therefore, research tries to solve this classification problem using various optimized models. Proposed model, analyzes whether a given tweet, is sarcastic or not without the presnece of hashtag sarcasm or any kind of specific context present in text. To achieve better results, we used different machine learning classification methodology along with deep learning embedding techniques. Our optimized model uses a stacking technique which combines the result of logistic regression and long short-term memory (LSTM) recurrent neural net feed to light gradient boosting technique which generates better result as compare to existing machine learning and neural network algorithm. The key difference of our research work is sarcasm detection done without #sarcasm which has not been much explored earlier by any researcher. The metrics used for evolutionis F1-score and confusion matrix.

Keywords

Dataset; Deep learning; Hashtag; LSTM; Machine learning; Neural network; Sarcasm detection

Mathematical Problems in Engineering

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Machine Learning Model for Group Activity Recognition Based on Discriminative Interaction Contextual Relationship

Smita S. Kulkarni ✉ [1,2] and Sangeeta Jadhav [3]

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Academic Editor: Essam Houssein

Evaluating the performance of load balancing algorithm for heterogeneous cloudlets using HDDB algorithm

Aparna Joshi ✉ & Shyamala Devi Munisamy

Abstract

Load balancing is the major concern in cloud computing where number of requests have to be handled by cloud resources. The load balancing techniques distribute the workloads among

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Multiclass cyber-attack classification approach based on the Krill Herd Optimized Deep Neural Network (KH-DNN) model for WSN

Samleti Sandeep Dwarkanath and R. Aruna

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Abstract

The Intrusion Detection System (IDS) is a useful infiltration detection tool. With IDS,

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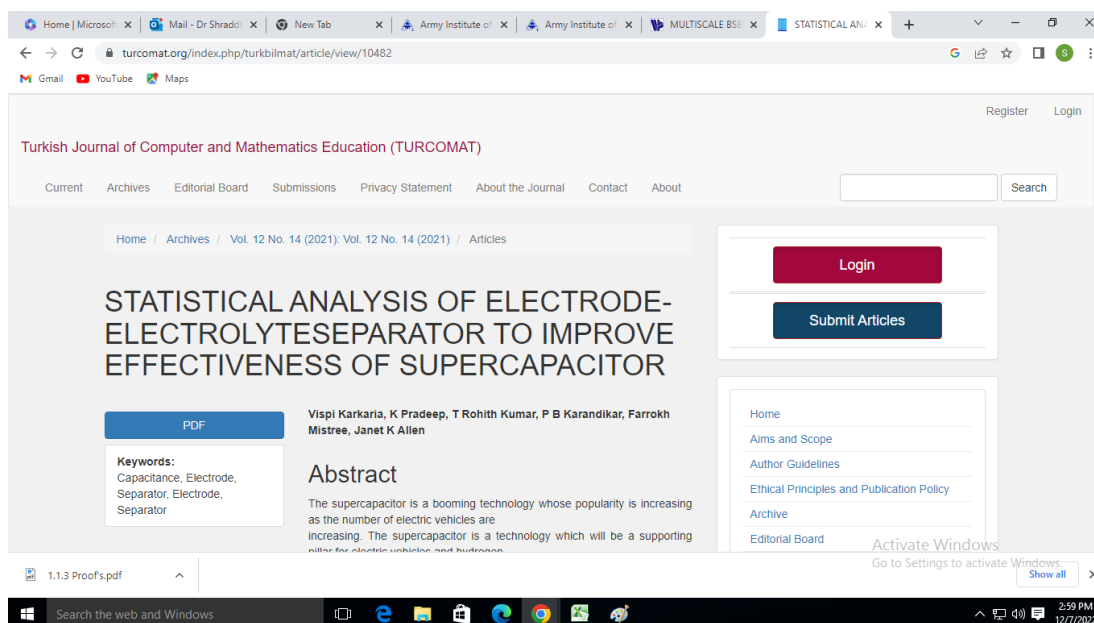**3.3.2 Number of research papers per teachers in the Journals notified on UGC website during the year**
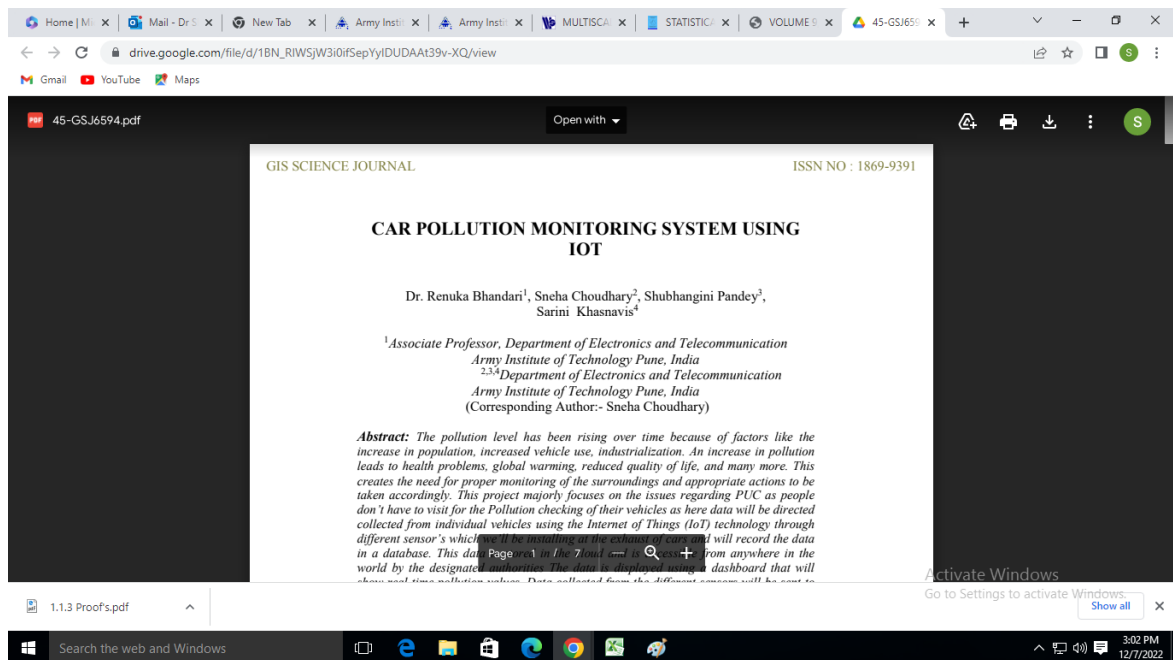
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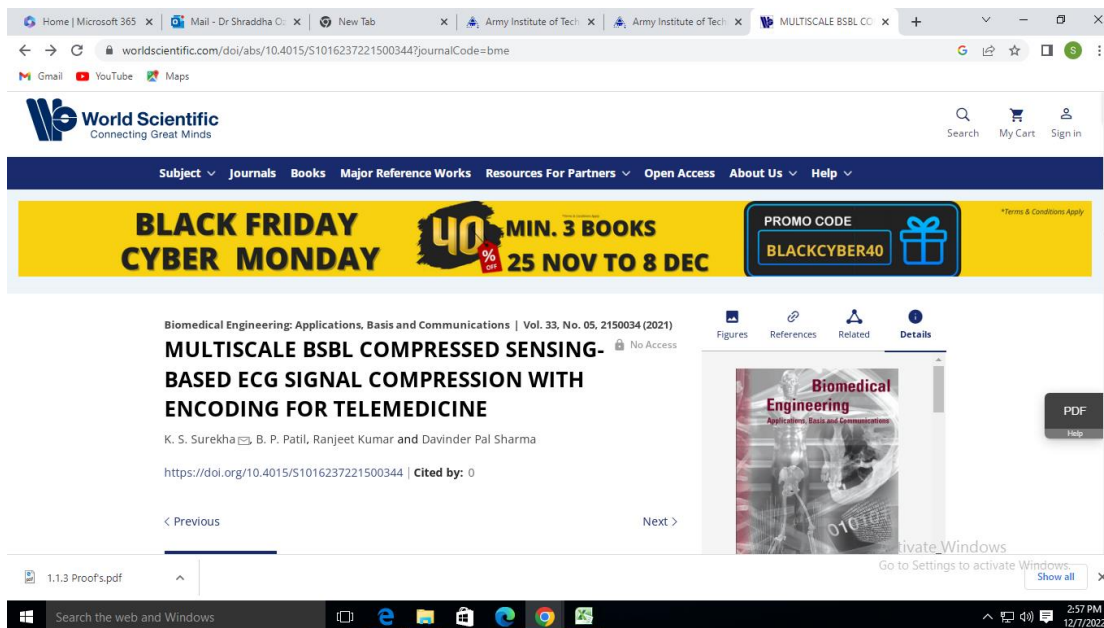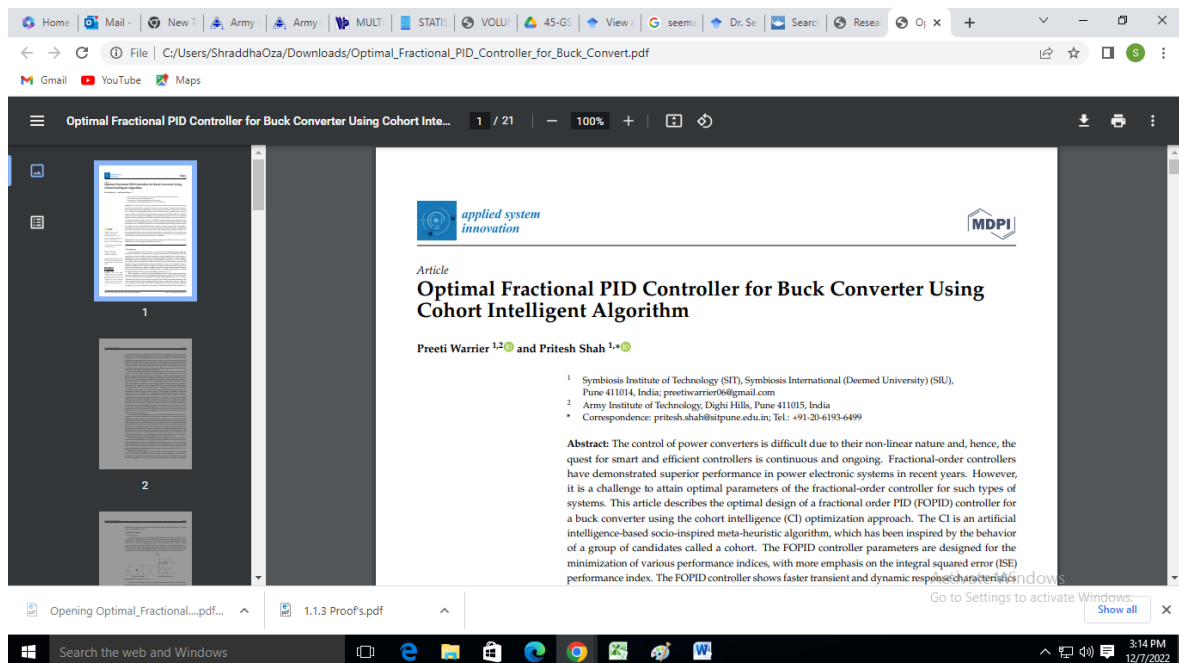

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5. A Comparative Study of Software Development Waterfall, Spiral & Agile Methodology.by Shilpa Ppawar

Exhaust Heat Recovery System using Organic Rankine Cycle (ORC) Technology: A Comprehensive Investigation

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ABSTRACT

The Organic Rankine Cycle (ORC) systems are well known as the advanced available method to develop mechanical or electrical energy.Continuous developments are undergone to develop new methods to improve the efficiency.In these systems, the organic fluids with medium temperatures are usually used to generate power.Large amount of exhaust gases and waste heat are generated in industries which are usually discharged into the environment.This heat is recovered and taken as input by the ORC system and used effectively in various processes.Earlier, only the low and medium temperature fluids were only used but now even high temperature working fluids are used for this purpose.This paper represents the technological and economic advances in the ORC technology to reuse the unwanted energy produced from various places and convert it into useful electrical or mechanical energy which can be used further.

Keywords:*Thermal energy, Organic fluid,ORC cycle, Waste heat recovery, Energy storage, Economical advancement*

1. INTRODUCTION

Organic Rankine system (ORC) was discovered on 1950s which was used to convert the low temperature energy into power.The working of the system depends on the fluid used as well as process undergone.The heat is recovered from the organic systems like biomass combustion, solar ponds and so on [1]. One of the significantimplementationsof ORC is the recovery of heat from exhaust of automobile engines which is one of the major causes for air pollution [2]. ORC have high range of promising heat recovery with huge potential market.They are preferable for low or medium heat sources which is reliable, and it can be easily accessible than steam Rankine cycles (SRCs) [3].Thisdevelopment emerged from SRC technology with both having same principle[4, 5].In case of SRCs the fluids used are mainly coal, oil combustion etc but in case of ORC it is usually organic fluids.Apart from this the former SRCs are used mainly in large power plants because the power generated will be high.While in case of later one the high temperature leads to the decomposition of organic fluids used[6-8].

Now-a-days the implementation of public power generation system based on sustainable methods becomes a necessary project to safeguard our environment.In this sense,the ORC plays an important role in generating electricity from renewable energy sources [9, 10]. In recent years, the use of this technology has spread worldwide with an average power generation of about 0.2 to 2.0 MW.The main aim is to generate economical,safer,non-toxic,inflammable,eco-friendly process.

2. ORGANIC RANKINE CYCLE (ORC): Working Principle

This is closed loop in which the working-fluid continuously flows inside loop to convert the waste heat generated to useful power[11, 12]. The selection of evaporation process is the initial stage;the waste heat generated is captured by the system which is used to increase the temperature of fluid passing through the device.Then the process of evaporation occurs, and this vapour is allowed to pass via the expander in which the mechanical or electrical power is produced.After that it is condensed into liquid form with the help of condenser.Finally, a pump compresses the fluid back into the system and energy is used as power.Thisis the operating principle of ORCs[13,14]. The working principle is same as SRC, but the fluid is organic in nature with low boiling point instead of liquid water [15].

3. WORKING FLUID REQUIREMENTS

This is mainly based on the temperature that needs to be used in the system.Apart the fluid selected should not cause much harm to the environment that is it should never contribute to ozone layer depletion and other natural calamities.Along with this the

The Grid Connected Roof Top Solar Project in Army Institute of Technology; a Case Study

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Army Institute of Technology, Dighi, Pune

Abstract: Educational Institutions are often under pressure for cost cutting. Electricity charges, especially in a residential institution, is one of the biggest drain on finances. In this case study, we would like to discuss the grid connected roof top solar project in Army Institute of Technology (AIT), Dighi, Pune. This 350 kW system has been installed without any cost to AIT, on Build-Operate-Transfer (BOT) model, for 25 years at the rate of Rs 6/- per electricity unit. The power generated by the system is approximately 1000 to 1200 electricity units per day as against a requirement of about 1800 to 2000 electricity units per day. Net Metering Policy implemented by Maharashtra Government enables AIT to send excess electricity generated during day time back to the grid. This excess power given to the grid is credited back during night time. A new Net Meter has been installed in AIT that provides daily status of the power import/export. This has resulted in Cost Savings of nearly Rs 1,50,000/- per month which comes close to Rs 18,00,000/- per annum.

Keywords: AIT, Build-Operate-Transfer, cost cutting, grid, roof top, solar

1. Introduction

Army Institute of Technology, Pune (AIT) which is located at Dighi on Alandi road, in Pune, is one of the reputed undergraduate engineering college. It is affiliated to the Savitribai Phule Pune University (SPPU). AIT is established only for the wards of Army Personnel, by a special permission from the Supreme Court of India. AIT functions under the patronage of the Army Welfare Education Society (AWES). As AIT is intended to be a residential college, with more than 1300 students staying on its campus, it attempts to be self-contained. The most important building and by far the largest in AIT, is the Academic Block, which accommodates most of the lecture halls and laboratories, some of which are airconditioned, offices for the administration and an auditorium. Since AIT is a residential college, it has separate hostels for girls and boys, as well as staff quarters, on its campus. There are various shops for common household products, messes and cafeterias, along with an ATM of the HDFC Bank. Sports are encouraged in AIT and the campus has well maintained basketball court, a cricket ground, a volleyball court, a tennis court, a football ground, a badminton court, separate gym for girls and boys, a croquet lawn and two squash courts. AIT also has some popular indoor sports like chess, pocket billiards and table tennis. AIT library and the reading rooms are open to all staff and students for 18 hours a day.

As can be deduced from above, electricity is consumed to a great extent in day to day functioning of the institute.

In teaching and learning also there has been a major shift towards usage of ICT tools. Increased usage of technology both in teaching and learning and in everyday life has resulted in increased dependence on electricity.

Further, the electricity price has been rising steadily. This had become a substantial burden on the institute's resources, especially since AIT is a residential, self-sufficient institution.

The institute brainstormed for a strategy with a goal to move towards a cheaper and more sustainable energy source, possibly with lesser carbon footprint.

The solution to the above mentioned problem was found in the Grid Connected Roof Top Solar Power Generator (Nwaigwe et al 2019; Tobnaghi 2016; Chang and Tao 2013; Khyani, and Vajpai, 2014; Meena et al, 2014). A typical diagram of rooftop solar system is shown in Fig 1.

Solar energy is the least expensive amongst all sources of renewable energy and it is available in abundance and free of cost in most of the regions in the world (Kabir E., Kumar P., Kumar S., Adelodun A. A., Kim K., 2016; Kannan and Vakeesan 2016; Wiginton et al 2010).

As per Ministry of New and Renewable Energy, Government of India, a road map for generation of solar power till 2022 is 1,00,000MW. Out of this 40,000MW is dedicated for solar rooftop projects only. (Source: https://mnre.gov.in/img/documents/uploads/cf28af553bf04afe87a972e4aba0987a.pdf)

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ENERGY RESEARCH WILEY

SHORT COMMUNICATION

Electrodeposited bimetallic microporous MnCu oxide electrode as a highly stable electrocatalyst for oxygen evolution reaction

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Summary
Bimetallic electrocatalysts have attracted great importance and they have proved themselves as a promising strategy for high-performance electrocatalysis. They offer the synergetic effect between different elements and structural modification to enhance the electrochemical surface area (ECSA) and conductivity. In this study, efficient nonprecious bimetallic electrocatalysts of $Mn_{1-x}Cu_x$ oxide ($0.15 \leq x \leq 0.75$) have been synthesized using a simple and cost-effective electro-deposition technique. The effect of compositional ratios between Mn and Cu on the electrochemical properties has been systematically investigated. The dramatic change of morphology upon composition variation suggests the alteration of ECSA, which is an important factor for electrocatalysis. The optimized $Mn_{0.50}Cu_{0.50}$ catalyst exhibits a low overpotential of 291 mV to reach a current density of 10 mA cm^{-2} with a low Tafel slope of 54.6 mV dec^{-1}. It showed ultra-high stability at a very high current density of 500 mA cm^{-2} in alkaline media. The enhanced catalytic activity of $Mn_{0.50}Cu_{0.50}$ electrocatalyst is associated with the enhanced ECSA, formation of porous morphology, which facilitates the diffusion coefficient, and enhanced electronic conductivity. Overall, Mn-Cu is one of the best capable electrocatalysts for oxygen evolution reaction, which confirmed abundant potential in realistic applications.

KEYWORDS
electrocatalysis, electrodeposition, Mn-Cu oxides, oxygen evolution reaction, thin film

1 | INTRODUCTION

The rapid progress and innovation of industrialization, transportation, and engineering culture force the extreme utilization of fossil fuels. Moreover, the increase in population and huge energy demands exhausted the available energy technologies. Thus, the excess use of fossil fuels creates a serious environmental issue and climate change, which is unsafe to the entire ecosystem on the earth.[1,2] Therefore, it has become a challenging issue for researchers to develop green technology using abundantly available air, sun, and water on the Earth's crust.[3] Recently, hydrogen has attracted much attention because of its advantages such as zero carbon emission, high conversion efficiency, high energy density, and good recyclability.[3,4] Recently, the fuel cell technology and

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